Occupational class and health: The differentials in mortality, morbidity and workplace injury rates by occupation, education, income and working conditions in Korea

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by

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Abstract

Background: health differentials between socio-economic classes and increasing general inequalities in health have become worldwide concerns. However, little research has been carried-out concerning inequalities in health in developing countries.

Objective: this thesis explores the relationship of occupation, education, income and working conditions to mortality, morbidity and workplace injury rates in Korea, focusing on the association of occupational class with health inequalities.

Methods: the study uses existing Korean national data on occupation, socio-economic factors, mortality, morbidity and workplace injuries, along with a cohort for workplace injury analysis in a Korean car factory. SMRs, PMRs, Poisson regression, logistic regression, multilevel and Cox regression analyses are used to explore the relationship of occupation, education, income, health behaviours and working conditions with mortality, morbidity, and injury rates. In-depth interviews and walk-through surveys are undertaken in order to gain insight into working conditions, focusing on increases in work intensity in one car factory.

Results: we show that occupational class is strongly related to mortality, morbidity, and deaths due to workplace injuries, for both male and female workers in Korea. We also conclude that there is an inverse relationship between education and mortality, as well as between education and income and morbidity and deaths due to workplace injury. After adjusting for education, the occupational effect on mortality and morbidity reduces. In the particular car factory used in the study, workers in the press and body welding departments, and those working at the conveyer line and doing shift work, suffer significantly higher injury rates. We note, in particular, an increasing incidence of lower-back pain, especially HIVD, from 1995 to 1997. In-depth interviews and walk-through surveys indicate that this was a period in which work intensity increased significantly.

Discussion: This study has a data quality limitation, a numerator-denominator bias is possible, as variables from the secondary data were not collected specifically for this piece of research. Nevertheless, we suggest that education has an influence on occupation, which in turn influences material living conditions and health inequalities in Korea. It appears that occupation and education are stronger determinants of health in Korea than in other European countries.

Contents

List of tables

Chapter 2: A review of the literature on health differences according to occupational class, socio-economic status and working conditions

Chapter4: Occupational class and mortality

Chapter 5: Occupational class, chronic disease and perceived general health

Chapter 6: The role of occupation, education and income in deaths due to workplace injury in Korea

Chapter7: Working conditions, socio-economic factors and injury rates in one car factory

Chapter 8: A comparison of variable values between NSO death data and WELCO death data due to workplace injury

List of figures

Acronyms

CVA : Cerebro Vascular Artherosclerosis

HIVD : Herniated Inter Vertebral Disc

NAC : New Autonomous Concept

NSO : National Statistics Office

SMRs : Standardised Mortality Ratios

PMRs : Proportionate Mortality Ratios

WELCO: Korea Labour Welfare Corporation

KSCO: Korean Standard Classification of Occupations

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Chapter 1: Introduction

1.1 Inequalities in health: a widening gap?

Substantial social inequalities in health have been shown to exist in all the countries which have set out to assess the scale of the problem (Drever and Whitehead, 1997). A widening of these inequalities has been demonstrated over recent decades in several countries: UK, USA, Finland, Sweden (Hart, 1986; Pamuk, 1985; Valkonen, 1993; Diderichsen, 1997). As the Black Report (1982) points out, material deprivation based on class differentials may be a key factor in inequality in health. Nevertheless, since the publication of the Black Report, this mechanism or causal pathway has rarely been investigated (Davey Smith et al, 1994).

While most studies of inequalities in health have focused on European countries and the USA, there has been little such research in other countries. In developing countries, several studies on intra-urban differentials and health at local level began in the early 1980s, especially in Latin America (Stephens, 1995). However, a broader picture of the relationship between socio-economic factors, especially occupational class, and health, taking into account whole national populations, has not been developed either in most developing countries or in rapidly industrialising countries such as Korea. Given that Korea has an emerging economy and an industrialisation drive based largely on a low-waged workforce[1] and extended working hours, social inequalities in health are likely to be that much greater. The present study, therefore, initially attempts to develop an enquiry into the relationship between occupational class and health in Korea. In particular, it aims to investigate the relationships between socio-economic factors (such as occupation, education, income), health behaviours and work conditions (work department, shift work, conveyer work, work intensity) and mortality, morbidity and workplace injury deaths among the Korean population. It focuses on workplace injury in one car factory as a way of clarifying the issues involved at a practical level.

[1] Williams K et al (1994) mentioned that low wages were and are the secret of success for Asian new entrants such as Korea (p13).

1.2 What are the main causal relationships in health inequalities?

Many researchers have used 'occupation' as an index of social class and have shown the widening gap in mortality and morbidity rates between manual workers or those in lower social class groups and those in higher social class groups, especially managers (Black Report, 1982; Pamuk, 1985; Marmot and McDowell, 1986; Diderichsen and Hallqvist, 1997; Tuchsen and Endahl, 1999). However, it is our contention that interactions between occupational class and other socio-economic factors need to be investigated further. Many studies have also reported that less well-educated groups have higher mortality and morbidity than the better educated. Again, however, the exact nature of the associations between education and other socio-economic factors have not yet been fully developed. Thus, differences in educational level among and between social classes may be greater in rapidly industrialising country like Korea. Therefore, further study needs to be focused on the relations between social class and education. Also, the understanding of educational variables should be explicitly focused on the relation to 'class' rather than separate issues. The inverse relationship between income and mortality (Kaplan et al, 1996; Kennedy et al, 1996; Duncan et al, 1996), and between income and workplace injury deaths (Baker et al, 1992) has been reported. Recently, important debates concerning the relationship between income and inequality in health have occured around the question of whether relative or absolute income should be taken into account (Wilkinson, 1996; Davey Smith, 1996; Kaplan, 1996; Muntaner and Lynch, 1999; Black Report, 1982). However, as the latter proposes, relative as well as absolute poverty need to be considered. In particular, on a global scale, absolute material deprivation does not seem to have been reduced in especially deprived areas. Thus, further study is needed if we are to understand in detail, the pathways of absolute and relative income inequality in health in relation to social class and material deprivation.

Little research has been developed in the relationship between social inequalities in health related to work and working conditions. Also, most traditional occupational epidemiologists have focused upon individual worker's characteristics or job tasks. The prevailing ideology describes working conditions as a miscellaneous collection of the 'physical' and 'social' features of a particular job (Sass, 1986). Yet, as Sass points out:

"the reality of the situation is just the opposite: the social organisation or work produces both the job and its environment (p574)".

Even though several studies in the area of social epidemiology have focused on the psychological aspect of working conditions and socio-economic status (Theorell, 2000; Marmot and Theorell, 1988), these studies cannot explain how psycho-social factors appear in relation to class in the workplace and how psychological factors are related to physical working conditions. Indeed, few pieces of research have been able to exhibit the precise relationship between 'physical[2] working conditions' and socio-economic factors in inequality in health. Nevertheless, several studies have pointed out that the intensification of the working day has increased due to increased exploitation during the labour process in contemporary capitalist society (Braverman, 1974; Nichols, 1996; Grunberg, 1983; Fucini and Fucini, 1990; Moody, 1997; Danford, 1999; Graham, 1995; Rinehart et al, 1997; Delbridge, 1998). Also, several studies have shown that the intensification of labour increases workplace injury rates (Grunberg, 1983; Nichols, 1997; Novek et al, 1990).

In addition to this, several researchers have described how the intensification of the working day impacts on workers' health and how workers themselves have felt about this process (Graham, 1995; Fucini and Fucini, 1990; Kenney and Florida, 1993). In Korea, workers in most large-scale industries have experienced this intensification as an increase in the pace of work and a reduction of the numbers of workers employed in particular sectors since the early 1990s (Kang et al, 1996; Park et al, 1996). It is evident that employers in rapidly industrialising countries such as Korea, having to compete with larger, multinational capitalist enterprises, throw the burden of this competition onto the workers. Consequently, specific ailments such as repetitive strain injuries along with injury rates in general have increased in several large car companies in Korea (Kang et al, 1996; Park et al, 1996). Despite or rather because of this, more detailed investigation into the mechanisms through which working conditions impact on workers' health and how these are related to socio-economic conditions needs to be carried-out. It is in this light that we will argue that, even though studies on inequality in health have developed

[2] Physical working conditions means the working conditions which need higher physical load and manual work rather than psychosocial factors

several different points of view, the concept of 'social class' is fundamental to any study of inequality in health. Furthermore, research geared towards the interaction between socio-economic variables (occupation, education, income and material deprivation) on ill-health is needed. And this research needs to be extended to the study of how class relations of exploitation in capitalist economies are related to inequalities in health in the workplace.

1.3 How does this study fill the gap in this area of research?

This study attempts to fill the gap which we have identified in contemporary studies on inequality in health in several senses. Firstly, this is the first attempt to explore the relationship between occupational class and mortality, morbidity and workplace injury deaths across the entire Korean population. Secondly, we explore the interaction between different socio-economic factors, such as occupation, education, income, and deprivation as they affect mortality, morbidity, and workplace injury deaths. Also, the role of health behaviours in the relationship between socio-economic factors and ill-health in Korea is considered. Thirdly, we explore the relationship of working conditions, focusing on work intensity and socio-economic factors with workplace injuries.

Our study may be useful from several points of views: firstly, the approach adopted in this thesis concerning the issue of health inequality in rapidly industrialising countries such as Korea may serve as a starting point for other studies concerning widening inequalities in health. Secondly, the methods utilised in our study may add to the understanding of the role of working conditions, especially work intensity, on the relations between class and health in the workplace. It may help others to understand the detailed causes of workplace injury by taking on board workers' own views in the light of the relationship between employers and workers.

1.4. Organisation of this thesis

The thesis is organised into nine chapters. In Chapter 2, the relevant epidemiological literature on socio-economic status, work and health is investigated. Chapter 3 deals with the hypothesis and objectives of the thesis. In chapter 4, the relationship between mortality and occupational class and education across the entire Korean population is discussed. Chapter 5 presents an overview of the complex relations between occupation, education and income as they impact on morbidity rates together with a description of the role of health behaviours in the relationship between socio-economic factors and morbidity in Korea. Chapter 6 deals with occupation, education and income as they affect deaths due to workplace injury among the Korean working population. Along with this, Chapter 6 also discusses the role of factory size in the relationship between socio-economic factors and deaths due to workplace injury. Chapter 7 concentrates on the relationship between working conditions and socio-economic factors and non-fatal, workplace injuries in a particular Korean car factory. We here highlight the role of increased work intensity, as described by workers themselves, as a key causal factor in workplace injuries. Chapter 8 gives a comparison of values of variables (occupation, education, cause of death) between two different sources of data for the validity of variables used in this study. Finally, we present our general conclusions, interpretation and our view of the implications of the study in chapter 9.

1.5. Timing of study in relation to Korean Economic crisis

The data for national mortality (Chapter 4), national morbidity (Chapter 5) and the data for workplace injuries in one car factory (Chapter 7) were collected before the economic crisis in November 1997, when Korea was near full employment. The data for death rates due to workplace injuries (Chapter 6) among Korea's working population included those in 1998, just after the economic crisis. The qualitative study in one car factory to investigate the causes for increasing work intensity in the labour process (Chapter 7) was conducted after the economic crisis, while tracing the historical process of how work has changed since the beginning of the 1990s.

Chapter 2: A review of the literature on health differences according to occupational class, socio-economic status and working conditions

This study investigates the relationship between occupational class and health. To extend our understanding of relations of occupational class and other related leading causes with health differentials, other socio-economic factors (education and income) and working conditions (department, work intensity, factory size, job status) need also to be considered. We turn, therefore, to a review of the literature on the impact of socio-economic factors and working conditions on differential health outcomes.

2.1 Development of studies on inequalities in health

Studies on inequalities in health have been undertaken since the industrial revolution; most have been concerned with social or occupational class. Since 1837, in the UK, the relationship between social class - a conception constructed on the basis of occupational criteria - and death has been reported in the Registrar Generals' *Decennial Supplements* (OPCS, 1986 and 1995). Concern over health inequalities in Britain has increased since the publication of Black Report in 1980. One might wonder why such concerns have increased in this period? Perhaps because evidence on widening differentials has been accumulating; perhaps, too, the phenomenon of increasing inequality in health outcomes is international in scope (Drever and Whitehead, 1997). Yet, while this issue has been widely discussed in many Western societies, it has not received the same attention the developing or rapidly industrialising countries.

Several studies have utilised a longitudinal approach and have reported that inequalities in mortality or morbidity across classes widen even though over the past several decades death rates have declined. According to Hart (1986), there is strong evidence to support the claim that differentials between social classes in the UK have widened over time. Fox et al (1985) show that differences in UK mortality rate between classes I and V widened during the decade between 1971 and 1981. Marang-van de Mheen et al (1998) found that the reason for the greater increase in social class differentials over time in Scotland is the greater decrease in death rates among privileged social groups, in combination with a smaller decrease in the death rates among under-privileged social groups. Guberan and Usel (1998) also report an upward trend in incidences of permanent work incapacity and mortality rates among the lower classes. In the US, Pappas et al (1993) prove that the inverse relationship between mortality and socio-economic status was more pronounced in 1986 than in 1960. Pamuk (1985) also notes how inequality in US mortality rates between social classes increased during the 1950s, '60s and early 1970s.

Several studies show that health inequalities exist in all European countries (Mackenbach et al, 1997; Kunst et al, 1998a and 1998b). It is also evident that European differentials have also been increasing. Valkonen (1993) reports a widening of mortality differentials according to occupational class between 1971 and 1985 in Finland. Diderichsen and Hallqvist (1997) reveal that the rate ratio of total mortality between Swedish industrial workers and professional and managerial staff increased from 0.86 in 1961-65 to 1.33 in 1986-1990. It is worth noting that this occurred in a society which was experiencing a narrowing of income differentials and relatively low unemployment. Similarly, Tuchsen and Endahl (1999) report that social inequality in Ischemic Heart Disease (IHD) has been rapidly increasing in Denmark.

Important as this work undoubtedly is, it is worth noting that most studies on inequalities in health across occupational class have focused on European countries and USA, the so-called 'developed countries'. Few studies into such differentials have been undertaken in other parts of the world. While a concern over the relationship between poverty and health differentials in intra-urban environments has been a focus of study in developing countries, these studies mostly focus on the problem in confined urban areas where levels of urbanisation have been increasing rapidly since the 1980s (Stephens, 1995). Thus, there is a need for research on inequalities in health across occupational classes in the whole population in non-Western countries.

2.2 Inequality in mortality and morbidity by occupational class, education, income and deprivation

2.2.1 What are the leading causes of differentials of mortality? Occupation, education, income and deprivation and the role of health behaviour

2.2.1.1 Occupational class

As tables 2.1 and 2.2 show, most research focuses on social class based on occupation. Using this occupational classification, comparing manual and non-manual workers, the Black Report (1982, p15) shows that inequalities in health increased for adults of working age between 1931 to 1971. Marmot and McDowell (1986) also report a widening health gap between manual and non-manual occupational classes between 1971 and 1983. Many other studies confirm such an increase (Pamuk, 1985; Diderichsen and Hallqvist, 1997; Tuchsen and Endahl, 1999). Kunst et al (1998a and 1998b) find that mortality from all causes is higher in manual than non-manual social classes in 11 European countries; rate ratios for total mortality are between 1.33 and 1.44. Moreover, mortality differences from IHD are strongly related to occupational class in England and Wales, Ireland, Finland, Sweden, Norway and Denmark. For France, Switzerland and Mediterranean countries, cancers made a large contribution to class differences, with rate ratios of between 1.18 and 1.71. Mackenbach et al (1997) show that the rate ratios for mortality among manual workers were between 1.3 and 1.7, compared to non-manual workers in 11 European countries.

As a socio-economic variable, occupation is based on social class schemes (Wright, 1989; Erikson and Goldthorpe, 1992; Ganzeboom et al, 1992). In Britain, an occupational grading system has been used to identify social class since 1913[1]. Wright (1989a and

[1] 'In 1913, Stevenson, the Registrar General (RG) applied to infant mortality rates around the 1911 census an eight-fold classification of father's occupation that was partly an occupational grading system and partly an industrial grading system (I. upper and middle classes; II. intermediate between I and III; III. skilled workmen; IV. intermediate between III and V; V. unskilled labourers; VI. textile workers; VII. minors; and VIII. agricultural workers' (Macintyre, 1997). The British General Social Class currently used in the UK are: I. Professional; II. Managerial and technical occupations (previously 'intermediate'); IIIN. Skilled occupations - non-manual; IIIM. Skilled occupations - manual; IV. Partly skilled occupations; and V. Unskilled occupations (OPCS, 1995).

1989b) and Erikson and Goldthorpe (1992) further develop the methodology for social class classification. Wright (1996) measures social class in terms of three factors: (i) ownership of capital assets; (ii) control of organisation assets; and (iii) possession of skill or credential assets (p149). Thus, he defines social classes as (i) capitalists; (ii) small scale employers; and (iii) wage labourers. Erikson and Goldthorpe (1992) categorise social class based on the following factors: (i) being an employer versus employee; (ii) having an employment contract of a service versus a labour type; (iii) performing manual work versus non-manual work; and (iv) working in an agricultural or non-agricultural setting.

According to the Black Report, occupational class has been used for many years as a convenient indicator of the standards of living and ways of life of different groups and has been used to represent social class. A person's named occupation is no more or less than a *pragmatic* guide to that person's social position and his or her likely command over resources. Townsend et al (1986) argue that:

> A specific occupation may indeed denote, within narrow limits, what a person's earnings are likely to be, and therefore what income he or she and the household are likely to have, what kind of home and area they are likely to live in, as well as the amount of wealth they are likely to possess, the education they are likely to have had and even the kinds of customs and leisure pursuits they are likely to pursue (p19).

However, this decidedly pragmatic method clearly has its limitations. One such shortcoming is that using socio-economic indicators based on occupational classifications may not capture disparities in working and living conditions across divisions of race/ethnicity and gender (Krieger et al, 1997). For example, the UK *General Household Survey* classifies married women according to their husband's occupational class and single women by their own occupation. The following problems arise from this approach:

(i) Classifying the 52% of married women who currently work outside the home in terms of their husband's occupation may conceal health hazards linked to their own employment;

(ii) Such classification schemes may conceal differences between housewives and the unemployed;

(iii) Women's earning may not be taken into account in calculations of the material resources at the disposal of a household;

(iv) Such approaches cannot be used for social groups outside of the recognised paid labour forces; such groups as the unemployed, homemakers, children and retired adults (Arber, 1989).

Recently, to overcome this limitation in using occupation[2] alone as the index of social class, several studies have suggested combining different indices. These include: area-based deprivation (Black Report, 1982; Castairs and Morris, 1989a, 1991; Townsend et al, 1986); area- and individually-based socio-economic data (Davey Smith, 1998); social class and other aspects of socio-economic position (e.g. income, poverty, deprivation, wealth, and education) and data collection at individual, household, and neighbourhood level (Krieger et al, 1997).

2.2.1.2. Education

Valkonen (1993) finds that differentials in mortality between Finnish educational groups shrank slightly in and after the mid-1970s, but grew clearly in the 1980s. Pappas G et al (1993) also report that poorly educated Americans have higher mortality rates than those of their compatriots with higher incomes and a better education and that this disparity increased between 1960 and 1986. Van Loon (1994) shows an inverse relationship between lung cancer prevalence and the highest level of education among people living in the Netherlands. Rosso et al (1997) finds that educated Italians of both sexes have better survival rates than their less well-educated fellow citizens for all malignant neoplasms and, particularly among men, for tumours which exhibit a better prognosis, such as cancers of the colon-rectum, larynx, prostate and bladder. Kunst et al (1994) shows that inequality estimates of total mortality by educational level from top to bottom among 35-44 year old men are between 0.72 (0.51-0.95) in the Netherlands and 2.62 (1.26-4.78) in

[2] Using occupation as a single indicator of social class has limitations. Firstly, occupational class may not fully encapsulate disparities in working and living conditions across divisions of gender and race/ethnicity. Secondly, occupation-based measures cannot readily be used for social groups outside of the recognised paid labour force: non-retired adults who are unemployed, homeworkers (chiefly women), persons employed in informal or illegal sectors of the economy, and also groups not expected to be in the active labour force: i.e. children and retired adults (*Black Report*, 1982; Krieger et al, 1997; Townsend et al, 1986; Castairs and Morris, 1989).

the USA. In this light, Davey Smith et al (1998) argue in a recent publication that occupational class is a better indicator of socio-economic position than education.

2.2.1.3 Income

Kaplan et al (1996) show that variations between US states in the distribution of income are significantly associated with variations between states in a large number of health outcomes, social indicators and mortality trends. Kennedy et al (1996) also report that income inequalities between US states are associated with increased mortality from several causes: infant mortality, coronary heart disease, malignant neoplasm and homicide. A 1996 review by Duncan suggests that family income is a powerful component in the linkage of socio-economic factors and poor health, as expressed in rates of low birth weight, cognitive development, stunting, early childhood wasting and mortality in later adult years.

Recently, a significant debate concerning the relationship between income and inequality in health has broken-out. The central point at issue in this debate is whether relative or absolute income should be the central focus of research in this area. Wilkinson (1989) concludes that trends in mortality differentials are not related to trends in class differences (as measured by average earnings), but are related instead to trends in relative poverty. Against Wilkinson's assertion (1996) that relative income and related psycho-social conditions are more important than absolute income in developed countries, many researchers argue that both absolute and relative deterioration produce poor health outcomes (Davey Smith, 1996; Kaplan, 1996; Muntaner and Lynch, 1999). The latter argue that Wilkinson's model ignores class relations and that this factor may well help explain how income inequalities are generated and account for both relative and absolute deprivation. The Black Report of 1982 had already 'replied' that relative poverty as well as absolute poverty is an issue in this area and further stressed that the material deprivation of some sections of the population can grow even when, paradoxically perhaps, their incomes increase, relative to changing structures and amenities. The important point here is that when the Report uses the term 'relative income', it refers to levels of lifetime income substantially below the average standard of life, not just relative to higher income.

2.2.1.4 Deprivation

Several deprivation indices have been developed (Townsend et al, 1986; Carstairs and Morris, 1991; Greater Glasgow Health Board, 1984; Hunt and McEwen, 1980; Jarman, 1983 and 1984). See Appendix I for more on this issue. The indices developed by both Townsend and Carstairs are specially designed to measure material deprivation and its link with health (see Appendix 1).

There has been a suggestion that using deprivation indices can overcome the limitation of using occupation as a single socio-economic indicator and can therefore contribute to illustrating the causes of health differentials. Carstairs and Morris (1989b) suggest that deprivation measures based on geographical areas overcome many of the limitations[3] associated with social class analysis in studies of the UK population. They also suggest (1989a) that gradients in mortality by social class and deprivation are so similar as to suggest that there is little to choose between them as a basis for explaining differences in mortality between populations. Moreover, they show a not inconsiderable association between the two measures, with more affluent areas having a higher proportion of persons in non-manual social classes and vice versa. In addition to this, Krieger et al (1994) point to two advantages when using area-based measures of social class: (i) area-based measures classify individuals by the characteristics of their neighbourhoods, allowing women and men to be classified by the same measure and can be applied equally well to infants and adolescents, employed and unemployed or retired adults; (ii) area-based measures allow assessment of the link between health and class conditions at the community level, a link that is all too often overlooked in individualistic societies such as the US.

Many researchers note the relationship between deprivation levels by area and health differentials. Carstairs and Morris (1989a) find that social class also exhibits gradients in mortality across UK deprivation categories; the corresponding rates in the most deprived category being around twice those in the most affluent area. Gradients by deprivation

[3] These limitations being: lack of homogeneity within a social class and changes in the allocation of occupations over time; methodological bias resulting from lack of agreement in recording occupation on the *Census* document and at registration of death; problems of interpretation due to the discrete nature of the classification; and the exclusion of large sections of the population such as women, retired or unemployed people.

category remain after standardising for differences in social class composition in Scotland. They also find (1989b) that deprivation is much more severe in Scotland than in England and Wales. Eames et al (1993) also find a significant association between increasing deprivation and mortality rates for UK citizens under 65 years of age from all causes, coronary heart disease and smoking related diseases. Sloggett and Joshi (1994) propose a linear relation between the level of deprivation of the ward of residence in 1981 and death from all causes in the UK between ages of 16 and 70 before 1990. Bentham et al (1995) find that British mortality and long-term illness rates are both positively associated with six social deprivation indicators. Ben-Shlomo et al (1996) show that mortality rates in Britain are strongly positively associated with average deprivation levels. Jessop (1996) also notes an association between UK mortality rates, especially for respiratory disease, and three markers of deprivation (electoral ward deprivation score; home ownership; car ownership). Lamont et al (1997) report that, within the lowest UK deprivation category, there is evidence for a further excess risk among homeless men for cancers of the oral cavity and pharynx, oesophagus, larynx and lung. Maheswaran et al (1997) find that higher rates of stroke mortality among middle-aged adults in Greater London, compared to with the surrounding South East Region, are associated with socio-economic deprivation and ethnicity. Finally, Davy Smith et al (1998b) suggest that cardiovascular disease and 'all causes' mortality rates were both inversely associated with socio-economic position whether indexed by area-based deprivation or by social class.

2.2.1.5 The role of health behaviour

One of the outstanding results of recent work on inequalities in health has been the clarification of the role of health behaviours in health inequalities. Adler et al (1993) suggest that observed patterns are most consistent with a strong emphasis on health behaviours as explanatory variables. On the other hand, many researchers argue that conventional behavioural risk factors - diet, smoking, drinking, cholesterol levels, etc., - cannot explain socio-economic differentials in health (Davey Smith, 1994 and 1997a). In the Whitehall study, Davey Smith et al (1990) find that while the lower grade and non-car owning civil servants were more likely to smoke than the higher grade and car owning groups, the pattern of mortality differentials was identical among men who had never smoked (Davey Smith et al 1991a and 1994). They also note that simultaneous consideration of a range of risk factors (including smoking, blood pressure, cholesterol levels and prevalent cardio-respiratory disease) fails to account for grade differences in cardiovascular and non-cardiovascular mortality (Davey Smith et al, 1990). In the Whitehall II cohort study, mean cholesterol levels again appear not to contribute to the occupational gradient in coronary heart disease risk, as in both sexes the mean cholesterol level at baseline was similar in each grade (Marmot et al, 1991).

In another Finnish study (Lynch et al, 1996), on adjustment for all risk factors including health behaviours, the association between social position and cardiovascular disease mortality was greatly attenuated, but remained substantial. Chandola (1998) showed that the association between the measure of occupational class and coronary heart disease, after adjusting for health behaviours, remained in men using the Cambridge and Erikson-Goldthorpe scales, and in women using the Register General's Social Classification, Erikson-Goldthorpe and Cambridge scales. In the interrelationship between smoking, socio-economic factors and mortality, according to Davey Smith (1994), the significant part of the association between smoking and mortality appears to be due to the relationship between smoking and socio-economic position.

Finally, the Black Report concludes that the most coherent explanation is found with the 'materialist' approach (p6 and p114). However, there can be little doubt that, amongst all the evidence, there is much that is convincingly explained in alternative terms: cultural, social selection and so on. A consensus has emerged which suggests that, whilst health behaviours contribute to class differences in health, behaviours may themselves be rooted in material conditions or structural position (Macintyre, 1997). The importance of this clarification of the role of health behaviours would be most obviously felt at the practical level of health promotion policy. The tradition of health promotion studies which fail to discriminate between social classes might well be said to have failed. What now needs to be done is the integration of social class into health promotion studies. Macintyre clearly puts the question of further research as follows: "how do material conditions/social structural position shape particular clusters of health-promoting or health-damaging behaviours and the health effects of these behaviours?" (p739) In developing countries, there is still a need to break with the tradition of focusing health promotion studies on individual health behaviour.

Table 2.1. Selection of literature on differentials in mortality according to different socio-economic classes in ordering of published year

Authors (Year)	**Samples**	**Indices of inequality**	**Social class**	**Results**
Marmot et al (UK,1978)	Longitudinal study of 17530 Civil servants	Relative risks	Employ ment grade	Inverse relationship between grade of employment and coronary heart disease mortality
Pamuk (UK,1985)	Mortality data from 1921 to 1972 in England & Wales	SMRs, Slope index of inequality	Social class I-V	Level of inequality increased between 1949-53 and 1959-63 and again in 1970-2.
Fox et al (UK,1985)	Cohort data from 1% sample of the population of England & Wales from 1971 to 1981	SMRs, Regression coefficient	Social class I-V	The difference of mortality between class I and class V became wider during 10 years
Marmot and McDowall (UK,1986)	1979/83Decennial Supplement data	SMRs	Social class I-V	Mortality from coronary heart disease is higher in manual group and is higher in Scotland, Wales, and North of England than in the South.
Moser et al (UK,1988)	-Census data and Surveys longitudinal study of England and Wales	SMRs	Women's socio-economic class[2)]	High mortality was associated with working in manual occupations and living in rented housing with no car in the household.
Pamuk (UK,1988)	Infant mortality data in UK, (1921-1980)	Infant mortality, The Slope index of inequality	Social class I-V	Overall increase in the relative index of inequality between 1921 and 1970-72.
Carstairs and Morris 1989a)	Census data for 1981, Mortality data for 1980-2 in Scotland	SMRs	Carstairs indices[1)]	The gradient in mortality by social class (V) and deprivation were similar
Carstairs and Morris (UK,1989b)	Census data for 1981, Mortality data for 1980-2 in Scotland, England and Wales	SMRs	Carstairs indices[1)]	Scotland has greater deprivation and higher mortality than England & Wales
Vagero and Lundberg (UK/Sweden, 1989)	Censuses (70-72) and general household survey in UK, A new census linked deaths registry(61-79) and 5493 interviews in Sweden	Mortality, Long-term illness prevalence	Social class	Class differences of mortality and morbidity were observed in the UK and Sweden and was bigger in the UK.
Leclerc et al (UK/Finland/ France,1990)	Mortality data between England and Wales, Finland and France	Mortality rate, Gini coefficient	Socio-economic groups	Inequalities were of the same order in England and Wales and Finland, and greater in France.
Blane et al (UK,1990)	1971 and 1981 occupational mortality supplements	Years of potential life lost	Social class I-V	Inequalities in years of potential life lost have increased between 1971 and 1981
Davey Smith et al (UK, 1991a)	11678 male civil servants aged 40-64 at baseline screening between 1967 and 1969	Relative risks	Social class I-V	Employment grade and car ownership were independently related to mortality

Davey Smith et al (UK,1991)	Whitehall study of London civil servants, the OPCS Longitudinal study, the Registrar General's Decennial Supplement	SMR ratio	Five measures [3)]	Ssocioeconomic differentials displayed by a particular malignancy.
Eames et al (UK, 1993)	Ecological study using 1981 census variables and data on mortality for 1981-5	Regression between SMRs and deprivation scores	Townsend, Castairs, and the Underprivileged score	Deprivation of an area and mortality under the age 65 years are strongly linked
Pappas et al (USA,1993)	The National Mortality Followback Survey and The National Health Interview Survey in 1986, The matched record study n 1960	SMRs	Social class, education, income	The inverse relation between mortality and socio-economic status persisted in 1986 and was stronger than in 1960.
Valkonen (Finland, 1993)	Finland mortality data from 1971 to 1985	Mortality differences	Education and occupational class	The relative position of unskilled workers worsened all through the period.
Sorlie et al (USA,1995)	National Longitudinal Mortality Study : 530507 men and women 25 years or more	Relative risks	Education, occupation, income	Employment status, income, education, occupation, race, and, marital status have substantial net associations with mortality.
Duncan et al (Brazil,1995)	-Brazil : Mortality data	Mortality rate (SRR), Relative index of inequality, Mortality concentration curves	Social class	Mortality rate of unskilled workers was greater than any other group.
Kennedy et al (USA,1996)	-Income inequality indices (Robin Hood index and Gini coefficient) and mortality files in USA	Regression coefficient	Income	Lower incomes were associated with increased mortality from several causes.
Kaplan et al (USA,1996)	-The degree of income inequality and age adjusted mortality for the 50 states	Correlation coefficient	Income	A significant correlation (r=0.62) between the percentage of total household income received by the less well off 50% in each state and mortality
Lamont et al (UK, 1997)	-10 hostels for the single homeless in Glasgow	Proportional Incidence Ratio	Carstairs deprivation index	Homeless men have excess risk for cancers of the oral cavity and pharynx, larynx and lung
Maheswaran et al (UK, 1997)	Electoral ward population data for 1991	Mortality rate ratios	Carstairs deprivation index	Carstairs index and ethnic minority group were significantly correlated with stroke mortality at ward level
Diderichsen and Hallqvist	Census data in Sweden in 1960, 1970, 1980, 1985	SMR	Occupational	The rate ratios of mortality increased

(Sweden, 1997)			class	between industrial workers and professional group in 1961-1990.
Kunst et al (Netherlands, 1998b)	11 European countries in the period 1980-9	Rate ratios, rate differences	EGP[4)] scheme	Inequalities in lung cancer, cerebrovascular disease, and external causes of death also varied greatly between 11 countries.
Kunst et al (Netherlands, 1998a)	11 European countries in the period 1980-9	Rate ratios, rate differences	EGP[4)] scheme	In all countries, mortality rate ratio from all causes comparing manual classes to non-manual classes was higher.
Guberan and Usel (1998),	Retrospective cohort 5137 men	Relative Risk ratios	Occupational class	Mortality increased significantly with lower social class.
Marang-van de Mheen et al (UK,1998)	Census and death certificates in Britain from 1951 to 1981	SMR, Relative index of inequality	Social class	The increasing trend of mortality differentials in Scotland is because the greater decrease of death rate in privileged group rather than lower social class group.
Davey Smith et al (UK,1998a)	Prospective observational study	Relative index of inequality	Occupation and education	Occupational social class is better than education as a single indicator of socioeconomic position
Davey Smith et al (UK, 1998b)	Population based cardiovascular disease screening study between 1972 and 1976	Relative risk	Carstairs indices' Deprivation index, social class	The area-based and individual socioeconomic indicators made independent contributions to mortality risk.

1) Carstairs deprivation indices : male unemployment, no car, overcrowded housing, and low social class
2) Women's socio-economic class : marital status, own occupation, husband's occupation, economic activity, and indicators of household wealth (housing tenure and assess to a car)
3) Five socio-economic measures ; housing tenure, household access to cars, household access to domestic amenities, social class and educational qualifications.
4) EGP scheme : Occupational classification suggested by Erikson and Goldthorpe (1992)

2.2.2 Social differentials of morbidity

Morbidity is employed as a health outcome in the assessment of inequality in health as follows: acute or chronic self-reported illness (Lundberg, 1986); morbidity of Ischemic Heart Disease (Suadicani et al, 1997); four morbidity indicators, perceived general health, long-term disabilities, chronic conditions, long-standing health problems (Cavelaara et al, 1998) (Table 2.2). Most researchers focus mainly on chronic diseases or on long standing disabilities (Stronks et al, 1997; Cavelaara et al, 1998; Tuchsen and Endahl, 1999; Lundberg, 1986; Mackenbach et al, 1997).

Cavelaara et al (1998) show that the odds ratios of chronic conditions among manual workers, compared to managers and professionals are: 2.51 (CI: 2.00-3.14) in Sweden, 1.63 (CI: 1.36-1.95) in the Netherlands and 1.84 (CI: 1.56-2.16) in Germany. Also, the odds ratios for 'less than good' perceived health among manual workers, compared to managers and professionals, are between 1.63 (CI: 1.43-1.87) and 2.79 (CI: 2.13-3.65) in 7 European countries. Mackenbach et al (1997) find that the odds ratios for chronic conditions among the group with an educational level of less than lower secondary school are between 1.44 and 1.85 and for perceived general health between 1.55 and 2.57 in 11 European countries compared to those who have an upper secondary and higher level of education. Lahelma and Valkonen (1990) show that the relative risk of self-reported chronic illness among the lowest fifth income group was 1.80 in 1964, 1.95 in 1968 and 1.70 in 1976, compared to the highest fifth income group in Finland. Stronks et al (1997) show that the odds ratio for chronic conditions among lowest income group, compared to the highest income group is 1.41 (1.11-1.78) for Dutch men and 1.16(0.95-1.43) for women; for perceived general health, 3.38 (2.62-4.35) for men and 3.10(2.48-3.88) for women.

Several studies report social inequalities in coronary heart disease and Ischemic Heart Disease (Chandola, 1998; Suadicani et al, 1997). Marmot et al (1991) find an inverse relationship between employment grade and prevalence of angina, IHD and chronic bronchitis.

Table 2.2. Selection of literature on differentials in morbidity according to different socio-economic classes in order of published year

Authors (Year)	**Samples**	**Indices of inequality**	**Social class**	**Results**
Lundberg (Sweden, 1986)	-UK: general household survey and mortality data -Sweden: Swedish level of living surveys and mortality data	Regression coefficients of long standing illness	Social class	Class gradient in health in both UK and Sweden.
Marmot et al (UK, 1991)	10314 British Civil servants : The Whitehall II study	Test for trend, Cochran Mantel-Haenszel tests	Employment grade	Inverse relationship between employment grade and prevalence of angina, ischemia, and chronic bronchitis.
Lundberg	1981 level of living study	Regression	Six	Physical working conditions

(Sweden, 1991)		models	different factors[3]	are the prime source of class inequality in physical illness
Winkleby et al (USA,1992)	2380 subjects in two cities in USA	Regression methods	Occupation, education, income	The relationship between these SES measures and risk factors was strongest and most consistent for education.
van Loon (Netherlands, 1994)	3 year-follow up study of 58279 men	Rate ratios	Occupation, income, education	An inverse relationship between lung cancer and highest level of education.
Bentham et al (UK, 1995)	401 local authority districts in England and Wales	SMRs, SIRs	Social deprivation	Mortality and long term illness are positively associated with indicators of social deprivation.
Stronks et al (1997)	Longitudinal Study on Socio-Economic Health Differences	Prevalence and Odds ratios	Income, education, occupation	Strong association between income and chronic conditions and perceived general health.
Valkonen et al (Finland, 1993)	1986 Self reported survey on living conditions (n=12,057)	Life expectancy	Education	The higher level of education, the higher the life expectancy and disability free life expectancy
Suadicani et al (1997)	Prospective cardiovascular cohort study	Ischemic heart disease Relative risk	Social class	The ischemic heart disease in low social classes higher and lifestyle and working environment are strong mediators of social inequalities in risk of ischemic heart disease.
Mackenbach et al (Netherlands 1997)	Morbidity data from 11 European countries	Four categories of morbidity[1]	Education	Inequality in health found in all 11 EU countries.
Rosso et al (Italy, 1997)	11653 Cancer registry cases in Turin area in Italy	Case Fatality Ratio	Education	There were major differences in cancer survival showing a poorer outcome for those from the lower social class.
Chandola (UK, 1998)	The health and lifestyles survey : longitudinal panel study	Coronary heart disease	Occupational classes[2]	Most of the measures of occupational class are associated with coronary heart disease in men and women.
Cavelaara et al (1998)	National health interview data between 1986 and 1992 (7 countries)	Four morbidity indicators[1] (Odds ratio)	Occupational class	For all countries, higher than average prevalence was found for skilled and unskilled manual workers and agricultural workers.
Sihvonen et al (Netherlands, 1998)	Mortality data and morbidity data in Finland and Norway	Partial life expectancies and partial health expectancies	Education	In both countries, the higher educated have higher life expectancy and higher health expectancy.
Schrijvers et al (Netherlands, 1998)	6932 subjects from the postal survey	Odds Ratio	Working conditions, Occupational class	Working conditions can be an explanatory factor in the relationship between occupational class and health
Tuchsen and	Three successive cohorts :	Standardized	Occupatio	Blue collar workers had a

Endahl (Denmark, 1999)	1981, 1986, 1991	hospitalisati on ratios	nal class	high and increasing relative risk than managers and white collars. Social inequality in IHD is rapidly increasing

1) Four morbidity indicators: perceived general health, long term disabilities, chronic conditions, and long standing health problem.
2) British Registrar General's Social classification, Erikson-Goldthorpe Scheme, and Cambridge scale
3) Six different factors : Occupational class, economic hardship during childhood, physical working conditions (heavy and dangerous), social behavioural factors, psychological working conditions, indicator of weak social network

2.2.3 Development of inequality indices in the study of health differentials

Several different inequality indices have been developed to measure inequalities in health. SMRs and their equivalents have been employed for differential social classes within countries (Tables 2.1 and 2.2). Le Grand et al (1989) and Leclerc et al[4] (1990) have employed the Lorenz curve and Gini coefficient to measure inequalities in health. Wagstaff et al (1991) criticise the use of such methods as they fail to reflect the socio-economic dimension of inequalities in health as classes are ordered according to their health. They therefore suggest the concentration curve and index[5]. Pamuk (1985) suggests that the slope or relative indices of inequality[6] reflect the socio-economic dimension of inequalities in health; the slope of the regression line showing the relationship between the health status of a class and its relative rank in the socio-economic distribution. Mackenbach et al (1997) suggest the relative indices of inequality based on Poisson regression. Blane et al (1990) employ years of potential life lost as a measure for giving more weight to deaths that take place at younger ages, which can also be used to analyse social class differentials in mortality. Ford et al (1994) suggests relatively simple linear models of the relation of health to social class to describe patterns of inequality at different points in the life-span across a range of health measures. Sihvonen et al (1998) calculate partial life and health expectancies using mortality and morbidity data.

[4] Leclerc et al (1990) employ grouped data rather than individual level data. The groups are not health but rather occupational classes. These classes are ranked by mortality rates, beginning with the class with the highest mortality. The Lorenz curve plots the cumulative percentage of the population, grouped into occupational classes, which are then ranked by health status against the cumulative percentage of deaths.

[5] Wagstaff et al (1991) plot the cumulative proportions of the population by socio-economic status (beginning with the most disadvantaged and ending with the least disadvantaged) against the cumulative proportions of health. The only difference between the Lorenz curve and concentration curve is that the latter is ranked by the socio-economic status, while the former is ranked by health.

[6] Pamuk (1988) calculates the slope index of inequality as the slope of a line fitted to the class-specific infant mortality rates ranked according to status (from lowest to highest) and positioned against the midpoint of the cumulative proportion of births attributed to each class.

Mackenbach and Kunst (1997) suggest 12 different measures[7] for inequality in health. Kawachi and Kennedy (1997) compare six different income inequality indicators[8].

2.3 Social inequalities in disease and death related to work and work conditions

Only a few studies present the relationship between social inequalities in health related to work and work conditions from several points of view: working environment, including psycho-social working environment (Marmot and Theorell et al, 1988; Suadicani et al, 1997); physical working conditions (Lundberg, 1991; Schrijvers et al, 1998); women workers (Kauppinen, 1997). As for psycho-social working conditions, several studies assert that the lower social classes suffer higher rates of psycho-social stress and cardiovascular disease (Marmot et al, 1988). Karasek (1979) and Karasek and Theorell (1990) suggest that more intense job demands and lower decision-making requirements are related to psychological stress and are therefore related to increased risk of cardiovascular disease.

As for mechanisms, most researchers report increased job strain as a cause of high blood pressure during working hours (Theorell, 2000). Several researchers show: the relationship between blood lipid level and job stress (Stjernstrom et al, 1993; Brunner and Marmot, 1999); the relationship between job strain and low level of high density lipoprotein in blood among farmers (Stjernstrom et al, 1993); an increasing tendency for blood clotting with stress (Brunner and Marmot, 1999). Brunner and Marmot (1999) conclude that social and individual differences in response to social and environmental stress appear to be determined by many factors, including birth-weight and conditioned hypo- or hyper- responsiveness. However, these approaches have failed to explore how

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[7] 1. Rate ratio of lowest versus highest SES group; 2. Rate difference of lowest versus highest SES group; 3. Regression-based relative effect index; 4. Regression-based absolute effect index; 5. Population-Attributable Risk (%); 6. Population-Attributable Risk (absolute version); 7. Regression-based Population-Attributable Risk (%); 8. Regression-based Population-Attributable Risk (absolute version); 9. Index of dissimilarity; 10. Index of dissimilarity (absolute version); 11. Relative Index of Inequality; 12. Slope Index of Inequality. Kunst et al (Netherlands, 1998a and 1998b) introduce rate differences as the absolute difference between mortality in manual and non-manual classes.

[8] The Gini coefficient, the decile ratio, the proportions of total income earned by the bottom 50%, 60% and 70% of households, the Robin Hood index, the Atkinson index and Theil's entropy

class relations appear in the workplace and how these psycho-social factors are related to other working conditions such as physiological working conditions. It is our contention that, although psycho-social factors can play an independent role at the level of working conditions, they cannot account for the total picture and certainly cannot be separated from physical and hazardous working conditions. Moreover, these studies omit to address the most fundamental question: why do the lower classes suffer more psycho-social stress than higher social classes?

For the relationship of physical working conditions and social class with ill health, Lundberg (1991) suggests that physical working conditions are the prime source of class inequality in physical illness, although economic hardship during upbringing and health related behaviours also contribute. Schrijvers et al (1998) also suggest that the differential distribution of hazardous physical working condition together with the experience of less and less control over the work process can be explanatory factors in the association between occupational class and the prevalence of a 'less than good' perceived general health assessment among the working population.

Thus, we contend that too little research has attempted to develop a precise understanding of the relationship of working conditions and socio-economic factors to death and disease focusing on class relations in the workplace. This may be because the traditional approach of occupational epidemiology has focused on individual factors concerning the worker's particular situation or job tasks and has omitted the variable of social structure in its accounts of the causal pathways of occupational disease in the workplace. The broad approach of 'social epidemiology,' without focusing on the concept of 'class' or the basic relations of exploitation, may not recognise the fundamental mechanisms of social relations and health in the workplace. Thus, Navarro (1998) argues that "Our criticism of epidemiological research, for example, was that it focused on individual characteristics – called individual risk factors – as the cause of death and disease" (p398). He also finds that individual focus to be insufficient because society is more than the aggregate of its individuals.

2.4 Workplace injuries and occupation, educational level, income, industry, factory size and working conditions

Several studies have focused on the relationship between workplace injuries and occupation, educational level, income, industry, factory size and working conditions. By and large, these studies have not been focused on class relations and workplace injury prevalence. However, they may be useful for our purposes in providing clues as to the origin and scope of social inequalities as they impact on workplace injury rates.

2.4.1 Occupation and workplace injuries

Several studies deal with the relationship between occupation as a risk factor and fatal[9] workplace injury rates. They report higher fatal injury rates among labourers in the USA and Canada. Bailer et al (1998) note the occupations with high fatal injury rates as transport, material moving (21.84 rate per 100,000 workers), farming, forestry and fishing (20.26 rate per 100,000 workers) and labourers (13.22 rate per 100,000 workers). Ore and Stout (1995) also report that labourers have higher occupational fatal injuries in both the USA (32.3 per 100,000 workers) and Australia (26.6 per 100,000 workers). Kisner and Fosbroke (1994) show that, for fatal injuries, the sectors of the construction industry exhibiting the greatest frequency of deaths are the precision production/craft/repair sectors (48%), labourers (27%) and transport operatives (12%).

Kisner and Fosbroke (1994) also show that non-fatal injury rates were higher among machine operators and labourers. Zwerling et al (1996 and 1998) show that mechanics and repairers, machine operators and labourers had significantly elevated odds ratios for non-fatal occupational injury compared to other occupational groups among older workers.

[9] According to ILO (1998), a fatal occupational injury is an occupational injury leading to death within one year of the day of the accident. In most studies, fatality means death from injury at work (Ore and Stout, USA, 1996; Bailer et al, USA, 1998).

2.4.2 Income/education and workplace injuries

Relatively few studies have been undertaken on the relationship of income and education to workplace injuries. Kirschenbaum et al (Israel, 2000) found no significant effect for education on injury accident rates. Higher-paid workers were more likely to suffer repeat injuries. However, Zwerling et al (1996 and 1998) show that lower educational level was also related to non-fatal occupational injury in univariate analysis.

2.4.3 Industries and occupational injuries

Several studies have analysed industries having the highest occupational injury rates. For fatal occupational injuries, the industrial sectors with higher injury rates were the primary sectors of mining, fishing, forestry, construction and transportation, communication and utilities in the USA (Stout et al, 1996; Castillo et al, 1994; Bailer et al, 1998; Ore and Stout, 1996). One report also shows that these sectors have an increased tendency towards fatal injury rates according to calendar year in Canada (Rossignol, 1993). Stout et al (1996) show that mining, construction, transportation and agriculture had higher injury death rates than all other industries in the USA. However, the above data comes from the NTOF (National Traumatic Occupational Fatalities) surveillance system, a nationwide US census based on death certificates, which several researchers employ (Stout et al, 1996; Castillo et al, 1994; Bailer et al, 1998; Ore and Stout, 1996). As the information concerning occupational injury is based only on positive responses to an 'injury at work' question on the death certificate, no supplementary information on type of injury, etc., is given. A further limitation of these studies (Ore and Stout, 1996; Rossignol and Pineault, 1993; Stout et al, 1996) is that age and sex-adjusted injury rates are not calculated.

For non-fatal injuries, Kisner and Fosbroke (1994) show that the construction industries had the highest rates of workers' compensation claims in the Bureau of Labour Statistics' Supplementary Data System with the second highest being the mining industry.

2.4.4 Factory size and occupational injuries

Several studies report an inverse relationship between factory size and workplace injury rates (Hunting and Weeks, 1993; Reilly et al, 1995). Hunting and Weeks (1993) find that mines employing less than 20 or between 20 and 50 workers suffered higher injury rates than larger mines. Reilly et al (1995) also report an inverse relationship between injury rates and establishment size. Nichols (1997) also suggests a generally negative association between size of employment unit and injury rate, whether the employment unit is defined as the establishment or the organisation of which the establishment is a part.

On the other hand, according to Berkowitz (1979) and Smith (1979), there is an 'inverse U-shape relation' between workplace size and injury rates which indicates that "the largest sized and the smallest plants have the lowest accident frequency rates as compared to mid-size firms" (Nichols, 1997, p164). Against the argument that large industries have higher injuries, Nichols (1997) points out that total reported injuries, in which minor injuries dominated, tend to have a positive relation to size of establishment; by contrast, rates for the more severe injuries (a more precise indicator of general workplace safety) tend to have a negative relation to size of establishment. According to Thomas (1991), "to be the reverse of that for major injuries, with the rate of injury generally increasing with size of establishment" (Nichols, 1997, p164).

As for reasons why relatively fewer minor injuries appear to occur in smaller rather than larger industries, Nichols focuses on the structure of social relations rather than the economic vulnerability of smaller establishments. Thus, he supposes that individual workers may have less power and there may be lack of provision to take time off for minor injuries in smaller establishments. Nichols argues that higher major injury rates in smaller establishments must be due to the fact that smaller firms are less safe places to work. Thomas (1991) agrees, suggesting that "the most likely reason for this was underreporting in the smaller establishments, underreporting being held to be generally much more prevalent for over-three-day injuries than for the more serious fatal or major injuries." (Nichols, 1997, p164).

Table 2-3. Selection of the literature on differentials in injury rates according to different socio-economic class in order of published year

Authors (Year)	Samples	Indices of inequality	Classification	Results
Leino et al (Finland, 1988)	502 employers in metal industry plants	Age adjustment of morbidity score	Blue/White collar	Musculoskeletal symptoms are more frequent
Hunting and Weeks, (USA,1993)	Mine Safety and Health Administration surveillance:1986, 1987 (8000 sub-units of mines)	Proportionate injury ratio	Factory size	The smallest mines have a substantially higher proportion of high-rate sub-units than did larger mines.
Rossignol and Pineault (Canada,1993)	1227 fatal injuries from the Quebec Worker's Compensation Board from 1981 to 1988	Crude fatal injury rates	Industry	primary sector (fishing, mining, and forestry) show higher and a regular increase in fatal injury rates
Kisner and Fosbroke (USA, 1994)	Bureau of Labour Statistics, Supplementary Data System for 1981 through 1986	Non-fatal, and fatal injury	Occupation, industry	Mining and construction industries, and labourers have higher fatal occupational injury.
Ore and Stout (USA, 1995)	Construction injury fatalities from USA(NTOF*) and Australia (database of work related fatalities and Labour Force Survey)	Crude fatal injury rates	Occupation	The high fatality rate finds among construction labourers in both the US and Australia
Stout et al (USA, 1996)	Data from NIOSH, NTOF* (1980-1989)	Crude fatal injury rates	Industry	Mining and construction industries are higher than rates in all other industries.
Zwerling et al (USA,1996)	7089 subjects 51-64 years old age in the Health and Retirement Study	Non-fatal injury	Occupation, education	Mechanics, machine operators, and labourers have higher injury rates.
Zwerling et al (USA,1998)	5600 subjects 51-64 years old age in the Health and Retirement Study	Non-fatal injury	Occupation, education	Heavy lifting remains as risk factors for occupational injury.
Bailer et al (USA, 1998)	Data from NIOSH, NTOF* (1983-1992) were combined with data on employment from BLS*	Age adjusted fatal injury rates	Occupation, industry	Mmining,construction, agriculture, and transport industries and transport, farming, and labouring occupations have higher fatal injury rates
Kirschenbaum et al (Israel, 2000)	200 injured workers interviewed upon entering hospital emergency wards in Israel.	Injury accidents	Education, occupation, income,	No significant effect for education on the injury accident was found. Subcontracted and higher-paid workers are more likely to get repeat injuries.

* NTOF : National Traumatic Occupational Fatalities
* BLS : United States Bureau of Labour Statistics(BLS)

2.4.5 Work intensity and occupational injuries

Several studies describe the intensification of work practices and processes due to increased exploitation in contemporary capitalist society (Braverman, 1974; Nichols, 1996; Grunberg, 1983; Fucini and Fucini, 1990; Moody, 1997; Danford, 1999; Graham, 1995; Rinehart et al, 1997; Delbridge, 1998). Braverman (1974) argues that, in the capitalist mode of production, so-called Taylorism[10] exploits workers through the intensification of the labour process and the de-skilling of workers. Nichols (1991) suggests that increased labour intensity plays a special role in the changes in productivity performance in British manufacturing that occurred between the 1970s and the first half of the 1980s. Recently, several researchers describe how work has been physically intensified due to capitalist forms of production - Taylorism and Fordism - in manufacturing industries, and how it has become worse for workers with the introduction of the Japanese model of production since in the 1980s (Fucini and Fucini, 1990; Graham, 1995; Moody, 1997; Rinehart et al, 1997; Delbridge, 1998; Danford, 1999).

Several studies also describe how increases in the pace of work lead to increases in injury rates (Grunberg, 1983; Nichols, 1997; Novek et al, 1990). Nichols points out that the intensification of labour is the key factor determining incidences of injuries in the workplace. In several studies, Nichols also argues that this intensification is probably part of a wider deterioration which also entailed increased corner-cutting, the neglect of maintenance and training and other injury prevention practices (Nichols, 1986, 1989, 1991). Grunberg (1983) has stated that "the greater the intensity of labour, the higher will be the incidence of accidents" (Nichols, 1997, p111). Novek et al (1990) argue that the factors contributing to high and rising injury rates are mainly deteriorating labour relations in the face of falling profits and an intensified labour process, they lay particular emphasis on production line speed-ups and a growing risk of repetitive strain injuries. Using factory observation, interviewing or participation, Graham (1995) explores how the

[10] Braverman (1974) summarises Taylorism as follows: 'If the first principle is the gathering and developing of knowledge of labour processes, and the second is the concentration of this knowledge as the exclusive province of management - together with its essential converse, the absence of such knowledge among the workers - then the third is the use of the monopoly over knowledge of the labour process to control each step of the labour process and its mode of execution'

increasing speed of labour processes causes more rapid and repetitive limb movements and results in Carpal Tunnel Syndrome and other disabilities after just a few months of employment. Fucini and Fucini (1990) also note that a more rapid performance of repetitive tasks, as well as working for longer periods without rest, increased the strain on muscles and tendons by denying workers the chance to rest over-used wrists and arms in a Mazda car factory. Kenney and Florida (1993) report higher injury rates in more intensive car factories than in other car factories in the USA. In developing countries, such research is yet to be undertaken.

2.5 Three theories relating inequalities in health to work and working conditions

To understand the relation between inequalities in health and work and working conditions, three theories need to be explicated and discussed: the orthodox theory, the dual labour market theory and the radical theory. In the orthodox economist's view, the origins of poverty and under-employment are to be found in problems of human productivity, such as lack of education and training (Lonsdale, 1985; Gordon, 1972). Orthodox economists try to explain poverty and underemployment in terms of 'marginal productivity'. They derive this from a single fundamental theoretical hypothesis: 'in the short run, given assumptions of perfect competition and market equilibrium, workers' wages equal their marginal productivities' (Gordon, 1972). Based on the income/marginal productivity hypothesis, orthodox economists try to justify the wage and income variations in terms of variations of (hypothesised) productivity components like education, ability and experience (Gordon, 1972). Based on this orientation, orthodox economists explain income determination and distribution with a demand-supply hypothesis. On the supply side, they assert that the varying productivities in given job situations are dependent on the individual workers' capacities: innate ability, formal education, vocational education, on-the-job training, and on-the-job experience (Gorden, 1972).

The dual market theory has developed since the 1960s. Its central hypothesis is that the allocation of job opportunities has to be understood in terms of division of the labour market into a primary and secondary sector[11] (Lonsdale, 1985). Therefore, dual market theory explains inequalities at work from the separation of sectors.

In Marxist theory, the origin of inequality at work is the social division of labour. The social division of labour, produced by the social relations of production, creates a division of society into economic classes (Gordon, 1972). In the capitalist work process[12], capitalists pay for a day's worth of labour power, control the workers in the work process and use the labour power for the day that it belongs to him. Capitalists thus make workers create surplus value, and this surplus value becomes the capitalist's property. This exploitation of workers by capitalists is the origin of unequal relationships between the classes and becomes the focus of conflictual social relationships between workers and employers. For Marxist theory, the source of inequalities originates in the relationship between labourers and capitalists. During the labour process, the capitalist increases

[11] According to Piore (1979), primary industrial sectors are defined as consisting of large firms, using modern technology, facing a stable market and enjoying market power. Therefore, primary markets offer high wages, good working conditions, employment stability and job security, equity and due process in the administration of work rules and chances for advancement. On the other hand, secondary industrial sectors are composed of small firms, using traditional technology, facing competition and often declining product markets and frequently acting as subcontractors to the primary sector, bearing the brunt of cyclical downswings and providing flexibility in the upswings. Therefore, the secondary market tends to involve low wages, poor working conditions, considerable variability in employment, harsh and often arbitrary discipline, and little opportunity to advance (Piore, 1979). The Labour Studies Group (1982) mention that the primary sectors are large, automated, pay high wages, engage in company and plant bargaining and are strongly unionised (LSG, 1982). Secondary industrial sectors are very small firms, usually employing less than 25 employees, employing traditional, labour-intensive techniques.

[12] According to Marx (1981), "in the labour process, therefore, man's activity, with the help of the instruments of labour, effects an alteration, designed from the commencement, in the material worked upon" (p457). The labour process is human action with a view to the production of use-values. Therefore, the labour itself is productive labour. However, after the capitalist buys the labour power in order to use it, the labour process, turned into the process by which the capitalist consumed labour power, exhibits two characteristic phenomena. "Firstly, the labourer works under the control of the capitalist to whom his labour belongings" (p461). "Secondly, the product is the property of the capitalist and not that of the labour, its immediate producer" (p461p). In capitalist society, the labour process is merely the process between things that the capitalist has purchased, things that have become his property. To make the property, the capitalist makes the surplus value in the labour process. Marx found the origin of surplus value in the characteristics of labour, which is labour power in use in the labour process. The characteristic of labour, labour power in use, is the specific use-value which this commodity possesses of being a source not only of value, but of more value than it has itself (Marx, 1981). Therefore, the capitalist pays "the value of a day's labour power; his, therefore, is the use of it for a day; a day's labour belongs to him" (p467). "The circumstances that on the one hand the daily sustenance of labour power costs only half day's labour, while on the other hand the very same labour power can work during a whole day" (p467). Thus, the process of creating surplus value is the continuing of labour process of producing value beyond the point where the value paid by the capitalist for the labour power (Marx, 1981). That is, surplus value is created by being more used than the value of labour power in the labour process. Therefore, "the process of production, considered on the one hand as the unity of the labour process and the process of creating value', is production of commodities; considered on the other hand as the unity of the labour process and the process of producing surplus value, it is the capitalist process of production, or capitalist production of commodities" (p469).

production primarily through increased exploitation of individual workers. Thus, the worker's resistance to capitalism is inevitable as it is his working conditions which are continually under threat in the drive to increase productivity.

2.6 Conclusions

Let us sum-up the conclusions we draw from our brief review of the literature:

Firstly, there is evidence of increasing health inequalities based on socio-economic differentials in Western countries. There has, however, been little research on social inequalities in health outside the West.

Secondly, many studies have looked at the relationship between socio-economic factors (occupational class, education, income and deprivation) and health. Nevertheless, few studies have so far investigated either possible interactions between these variables nor the precise mechanisms of socio-economic inequalities in health.

Thirdly, there is a gap in the literature which indicates the need to explore the relationship of socio-economic factors to working conditions and workplace injuries.

Further research on inequalities in health:

One of the important points to have emerged from the literature is the need to explore inequalities in health in developing or rapidly industrialising countries. The gap between the rich and the poor may have widened profoundly and very rapidly during the recent intense bout of industrialisation and urbanisation. Intra-urban health differentials have appeared in the poor environmental conditions within which particular 'slum' communities try to live in developing countries (Stephans, 1995). It is likely that the health status of different socio-economic groups reflects this widening gap. Research on this subject in newly developed or under-developed countries is needed to confirm this and to identify trends which may not conform to Western research models.

Another important point to emphasise is the need for extended studies on the relation between occupational class and other causes of ill-health: education, income, deprivation and health behaviours. Most studies have not included all of these factors; where they have, each variable has been considered separately. In addition, there is a striking need to break down the traditional approach which has long focused on behaviours themselves in developing strategies for health promotion. Further study focusing on 'social class' as the most potent variable explaining mortality and morbidity differentials is needed. As Naverro (1998) argues, the study of precisely how relations of exploitation and/or domination (class, race and gender) are related, reproduced and are materialised in everyday life and, indeed, in death is still needed. In short, work on detailed mechanisms, the 'how' and 'why' lower social class groups have higher mortality and morbidity rates and how class relations of exploitation impact on health differentials need to be investigated.

Another important direction for further research is the study of the relationship between socio-economic status, working conditions and workplace injuries. In previous studies, as socio-economic factors and working conditions have been dealt with separately, the risk factors of workplace injuries seem to be limited only to the problem of each industry or factory unit or even to individual workers, rather than being seen as a social or structural problem. Even though the relationship between injury rates, occupational categories and industry have been discussed, then, there is little research which connects socio-economic factors to occupational injuries. To understand the causal pathways of workplace injuries, our concern must be to understand how socio-economic *structural* factors effect workplace injury rates.

There is also a pressing need to study the relation between changes in work intensity and injury rates. Especially in developing countries, the intensification of work - increases in the pace of work, reductions in the number of workers, extensions to the working day - has been a central factor in increased productivity. Despite the fact that workers in Third World countries may suffer more from increases in work intensity, hardly any research on the relationship between work intensity and health has been undertaken. Such work is clearly long overdue.

Chapter 3: Hypotheses, aim and objectives

This thesis explores the following hypotheses:

1) Differentials of mortality, morbidity and death rates due to workplace injury exist across different occupational classes, incomes and educational levels in Korea.

2) Workplace injury rates are caused by hazardous working conditions such as work department, work intensity, and shift/conveyer work.

3.1 Aim and objectives

This thesis aims to explore the relationship of occupation, educational level, income and working conditions to mortality, morbidity and workplace injury rates in Korea, focusing on the association of occupational class with health.

It seeks in particular:

1) To examine inequalities in mortality across occupational classes and educational groups in Korea.

2) To examine inequalities in morbidity across occupational classes, educational groups and income groups controlling other health behaviours in Korea.

3) To examine inequalities in deaths due to workplace injuries across occupational classes, educational groups, income groups, and factory sizes in Korea.

4) To examine the relationship between working conditions – work department, shift/conveyer work and work intensity – with workplace injury rates and to understand the sources of hazardous working conditions, in particular, work intensity by focusing on the relationship between workers and employers.

4: Occupational class and mortality

4.1 Introduction

This chapter focuses on the relationship between occupational class and other socio-economic factors (education and deprivation) to mortality in Korea. Most researchers use 'occupation' as an index of social class in the study of inequalities in health (Chapter 2). The claim is that occupation can function, as a proxy for class differences as it tends to determine the ownership of property, material well-being and position in social hierarchies. Evidently, occupation primarily and directly impacts on working conditions. Education, or its lack, also plays a role in differentiating populations into classes along with variations in degrees of material deprivation across different sectors. Taken together, such factors serve as leading causes of health inequalities.

Many studies show how occupational class and other socio-economic factors relate to health outcomes (Chapter 2). However, more extended research, linking these variables and exploring their inter-relationship, is needed. This is particularly the case for Korea, where no significant work on this area has been undertaken. Consequently, the present study focuses on the relationship between occupational class and mortality and deals with associations between the latter, occupation, education and deprivation. A further discussion of area-based deprivation indicators gives a subsidiary analysis. We propose that the analysis of deprivation levels can help to overcome limitations in occupational data (Chapter 2).

4.2 Hypothesis and objective

The hypothesis of the present chapter is that differential mortality rates exist across occupational classes, educational groups and levels of deprivation in Korea. The objective of this study is to examine the relationship of occupation, education and deprivation to Korean mortality rates.

4.3 Methods

4.3.1 Data sources

4.3.1.1 Numerators

To calculate mortality rates, we use registered death data from 1993 to 1997 obtained from the Korean National Statistics Office (NSO) as numerators. Age, sex, occupation, education, area of residence, education and cause of death are included in individual records of deaths. To verify the completeness of the data, annual numbers of deaths according to age and sex are compared. We find them to be well-matched to the tabulated data in the *Annual Report on Cause of Death Statistics* published by the National Statistics Office.

4.3.1.2 Denominators

Denominators are drawn from the *1995 Census* which includes a 10% stratified random sample of the population. Individual records from the *Census* include variables for age, sex, occupation, education and area of residence. The sampling weights calculated by the National Statistics Office are based on administrative area, sex and age. We calculate national population size using the 10% stratified sample by multiplying the weights. To verify this data, we compare age and sex classified total population figures and find them to be well-matched to those of the *Census Report* published by the National Statistics Office.

4.3.2 Completeness of data and process of study population selection

4.3.2.1 Missing values

The proportion of missing values for men and women aged 20-64 years are described and compared. The distribution of missing values is shown in Table 4.1 and missing values for occupation and education differ somewhat between the two data sources. However, these are unlikely to affect our study, as they do not represent a significant proportion of the total data.

Table 4.1 Percentage of missing values in the study population from deaths and 1995 *Census* (20-64 years)

Unit: number (percentage of total, %)

	Deaths from 1993 to 1997					Census in 1995				
	Sex missing	Men	Women	Total	Deaths at the age 20-64	Sex missing	Men	Women	Total	Total Population aged 20-64
Sex	0	0	0	0	484110 (100.00)	25 (0.00)	0	0	25 (0.00)	27163800 (100.00)
Age	0	0	0	0	484110 (100.00)	0	0	0	0	27163800 (100.00)
Occupation	0	3056 (0.88)	1632 (1.19)	4688 (0.97)	484110 (100.00)	25 (0.00)	2557 (0.01)	530 (0.002)	3112 (0.011)	27163800 (100.00)
Education	0	1070 (0.31)	485 (0.35)	1555 (0.32)	484110 (100.00)	25 (0.00)	4576 (0.02)	2675 (0.01)	7276 (0.03)	27163800 (100.00)
Cause of disease	0	5073 (1.46)	2215 (1.62)	7288 (1.51)	484110 (100.00)					27163800 (100.00)

4.3.2.2 Value of the variables in national death data

To test the validity of the explanatory variables for occupation, education, cause of death, age and sex, variables from death data collated by the National Statistics Office (NSO) are compared to data on death rates due to workplace injuries from WELCO (detailed results are provided in Chapter 8). The results of this test are as follows: a Kappa index of 0.48 is arrived at when occupational groups are divided into two categories (*manual* and *non-manual* workers) and 0.36 when categorised in 8 broad groups (excluding agricultural workers). A lack of agreement between NSO and WELCO injury death data is noted, leading us to suspect some 'promotion' of occupation in the NSO death data (Chapter 8). Also, Kappa indices for educational groups are: 0.32, where the three-category classification of graduation level is used (*university*, *high school* and *less than middle school*); 0.24, where the four-category classification is used (*university, high school, middle school* and *less than elementary school*); and 0.49, where education is grouped into two categories (*more than university* and *less than university school*). This result suggests that information on education is poorly matched between the two surveys (Chapter 8). For cause of death, the Kappa index is 0.68 for three-categories of disease: (a) injury, poisoning and certain other consequences of external causes (S00-T98, ICD10); (b) diseases of the circulatory system (I00-I99, ICD10); and (c) other diseases. The Kappa index for the 5-year age band is 0.99, making it well-matched between surveys. There is no disagreement in relation to gender.

4.3.2.3 Possible of mis-classification of occupational statements

A major problem in the calculation of mortality by occupation using *Census* data as denominators and NSO death data as numerators is the likelihood of numerator/denominator bias. Recording systems for occupational data differ between the two sources. The *Census* has more detailed occupational information than the NSO material as it is encoded using three digits. The question concerning occupation in the *Census* is:

> **What is your department and position? What do you do in the workplace?**
> **Please write in detail**

For death reports, the reporter completes the field requesting information on the deceased's occupation. Instructions on death reports specify 'occupation' as type of work performed in the period immediately before death or when the deceased contracted the condition which caused his or her death. However, according to several village officers, informants tend to complete the form by including the *usual* occupation of the dead person, the job that he or she engaged in during the greater part of their working life. Thus, discrepancies in the recording system for occupation between the *Census* and the NSO death data may bring about numerator/denominator bias. Secondly, officials in the Civil Office receive death reports from the deceased's family or close acquaintances and encode the information from a scale of 0 to13, the general categories of the *Korean Standard Classification of Occupation*. This data is then fed into the central computer at the National Statistics Office. As a consequence, there is an obvious potential for mis-classification; both in the input of the data and in the reporting and recording of the original information (see Appendix).

4.3.2.4 Misclassification of the employment status

(1) Possible mis-classification of part-time and full-time workers

The *Census* records the most recent full-time occupation[1] for the majority of the population. For part-time workers, however, previous full-time occupations are not recorded. In contrast, NSO death report forms are organised in such a way that no field is provided allowing for the differentiation of part-time from full-time occupations. Generally, occupation is usually expected to refer to permanent employment by which the deceased earned a living before death or before contracting the condition leading to death (Kim, 1986). It is not clear, then, whether part-time workers are actually recorded in death reports. Such a discrepancy between data sources may evidently create numerator/denominator bias.

To find out if this is actually the case for our study, we calculate the percentage of part-time jobs held by manual and non-manual workers among different age groups from *Census* data. The percentage of Korean part-time workers is said to be 1.14% of the male, and 20% of the female, economically-active population (NSO, 1995). In terms of the proportion of part-time workers classified as manual or non-manual, for male workers there is little difference; for women, on the other hand, the difference is much more significant. Thus, while part-time work among male workers is unlikely to create differential bias, there may be some bias among female workers. Interestingly, over 60% of women's part-time work is based in the agricultural and retail sectors. While most women whose husbands also work in these sectors work and do housework.

We asked several Civil Officers how part-time occupations are dealt with in death reports. Some claim that death certificates record a person's main job during his or her life. In this case, part-time jobs risk being ignored, especially for women, if not for men. However, other officers claim that some women's part-time jobs, though not all of them, are recorded in death reports when they worked in agriculture or retail sales in cases where husbands are either agriculture workers or self-employed shop workers.

We conclude, in conclusion, that death reports do not formally provide researchers with adequate information on part-time work. Thus, as an alternative, we include information concerning part-time workers drawn from the *Census* (see Appendix Table). Even this, however, does not guarantee that numerator-denominator bias will be avoided.

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[1] In the *Census*, occupation of an employed person refers to the kind of work done during one month just before the *Census* survey date (1995 *Census*).

(2) Possible mis-classification of economic inactivity and unemployment

The *Census* data differentiates between economically active and inactive sections of the population using terms such as 'employed', 'unemployed' and 'retired'. This information is gathered using the following questions:

Question 1: What work have you been doing during the last month?
1. Full-time work; 2. Part-time work and housework; 3. Part-time work and study;
4. Part-time work and some other activity (volunteer work or religious mission);
5. Resting between jobs; 6. Looking for work; 7. Housework; 8. Full-time study;
9. Other (retired; below working age; ill)

Question 2: (If working) What is your department, job title and tasks?
Please answer in detail:

Department, job title:

Job task:

The problem with the NSO death data is that there are no means by which certain aspects of the dead person's economic status, whether they were retired or unemployed, for example, can be specified. Bias might occur, then, if unemployed or economically inactive people are included in the study population. To avoid this, values such as 'unknown', 'unemployed' and 'services' are excluded from our study population (see Appendix Table). Again, although this helps, it does not exclude the possibility that bias may remain.

(3) Possible mis-classification of causes of death

In Korea, families report the death of a loved one to the Civil Office. Death certificates, issued by medical doctors or doctors of oriental medicine, are submitted along with the death report. However, submission of a death certificate is not compulsory, especially when deaths occur at home or somewhere other than hospital. There is thus a potential for bias in cause of death variables. To take this into account, the rate of diagnosis among different occupational groups are compared, using official statistics from the National Statistics Office (Table 4.2 and Appendix).

We note that deaths of non-manual workers are more often confirmed by medical doctors than those of manual workers. This discrepancy, between manual and non-manual groups, is greater for women than for men. Hence, there may be differential error for cause specific mortality.

Table 4.2 Proportion of diagnoses for all-causes of death (1993 to 1997, aged 20-64) *

(Unit : percentage (%))

Occupational group	Diagnosis by medical doctor	Diagnosis by oriental medical doctor	Unclear about the diagnosis	Total
Men				
Unknown	80.42	1.60	17.98	100.00
Non-manual	87.64	1.22	11.14	100.00
Manual	65.31	0.94	33.75	100.00
Unemployment, housework	76.86	2.35	20.78	100.00
Army	83.74	0.62	15.64	100.00
Women				
Unknown	79.45	1.24	19.30	100.00
Non-manual	88.37	0.80	10.84	100.00
Manual	48.18	0.59	51.23	100.00
Unemployment, housework	76.81	2.03	21.16	100.00
Army	76.92	19.23	3.85	100.00

* This raw data come from the questionnaire in the death report – ref.: National Statistics Office in Korea

4.3.3 Exclusions and inclusions: the final study population

4.3.3.1 Exclusions

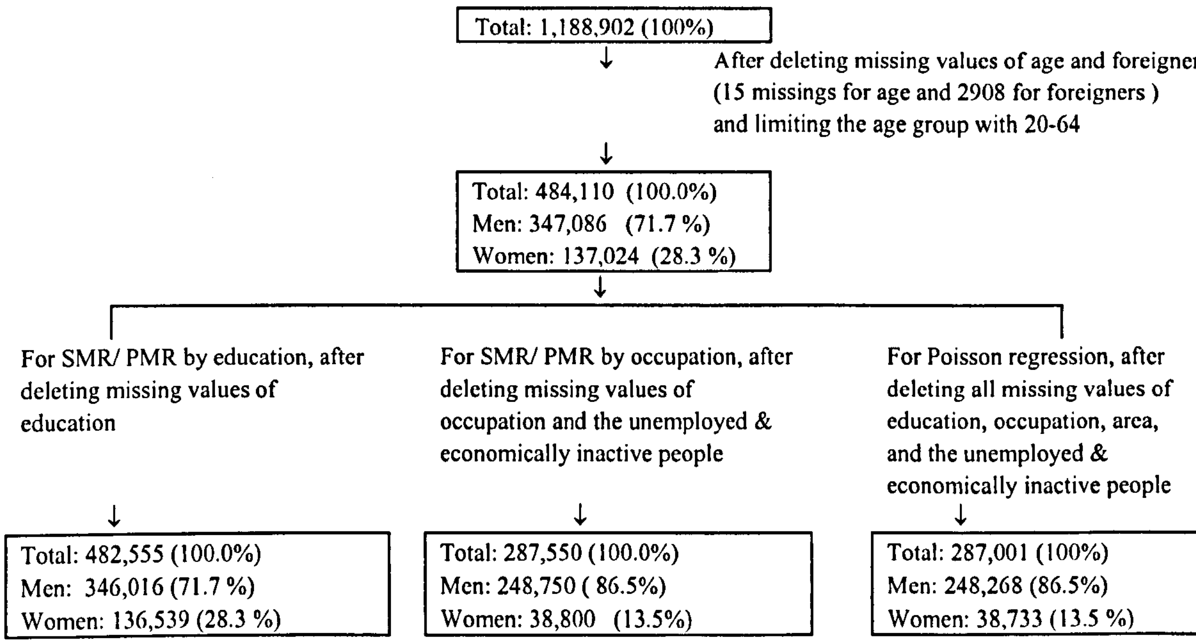
The study population is limited to the economically active working population aged between 20 and 64 years. As we focus on the effect of occupational class on mortality differentials, the unemployed and economically inactive (the retired, students and housewives) are excluded. Part-time workers, however, are included. The age group is limited to those between 20-64 years as a quite large percentage of the Korean population (men: 60% +; women: 20%+) work until 60-64 years of age. In addition to this, through discussion with several workers it is found that quite a large number continue to work beyond the formal retirement age (between 55 and 60) in the large factories (Daewoo: 60 years; Kia: 55; Hyundai: 57; Ssangyong: 57). Also, from correspondance with workers in small- to medium-sized factories, it is evident that no clear-cut retirement age is recognised in these workplaces.

At the other end of the scale, as it were, quite a large proportion begin their working lives between the ages of 20-24 years (men: around 45%; women: around 40%); a fact that we feel justifies the selection of ages 20 and 64 years as limits for our study population. Secondly, the use of this age group is comparable to other studies in other countries. For example, in Britain in a study of adult mortality rates, Farr selects the period between 25 and 65 years as that in which 'the influence of profession is most felt' (OPCS, 1978). Stevenson includes men aged 20-25 years because the 'average worker has at the age of 20 been sufficiently long subjected to the environmental influences of his occupation to make definite influence on his mortality possible' (OPCS, 1978). Today, the SMR for adults is still based on persons aged 15 to 64 years; the lower limit is related to the minimum school leaving age (15 years), the upper limit, to retirement age. Early retirement may affect rates in the older age groups, particularly for men aged 60-64 years (OPCS, 1978).

4.3.3.2 Deaths

Total deaths between 1993 and 1997 stand at 1,188,902; deaths between 20-64 age, 484,110 (after deleting 15 missing values for age and 2,908 deceased non-Koreans). The total deaths for Standardised Mortality Ratios (SMRs) and Proportional Mortality Rates (PMRs) by education, are 482,555, after excluding 1,555 (men: 1,070; women: 485) missing values for education (Figure 4.1). The total deaths for SMRs and PMRs by occupation are 287,550 (Figure 4.1). We exclude the unemployed or housewives (men: 92,378 (26.62%); women: 96,566 (70.47%)), those in the services (men: 2,902 (0.84%); women: 26 (0.02%)) or those for whom the occupational information is recorded as 'unknown' (men: 3,056 (0.88%); women: 1,632 (1.19%)). To explore the relationship between occupation and education, all the missing values of age, sex, geographical area, education and occupation were excluded, leaving us with total deaths of 287,001 (Figure 4.1). To explore the relationship of occupation, education and deprivation to mortality, considering the variability of mortality across 223 geographical areas, the total deaths are 286,377 (men: 247,825; women: 38,552) after deleting 624 deaths (men: 443; women: 181), which do not match the *Census* data.

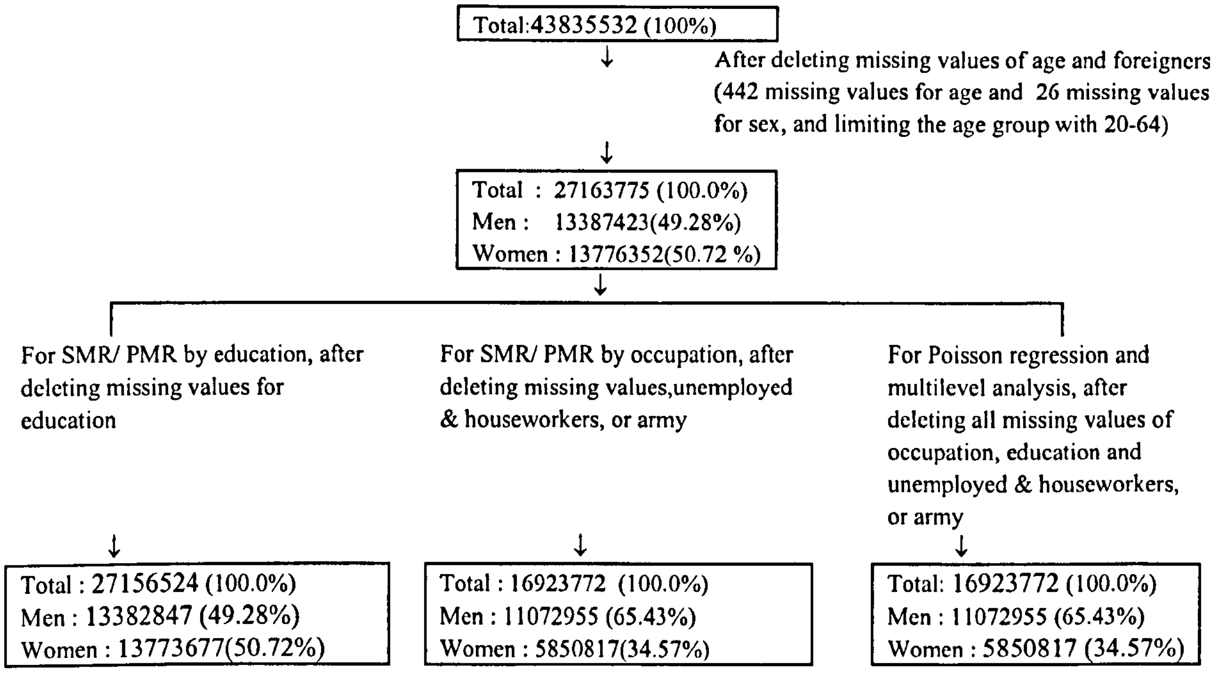
Figure 4.1 The total deaths for this study



4.3.3.3. The 1995 *Census*

The total study population for 'person years' between 1993 and 1997, deduced from a 10% stratified random sample from the 1995 *Census*, is 43,835,532. The study population aged between 20-64 age is 27,163,775, after deleting 26 missing values for gender and 442 missing values for age (Figure 4.2). To calculate SMRs by education, 7151 (0.03%) missing values (men: 4576 (0.03%); women: 2675 (0.02%)) have been deleted, leaving us with a study population of 27,156,524 (Figure 4.2). To calculate SMRs and PMRs by occupation we exclude the unemployed or housewives (men: 2,237,884 (16.72%); women: 7,923,991 (57.52%)), those in the services (men: 74,027 (0.55%); women: 1014 (0.01%)) or of unknown occupation (men 2557 (0.02%); women: 3087 (0.015)). Including part-time workers, the study population becomes 16,923,772 (Figure 4.2). This study population is also used to explore the relationship of occupation, education and deprivation to mortality rates.

Figure 4.2 Final study population of the 1995 *Census*



4.3.4 Definition of variables

4.3.4.1 The definition and regrouping of variables

(1) Occupation

Information on occupation obtained from the NSO death data is grouped in 9 broad categories using the *Korean Standard Classification of Occupations (KSCO).* Information on occupation obtained from the *Census* is grouped in more detailed three-digit set of categories also using the *KSCO.* After re-grouping the latter into the 9 broad *KSCO* categories, we divide the resulting set into broader *manual* and *non-manual* occupational classes (Table 4.4). This helps us to avoid potential numerator-denominator bias in the 9 categories of occupation for SMR and Poisson regression. In relation to PMRs, we investigated the 9 categories of occupation in order to ensure minimal numerator-denominator bias.

(2) Education

In the *Census* and NSO death data, education is defined by 'regular educational status', term used by the Ministry of Education (Table 4.4). Education in both surveys is re grouped into four categories: *less than elementary school, middle school, high school* and *higher than university*. In terms of duration of education, this comes out as: *fewer than 6 years, 9-12 years, 12-16 years* and *more than 16 years*. The uneducated group is included in the group of graduates from elementary school, as the genuinely uneducated are few in number.

(3) Deprivation index

As there has been no measurement of deprivation in Korea, we begin by proposing a measure of deprivation using the Korean *Census* data. We are able to utilise elements from Carstairs' deprivation index, these include: overcrowding, male unemployment and low social class. The Korean *Census* has no variable concerning car ownership; thus home ownership and housing amenities function as proxy variables. According to Townsend et al (1986), non-owner occupation reflects wealth as well as income. However, home ownership might not play this role in rural areas as people there tend to own houses which are much cheaper than those in urban areas. People in urban areas also face higher population densities and a shortage of appropriate properties, factors which reduce the likelihood of home ownership. Another issue here is differential quality of available housing in urban and rural areas, making the use of home ownership as an index of relative wealth or deprivation somewhat complicated.

To overcome this problem, we deploy the criteria of home ownership and quality (measured in terms of availability or absence of amenities) in tandem. In considering home ownership, the lowest boundaries of housing tenure are used. For example, the *Census* uses the following categories of housing tenure: (i) ownership; (ii) yearly rental; (iii) monthly rental with assured tenancy; (iv) monthly rental without assured tenancy; (v) irregular rental; (vi) rent free. 'Deprived' homes are classified as those with tenures entailing monthly rental without assured tenancy, irregular rental payment and/or rent free.

'Lower education' is also considered as a proxy of deprivation. This category, however, is highly correlated to the 'lower social class' variable (r=0.92 (p=0.0001)). We therefore removed 'lower education' from our criteria. Finally, to measure the deprivation index across geographical areas, five variables were selected from the *Census*. These are:

Overcrowding: persons in private households living at a density of >1.5 person per room as a proportion of all persons in private households

Male unemployment: proportion of economically active males who are seeking work

Low social class (occupation of head of household): proportion of all persons in private households with head of household in manual class

Monthly rental without assurance: persons in private households paying monthly rental without assured tenancy, irregular rental payment, or rent free

Lack of basic amenities: persons in private households which lack amenities such as kitchen, toilet or bath or sharing kitchen, toilet or bath

Overcrowding may reflect 'lack of material resources' (Carstairs and Morris, 1991). Townsend et al (1986) note that this indicator "helps to balance that on housing tenure, bearing in mind that in present day conditions owner occupation by no means always represents substantial command of resources".

Unemployment reflects "a great deal more than the lack of access to earned income and the facilities of employment, in that it carries implications for a general lack of material resources and the insecurity to which this gives rise" (Towensend et al, 1986). According to Townsend et al (1986), "unemployment is a harbinger of other misfortune".

Manual occupation class of head of household may usefully serve as a substitute for the 'low social class' variable in other deprivation indices (Carstairs' or Townsend index) in Korea. As Korea gathers no data on social classes I to V, as in the UK, but gathers information about occupation, a reliable substitute is to categorise social class using occupation. Carstairs and Morris (1991) argue that "being in low a social class – i.e. in semi-skilled or unskilled occupations- indicates earnings at the lower end of the income scale".

Monthly rental without assured tenancy may reflect a lack of wealth as well as income. In Korea, as housing ownership is different between urban and rural areas, we select 'monthly rental without assured tenancy' as an indicator of extreme poverty. This entails a lack of both material resources and security.

Lack of basic amenities reflects a lack of material resources. Even though Townsend et al (1986) propose that a lack of basic amenities is no longer widely representative of poor housing in the UK, this may help to balance our focus on the 'monthly rental without assured tenancy' variable as well as reflecting the lack of resources in Korea.

To categorise these deprivation indices, we combine the variables into a single score for each geographical area (223 areas, population range: 2874 -101,045) by means of the Z-score technique. This method is adapted from Carstairs and Morris (1989b) who use the five standardised component variables added together into one score, giving a population mean of zero and a standard deviation of 1. The combined index is split into quintiles ranging from *very affluent* to *very deprived.*

(4) Geographical area

The concept of geographical area used in the present study is based on the 245 Korean administration areas, as coded by the Korean National Statistics Office (NSO). Both the NSO death data and the *Census* use similar conceptions. Between 1993 and 1997, several new areas separated off and a few of the old areas were combined and certain codes were changed. We therefore re-coded several of the administrative areas in order to compare records across years. As a consequence, the study utilises 223 geographical areas (132 rural and 91urban).

(5) Age and sex

Age is categorised into 5-year bands with men and women calculated separately.

(6) Causes of death

Data on causes of death takes form of three-digit figures using ICD 9 (until 1994, thereafter, ICD 10). These are re-grouped into 17 general categories (Table 4.3). From these 17 categories, the most frequent causes are selected as follows: infections, neoplasms, nutritional diseases, mental health disorders, circulatory diseases, respiratory diseases, digestive diseases, musculo-skeletal diseases, injury and toxicity (i.e. external causes of death). The latter are re-grouped as follows: traffic accidents, accidental poisoning by, and exposure to, noxious substances, suicides, homicides, unexpected falls, unexpected drowning, injury by fires, exposure to inanimate mechanical forces and others.

Table 4.3 Main disease categories used in this study

Disease category	ICD 9	ICD 10	Special Occupational diseases
Main diseases			
1. All causes of diseases	001-999	A00-Z99	
2. Certain Infections and parasitic diseases	001-139	C00-D48	
2.1 Tuberculosis	010-018	A15-A19	
3. Neoplasms	140-239	C00-C48	
3.1 Malignant neoplasm of stomach	151	C16	
3.2 Malignant neoplasm of liver and intrahepatic bile ducts	155	C22	
3.3 Malignant neoplasm of trachea, bronchus, and lung	162	C33-C34	Known
3.4 Malignant neoplasm of colon, rectum, and anus	153-154	C18-C21	
3.5 Malignant neoplasm of pancreas	157	C25	
3.6 Malignant neoplasm of oesophagus	150	C15	
3.7 Leukemia	204-208	C91-C95	
3.8 Malignant neoplasm of breast	174	C50	
3.9 Malignant neoplasm of cervix	180	C53	
3.10 Melanoma of Skin and other neoplasms of skin	172-173	C43-C44	Known
3.11 Neoplasm of bladder	188	C67	Known
3.12 Neoplasm of the nose and nasal sinuses	160	C30	Known
4. Diseases of circulatory systems	390-459	I00-I99	
4.1 Cerebrovascular diseases	430-438	I60-I69	
4.2 Ischemic heart diseases	410-414	I20-I25	
4.3 Hypertensive diseases	401-405	I10-I15	
5. Diseases of respiratory systems	460-519	J00-J99	
5.1 Asbestos related diseases (Asbestos, mesothelioma, cancer of pleural area, cancer of retroperitoneum	501, 163, 158(158.0, 158.8,158.9)	J61, C45, C48	Known
5.2 Asthma	493	J45-J46	Known
5.3 Coal Worker's Pneumoconiosis (including silicosis)	500, 503, 505, 502	J60, J63, J64, J65, J62	Known
6. Diseases of digestive systems	520-579	K00-K93	
6.2 Diseases of liver	571-573	K70-K76	
7. Endocrine, nutritional and metabolic disease	240-279	E00-E90	
7.1 DM	250	E10-E14	
8 Mental disorder	290-319	F00-F99	
8.1 Mental and behavioral disorders due to psychoactive substance use	303-304	F10-F19	
9. Diseases of musculoskeletal system and connective tissue			
10. Injury, poisoning and certain other consequences of external causes	E800-E999	V01-Y98	
9.1 Traffic accidents			
9.2 Accidental poisoning by and exposure to noxious substances			Known
9.3 Suicide			
9.4 Homicide			
9.5 Falls			Known
9.6 Injured by fire			
9.7 Drowning			
9.8 Exposure to inanimate mechanical forces			
9.9 others			Known

Known: These diseases have been noticed to be more related to occupation, compared other diseases

Table 4.4 The definition and regrouping of the variables

		Grouping	Regrouping
Occupation	Deaths	0 Unknown or Inadequately described occupation (not enough information to code) 1 Legislators, Senior officials & managers 2 Professionals 3 Technicians & Associate Professionals 4 Clerks 5 Service workers & shop and Market Sales Workers 6 Skilled Agricultural & fishery workers 7 Craft & related Trades Workers 8 Plant & Machine Operators & Assemblers 9 Elementary Occupations 10, 11, 13 Unemployed & Not economic active 12 Armed forces	1-9 : 9 occupational groups 1-5 : Manual 6-9 : Non-manual
	Census	0 Unknown or Inadequately described occupation (not enough information to code) 1 Legislators, Senior officials & managers (001-131) 2 Professionals (002-246) 3 Technicians & Associate Professionals (003-348) 4 Clerks (004-422) 5 Service workers & shop and Market Sales Workers (005-523) 6 Skilled Agricultural & fishery workers (006-621) 7 Craft & related Trades Workers (007-744) 8 Plant & Machine Operators & Assemblers (008-834) 9 Elementary Occupations (009-933) 10 Unemployed & Not economically active (11 Unemployed & not economic active (full time house work, full time student, seeking job, and people who are old or have a disease) 12 Armed forces (011)	1-9 : 9 occupational groups 1-5 : Manual 6-9 : Non-manual
Education	Deaths	0 : Unknown 1 : Unschooled 2 : Elementary 3 : Middle school 4 : High school 5 : University	1 : less than elementary level 2 : Middle school 3 : High school 4 : University
	Census	0 : Unknown 1 : Not educated 2 : Elementary 3: Middle 4: High 5: College 6: University 7: Pose graduate	1 : less than elementary level 2 : Middle school 3 : High school 4 : University (from ex-code of 5, or 6, or 7)
Deprivation index	Census	Overcrowding Male unemployment Manual class head in house Housing ownership and lack of amenities	Each index was standardised by z-score, combined together and split into quintiles of seven categories
Area	Deaths	Administrative area of 1993,4,5,6,7	223 administrative areas
	Census	Administrative area of 1995	223 administrative areas
Age	Deaths	Calculated from the formula; death date - birth date informed in the social certificate number	- 5 year band age group - 20-64/20-49/50-59
	Census	Calculated from their real birth date regardless of social security number	- 5 year band age group - 20-64/20-49/50-59
Cause of disease	Deaths	ICD 9,10	-Regrouping into main diseases, cancers, and occupational diseases
external cause of disease	Deaths	ICD 9,10	-Regrouping into main diseases

4.3.5 Statistical analysis

The number of deaths from the NSO death data and person years from the *Census* are linked according to age, sex, occupation, education, urban/rural residence and 223 geographical areas. SMRs are calculated for the different occupational and educational groups. The formula for the confidence intervals for the SMRs are those suggested by Rothman and Boice (1979) (cited by Checkoway et al, 1989, p127). The advantage of using SMRs is that the comparison of mortality rates between the standard population and a particular group is easier (*OPCS*, 1995). However, there is a risk of numerator/denominator bias as different data sources are used to calculate the observed and expected numbers of deaths (*OPCS*, 1995). PMRs, standardised for age, are calculated for 9 categories of occupation. The main advantage of using PMRs is that they are free from the numerator/denominator bias that affects SMRs (*OPCS*, 1995). With PMRs, the proportion of deaths from a specified cause relative to all deaths among the particular group is compared with the corresponding proportion in the total population. The major problem in the interpretation of PMRs is that the relative frequency of other causes of death can affect proportional mortality for the highlighted cause. Both SMRs and PMRs are calculated for manual and non-manual occupational groups to illustrate the different results obtained.

Poisson regression is used to examine the relationship between occupation and mortality rates, adjusting for education, urban and rural residence area as well as for age. The interactions between the explanatory variables in their effect on outcomes are investigated. The relationship of occupation, education and deprivation indices with mortality is examined, taking account of variability of mortality across 223 geographical areas, using MLwiN software with a Multilevel Poisson model (Rasbash et al, 2000). In the Multilevel model, the residual variance between age, sex, occupation and education groups within an area is considered as level one, and between areas (223 geographical areas) as level two. Men and women are modelled separately, to allow for any gender differentiation in the relationships.

4.4. Results

4.4.1 Simple comparisons of mortality

4.4.1.1. Occupational class

(1) All-cause mortality between manual and non-manual occupational classes

Table 4.5 shows that Korean manual workers have higher SMRs for all-cause mortality than non-manual workers for both men and women aged 20-64 years. Male manual workers have a 21% greater mortality than all male workers aged 20-64 years, and female manual workers have a 12% greater mortality than all female workers aged 20-64. In particular, the difference in SMRs between manual and non-manual workers is higher among the younger group (aged 20-49) than the older group.

Table 4.5 The Standardised Mortality Ratios for all-causes of death by occupation, men and women aged 20-64

	Men				Women			
All causes	Deaths	Expected	SMR	(95% CI)	Deaths	Expected	SMR	(95% CI)
20-64								
Non-manual	82653	111003.2	74	74-75	12799	15632.9	82	80-83
Manual	166097	137746.9	121	120-121	26001	23167.1	112	111-114
20-49								
Non-manual	45247	62100.7	73	72-74	8874	10078.0	88	86-90
Manual	72239	55385.3	130	129-131	7050	5846.0	121	118-123
50-59								
Non-manual	27505	36505.9	75	74-76	2959	4082.0	72	70-75
Manual	60872	51871.2	117	116-118	10740	9617.0	112	110-114
60-64								
Non-manual	9901	12396.6	80	78-81	966	1472.9	66	62-70
Manual	32986	30490.4	108	107-109	8211	7704.2	107	104-109

(2) Cause-specific mortality between manual and non-manual occupational classes

Table 4.6 shows Korean cause-specific mortality. Manual workers have higher SMRs for all specific causes than non-manual workers, for both men and women aged 20-64 years. For the younger group (aged 20-49), manual workers have a higher mortality rate for most of the specific causes of death than non-manual workers, compared to the older group for both men and women (detailed results not shown).

It is clear that manual workers have particularly high SMRs for respiratory, mental and digestive diseases, injuries, infections and musculo-skeletal diseases. Because in later analyses we rely on PMRs, it is useful here to examine the relationship between SMRs and PMRs. The PMR for specific disease is approximately the same as the SMR for specific disease, divided by the SMR for all-cause mortality. For example, the PMR for infectious diseases is similar to the SMR divided by SMR for all-causes of death. Thus, it is 109 (=132/121) for male manual workers and 110 (=124/112) for female manual workers. In this study, the diseases which have SMRs higher than all-cause SMRs (male: 121; female: 112) among manual workers, are infectious diseases (tuberculosis), mental health disorders due to psychoactive substance use, respiratory (asthma), digestive (liver disease) and musculo-skeletal diseases. However, for neoplasms, nutritional and circulatory diseases, male manual workers have lower PMRs than male non-manual workers. For neoplasms and injuries, female manual workers have lower PMRs than female non-manual workers, despite higher SMRs. An interesting point is that, for circulatory diseases, male and female manual workers have lower mortality for Ischemic Heart Disease, but higher mortality for cerebrovascular disease and hypertension than non-manual workers (see Appendix).

Table 4.6 The SMRs and PMRs for specific-cause mortality by occupational class, men and women aged 20-64

	Men					Women				
	Deaths	SMR	(95%CI)	PMR	(95%CI)	Deaths	SMR	(95%CI)	PMR	(95%CI)
Infections										
Non-manual	1636	61	58-64	83	79-87	248	74	65-83	87	77-99
Manual	4432	132	128-135	109	105-112	468	124	113-135	110	99-119
Neoplasms										
Non-manual	24615	87	86-89	118	116-119	3406	84	82-87	106	102-109
Manual	43286	109	108-110	92	91-93	7751	109	106-111	98	96-100
Nutrition										
Non-manual	2117	79	76-83	107	103-112	190	58	50-67	75	65-86
Manual	4300	115	111-118	97	94-100	866	119	111-127	108	101-115
Mental										
Non-manual	607	36	33-39	50	46-54	53	43	32-56	52	39-68
Manual	2991	157	151-163	126	121-130	251	139	123-158	124	109-140
Circulatory										
Non-manual	14693	80	79-82	108	107-110	2093	67	65-70	87	83-90
Manual	28394	114	113-116	96	95-97	7579	115	113-118	104	102-107
Respiratory										
Non-manual	1446	65	62-68	86	82-91	171	72	62-84	90	77-105
Manual	4093	124	120-128	106	103-109	506	115	105-126	104	95-113

Digestive										
Non-manual	8055	56	55-57	77	76-79	400	57	51-62	72	65-79
Manual	23839	136	134-138	111	110-113	1696	122	116-128	110	105-116
Musculoskel etal										
Non-manual	97	42	34-51	55	45-68	84	76	60-94	92	74-115
Manual	489	138	126-151	119	109-130	188	117	101-135	104	90-120
Injury										
Non-manual	25503	72	71-73	95	94-96	5518	96	93-98	111	109-114
Manual	46885	127	126-129	103	102-104	5277	105	102-108	90	88-93

Infections: Certain Infections and parasitic diseases
Neoplasms: Neoplasms
Nutrition: Endocrine, nutritional and metabolic disease
Mental: Mental disorder
Circulatory: Diseases of circulatory systems
Respiratory: Diseases of respiratory systems
Digestive: Diseases of digestive systems
Musculoskeletal: Diseases of musculoskeletal system and conntective tissue
Injury: Injury, poisoning and certain other consequences of external causes

(3) External-cause mortality between manual and non-manual occupational classes

Table 4.7 shows that for most cases of external-cause mortality, manual workers have higher SMRs than non-manual workers for both males and females aged 20-64 years. Furthermore, the external-cause mortality categories which have excessively high SMRs, (i.e. higher risks than other external-cause mortalities) among manual workers, are accidental poisoning by and exposure to noxious substances, falls and exposure to inanimate mechanical forces. The younger group of manual workers have higher SMRs than the older group for accidental poisoning by, and exposure to, noxious substances, falls, exposure to inanimate mechanical forces, suicides, injuries by fire and drowning.

Table 4.7 The SMRs and PMRs for external-cause mortality by occupation, men and women aged 20-64

		Men					Women				
		Deaths	SMR	95% CI	PMR	95% CI	Deaths	SMR	95% CI	PMR	95% CI
TA	NM	15128	79	78-81	104	103-106	3010	101	97-104	118	114-123
	M	23535	120	118-121	97	96-99	2947	99	96-103	86	83-89
Toxic	NM	534	47	43-51	63	58-63	174	59	50-68	68	58-79
	M	1846	148	142-155	121	115-126	357	152	137-169	130	116-144
Suicide	NM	2925	66	64-68	88	85-92	793	82	76-87	94	87-100
	M	5984	134	130-137	107	104-110	797	129	120-138	107	100-115
Homicide	NM	673	83	77-90	111	102-109	413	135	122-149	155	141-171
	M	906	117	110-125	93	87-100	105	49	40-60	42	34-51
Falls	NM	1238	54	51-57	72	68-76	128	84	70-100	99	83-118
	M	3599	142	138-147	115	112-119	194	115	99-132	100	87-116

Fire	NM	555	77	71-84	103	94-112	174	113	97-132	130	112-151
	M	873	123	115-132	98	92-105	86	81	65-100	68	54-84
Drowning	NM	1316	78	73-82	102	96-107	137	77	64-91	89	74-105
	M	2062	123	117-128	99	95-103	179	130	112-151	111	95-129
Machine	NM	548	46	42-50	61	56-67	265	108	96-122	123	108-138
	M	1925	149	143-157	122	116-127	109	84	69-102	69	57-83
Others	NM	2682	59	57-62	80	77-83	432	89	80-97	104	94-114
	M	6543	139	136-142	112	109-115	522	112	103-122	97	89-106

TA: Transport accidents
Toxic: Accidental poisoning by and exposure to noxious substances
Suicide: Intentional self-harm
Homicide: Assualt
Falls: Falls
Fire: Exposure to smoke, fire, and flames
Drowning: Accidental drowning and submersion
Machine: Exposure to inanimate mechanical forces
Others: Others

(4) Case-specific mortality by 9 occupational groups

Table 4.8 gives the PMRs for specific diseases by occupation. This presents in more detail the relationship between 9 occupational groups and mortality, which are not available from the SMRs due to the risk of numerator/denominator bias. Injuries caused a higher proportion of deaths among industrial workers (craft and related trades, plant and machine operators and assemblers, labourers) than any other specific factor. In particular, labourers suffer higher proportions of infections, mental health disorders, respiratory, and digestive diseases, injuries and musculo-skeletal disorders (Table 4.8). Craft and related trade workers suffer higher rates of mental health disorders (among men), respiratory diseases and injuries. Plant and machine operators are inflicted with a higher proportion of neoplasms, respiratory diseases (among women) and injuries. A higher proportion of infections, nutritional, mental, respiratory, digestive and musculo-skeletal disorders afflict agricultural workers.

On the other hand, neoplasms, nutritional and circulatory diseases are found in higher proportions among all specific causes of death for managers, professionals, technicians and service, shop and market retail workers. Clerks suffer a higher proportion of neoplasms and circulatory diseases.

Table 4.8 PMRs of specific-cause mortality by occupation, men and women aged 20-64

	Men				Women			
	Deaths	Expected	PMR	95% CI	Deaths	Expected	PMR	95% CI
Infections								
Legislators, Senior officials & managers	22	35.1	63	39-96	-	-	-	-
Professionals	129	176.2	73	61-87	24	29.3	82	52-123
Technicians & Associate Professionals	135	152.0	89	75-105	19	19.3	98	59-155
Clerks	421	627.0	67	61-74	73	75.1	97	76-122
Service workers & shop and Market Sales	929	993.4	94	88-100	132	159.3	83	69-98
Skilled Agricultural & fishery workers	2576	2179.7	118	114-123	392	352.0	111	101-123
Craft & related Trades Workers	946	1020.8	93	87-99	53	47.8	111	83-145
Plant & Machine Operators & Assemblers	244	331.9	74	65-83	1	2.2	45	1-370
Elementary Occupations (Labourers)	666	552.8	120	112-130	22	30.0	73	46-112
Neoplasms								
Legislators, Senior officials & managers	539	417.4	129	118-141	9	10.7	84	38-164
Professionals	2569	2049.1	125	121-130	472	292.6	161	147-177
Technicians & Associate Professionals	1872	1558.8	120	115-126	265	196.9	135	119-152
Clerks	7915	6225.0	127	124-130	691	574.8	120	111-130
Service workers & shop and Market Sales	11720	10691.7	110	108-112	1969	2150.3	92	88-96
Skilled Agricultural & fishery workers	25723	27716.8	93	92-94	6832	6827.3	100	98-102
Craft & related Trades Workers	9523	10025.7	95	93-97	511	572.7	89	82-97
Plant & Machine Operators & Assemblers	3143	3074.2	102	99-106	25	26.0	96	62-143
Elementary Occupations (Labourers)	4897	6143.3	80	77-82	383	506.7	76	68-84
Nutrition								
Legislators, Senior officials & managers	48	39.5	122	90-162	2	0.86	233	26-1012
Professionals	215	193.2	111	97-127	13	22.6	58	31-100
Technicians & Associate Professionals	153	147.0	104	88-122	13	15.5	84	45-146
Clerks	494	583.1	85	77-93	30	44.5	67	45-97
Service workers & shop and Market Sales	1207	1011.5	119	113-126	132	170.3	78	65-92
Skilled Agricultural & fishery workers	2673	2617.5	102	98-106	798	710.1	112	105-120
Craft & related Trades Workers	794	950.1	84	78-90	30	45.6	66	44-94
Plant & Machine Operators & Assemblers	289	292.3	99	88-111	2	1.9	103	12-447
Elementary Occupations (Labourers)	544	583.0	93	86-101	36	44.5	81	57-112
Mental dis								
Legislators, Senior officials & managers	2	20.2	10	1-43	1	0.3	305	4-2492
Professionals	31	100.6	31	21-44	4	10.1	40	11-110
Technicians & Associate Professionals	46	94.2	49	36-65	5	6.4	78	25-193
Clerks	133	394.1	34	28-40	9	20.6	44	20-85
Service workers & shop and Market Sales	395	612.6	64	58-71	34	64.1	53	37-75
Skilled Agricultural & fishery workers	1561	1151.9	136	129-142	232	171.0	136	119-154
Craft & related Trades Workers	681	663.8	103	95-111	10	17.1	58	28-110
Plant & Machine Operators & Assemblers	127	222.3	57	48-68	-	-	-	-
Elementary Occupations (Labourers)	622	338.0	184	170-199	9	13.4	67	31-131
Circulatory								
Legislators, Senior officials & managers	273	258.3	106	94-119	5	8.1	62	20-153
Professionals	1402	1283.6	109	104-115	142	209.0	68	57-80
Technicians & Associate Professionals	1046	1020.0	103	96-109	108	144.2	75	61-91
Clerks	4226	4126.6	102	99-106	309	381.9	81	72-90
Service workers & shop and Market Sales	7746	6854.7	113	111-116	1529	1674.4	91	87-96
Skilled Agricultural & fishery workers	16330	16896.0	97	95-98	6726	6370.0	106	103-108
Craft & related Trades Workers	6286	6664.5	94	92-97	432	437.2	99	90-109
Plant & Machine Operators & Assemblers	2028	2095.9	97	93-101	12	19.2	62	32-111
Elementary Occupations (Labourers)	3750	3888.1	96	93-100	409	427.9	96	87-105

Respiratory								
Legislators, Senior officials & managers	18	33.9	53	31-85	1	0.6	164	2-1341
Professionals	133	169.3	79	66-93	17	17.4	98	57-158
Technicians & Associate Professionals	108	124.8	87	71-105	14	11.8	118	64-201
Clerks	383	495.2	77	70-85	32	36.6	87	60-124
Service workers & shop and Market Sales	804	849.4	95	88-101	107	123.3	87	71-105
Skilled Agricultural & fishery workers	2351	2355.3	100	96-104	438	423.2	103	94-114
Craft & related Trades Workers	1044	783.8	133	125-142	36	33.4	108	76-150
Plant & Machine Operators & Assemblers	185	238.5	78	67-90	2	1.5	131	15-567
Elementary Occupations (Labourers)	513	488.7	105	96-114	30	29.1	103	69-148
Digestive								
Legislators, Senior officials & managers	116	190.0	61	50-73	-	-	-	-
Professionals	635	916.1	69	64-75	34	48.3	70	49-99
Technicians & Associate Professionals	542	784.6	69	63-75	24	33.2	72	46-108
Clerks	2061	3208.4	64	61-67	55	89.3	62	46-80
Service workers & shop and Market Sales	4701	5337.4	88	86-91	287	384.1	75	66-84
Skilled Agricultural & fishery workers	14783	11274.8	131	129-133	1575	1338.5	118	112-124
Craft & related Trades Workers	4637	5415.4	86	83-88	51	100.7	51	37-67
Plant & Machine Operators & Assemblers	1031	1743.4	59	56-63	4	4.5	89	24-246
Elementary Occupations (Labourers)	3388	3024.0	112	108-116	66	95.6	69	53-88
Musculoskeletal								
Legislators, Senior officials & managers	-	-	-	-	-	-	-	-
Professionals	4	18.0	22	6-62	14	10.0	140	76-238
Technicians & Associate Professionals	6	13.1	46	17-104	7	6.2	112	45-241
Clerks	28	52.3	54	36-78	33	23.1	142	98-201
Service workers & shop and Market Sales	59	88.4	67	51-86	30	51.2	59	40-84
Skilled Agricultural & fishery workers	331	253.7	130	117-145	170	154.8	110	94-128
Craft & related Trades Workers	79	81.4	97	77-121	14	15.0	93	51-159
Plant & Machine Operators & Assemblers	17	24.8	69	40-111	-	-	-	-
Elementary Occupations (Labourers)	62	50.6	122	94-157	4	10.6	38	10-105
Injury								
Legislators, Senior officials & managers	317	335.4	95	84-106	22	14.9	147	92-225
Professionals	1618	1919.9	84	80-89	439	522.1	84	76-92
Technicians & Associate Professionals	2152	2190.0	98	94-103	329	347.0	95	85-106
Clerks	10172	10115.4	101	99-103	1502	1461.3	103	98-108
Service workers & shop and Market Sales	11244	12350.1	91	89-93	3226	2604.8	124	120-128
Skilled Agricultural & fishery workers	16896	18703.6	90	89-92	3629	4538.0	80	77-83
Craft & related Trades Workers	17079	15348.0	111	110-113	956	828.1	115	108-123
Plant & Machine Operators & Assemblers	6338	5364.1	118	115-121	48	37.1	129	95-172
Elementary Occupations (Labourers)	6572	6062.9	108	106-111	644	442.7	146	135-158

Infections: Certain Infections and parasitic diseases
Neoplasms: Neoplasms
Nutrition: Endocrine, nutritional and metabolic disease
Mental: Mental disorder
Circulatory: Diseases of circulatory systems
Respiratory: Diseases of respiratory systems
Digestive: Diseases of digestive systems
Musculoskeletal: Diseases of musculoskeletal system and conntective tissue
Injury: Injury, poisoning and certain other consequences of external causes

(5) External-cause mortality by 9 occupational groups

Table 4.9 shows that among these diseases, the proportion of deaths from injury at ages 20-64 among men is higher in craft & related trades workers, plant & machine operators & assemblers, and elementary workers than in managers and professionals. For craft & related trades workers, toxicity, falls, and injury due to machine were the highest risks compared to other external-cause mortality. For plant & machine operators & assemblers, the highest risks were traffic accidents, suicide, and injury due to machine. For labourers, the highest risks were suicide, homicide, falls and fire. Injury due to falls and injury due to machines could be closely related to working conditions, therefore, it could suggest that workers in a hazardous working environment are apt to have a higher mortality due to injury than workers in other environments. On the other hand, the manager group had a higher proportion of external causes of death from toxicity, suicide, homicide, and machinery.

Table 4.9 PMRs of external-cause mortality by occupation, men and women aged 20-64

	Men				Women			
	Deaths	Expected	PMR	95% CI	Deaths	Expected	PMR	95% CI
Transport accidents								
Legislators, Senior officials & managers	166	174.5	95	81-111	9	7.5	120	55-233
Professionals	992	1018.6	97	91-104	222	259.1	86	75-98
Technicians & Associate Professionals	1213	1186.0	102	97-108	176	175.6	100	86-116
Clerks	6309	5540.4	114	111-117	883	726.5	122	114-130
Service workers & shop and Market Sales	6448	6578.5	98	96-100	1720	1373.6	125	119-131
Skilled Agricultural & fishery workers	8427	9784.6	86	84-88	2000	2714.4	74	70-77
Craft & related Trades Workers	8280	8294.4	99.8	98-102	523	432.6	121	111-132
Plant & Machine Operators & Assemblers	4043	2906.9	139	135-143	32	19.0	169	116-240
Elementary Occupations (Labourers)	2785	3179.0	88	84-91	392	248.6	158	142-174
Toxicity								
Legislators, Senior officials & managers	12	12.0	100	52-178	1	0.8	124	2-1013
Professionals	28	64.7	43	29-63	13	28.0	46	25-81
Technicians & Associate Professionals	37	67.5	55	39-76	14	17.8	79	43-134
Clerks	187	303.5	62	53-71	48	73.9	65	48-86
Service workers & shop and Market Sales	270	402.3	67	59-76	98	135.0	73	59-89
Skilled Agricultural & fishery workers	1078	690.3	156	147-166	288	219.8	137	122-154
Craft & related Trades Workers	439	472.0	93	85-102	45	42.0	107	78-144
Plant & Machine Operators & Assemblers	135	161.2	84	70-99	4	2.0	197	53-548
Elementary Occupations (Labourers)	194	206.4	94	81-108	20	21.7	92	56-143
Suicide								
Legislators, Senior officials & managers	49	41.8	117	87-156	6	2.75	217	80-498
Professionals	170	236.7	72	61-83	102	96.8	105	86-128
Technicians & Associate Professionals	222	269.5	82	72-94	53	61.3	86	65-113
Clerks	956	1231.6	78	73-83	228	265.7	86	75-98
Service workers & shop and Market Sales	1528	1534.2	100	96-105	404	421.0	96	87-106
Skilled Agricultural & fishery workers	2494	2270.5	110	106-114	617	537.9	115	106-124

Craft & related Trades Workers	1821	1898.3	96	92-100	113	136.6	83	68-100
Plant & Machine Operators & Assemblers	755	666.2	113	105-122	2	6.4	31	4-136
Elementary Occupations (Labourers)	914	760.3	120	113-128	65	61.6	106	81-135
Homicide								
Legislators, Senior officials & managers	13	6.75	193	103-335	-	-	-	-
Professionals	29	40.5	72	48-103	19	28.8	66	40-104
Technicians & Associate Professionals	61	50.5	121	92-156	16	18.3	87	50-144
Clerks	159	236.7	67	57-79	54	74.6	72	54-95
Service workers & shop and Market Sales	411	274.2	150	136-165	324	143.8	225	201-251
Skilled Agricultural & fishery workers	202	353.1	57	50-66	40	184.4	22	15-30
Craft & related Trades Workers	382	358.5	107	96-118	39	43.2	90	64-124
Plant & Machine Operators & Assemblers	134	128.3	104	88-124	2	2.2	89	10-387
Elementary Occupations (Labourers)	188	130.6	144	124-166	24	21.8	110	70-165
Falls								
Legislators, Senior officials & managers	15	24.8	60	34-101	1	0.377	265	3-2164
Professionals	97	132.6	73	59-89	13	12.9	101	54-176
Technicians & Associate Professionals	133	136.7	97	81-115	9	8.9	101	46-197
Clerks	501	605.6	83	76-90	30	36.1	83	56-119
Service workers & shop and Market Sales	492	820.0	60	55-66	75	70.5	106	84-133
Skilled Agricultural & fishery workers	843	1419.0	59	55-64	108	156.8	69	57-83
Craft & related Trades Workers	1806	949.2	190	182-199	46	22.1	209	153-279
Plant & Machine Operators & Assemblers	190	324.0	59	51-68	-	-	-	-
Elementary Occupations (Labourers)	760	425.3	179	166-192	40	13.4	298	213-407
Fire								
Legislators, Senior officials & managers	3	6.33	47	10-155	1	0.387	258	3.4-2108
Professionals	21	37.5	56	35-86	7	14.5	48	19-104
Technicians & Associate Professionals	46	44.5	103	76-138	8	9.2	87	37-177
Clerks	196	206.3	95	82-109	32	39.9	80	55-114
Service workers & shop and Market Sales	289	246.6	118	105-132	126	69.5	181	151-216
Skilled Agricultural & fishery workers	234	344.0	68	60-77	48	93.2	51	38-68
Craft & related Trades Workers	389	314.0	124	112-137	26	21.8	119	78-176
Plant & Machine Operators & Assemblers	91	111.5	82	66-100	1	1.1	90	1-731
Elementary Occupations (Labourers)	159	118.5	134	114-157	11	10.4	106	53-194
Drowning								
Legislators, Senior officials & managers	15	14.5	104	58-173	-	-	-	-
Professionals	92	86.5	106	86-131	14	16.2	86	47-147
Technicians & Associate Professionals	143	106.5	134	113-158	16	11.2	143	82-236
Clerks	569	506.1	112	103-122	50	49.1	102	76-135
Service workers & shop and Market Sales	497	581.5	85	78-93	57	77.9	73	55-95
Skilled Agricultural & fishery workers	813	779.7	104	97-112	140	121.7	115	97-136
Craft & related Trades Workers	763	759.3	100	93-108	25	25.9	97	62-144
Plant & Machine Operators & Assemblers	211	268.6	79	68-90	1	1.1	90	1.2-731
Elementary Occupations (Labourers)	275	275.4	100	88-112	13	12.5	104	55-181
Machine								
Legislators, Senior officials & managers	14	10.0	140	77-239	4	0.5	728	196-2020
Professionals	20	54.0	97	23-58	9	22.5	40	18-78
Technicians & Associate Professionals	37	56.8	65	46-90	10	16.0	63	30-118
Clerks	235	255.8	92	80-104	66	80.0	83	64-105
Service workers & shop and Market Sales	146	336.8	43	37-51	168	86.7	194	166-226
Skilled Agricultural & fishery workers	671	570.8	118	109-127	45	94.6	48	35-64
Craft & related Trades Workers	536	396.7	135	124-147	30	34.2	88	59-126
Plant & Machine Operators & Assemblers	158	135.7	116	99-136	2	1.2	162	18-704
Elementary Occupations (Labourers)	172	172.4	100	85-116	13	11.3	115	61-200

TA: Transport accidents
Toxic: Accidental poisoning by and exposure to noxious substances
Suicide: Intentional self-harm
Homicide: Assualt
Falls: Falls
Fire: Exposure to smoke, fire, and flames
Drowning: Accidental drowning and submersion
Machine: Exposure to inanimate mechanical forces
Others: Others

(6) Conclusions

Manual workers suffer higher mortality rates across the board than non-manual workers. Manual workers have notably high SMRs, and a higher proportion of deaths, for infectious diseases (tuberculosis), mental diseases (due to psychoactive substance use), respiratory diseases (asthma, CWP), digestive diseases (liver disease), musculo-skeletal diseases, accidental poisonings by exposure to noxious substances, falls and exposure to inanimate mechanical forces. An interesting point is that labourers also have higher proportions for these diseases among other specific causes of death, compared to the 9 occupational groups. For women, the difference in mortality between manual and non-manual workers is not as significant as for men, even though the patterns of disease are similar. Differences in mortality for all-causes as well as specific causes between manual and non-manual workers are greater among younger (aged 20-49 years) than older workers.

4.4.1.2 Education

(1) All-cause mortality by education

There is a strong inverse relationship between SMRs and educational level (Table 4.10). SMRs become greater as the education level moves downwards (from university to elementary level) for both genders. Differences in SMRs between best- and least-educated groups are greater in the younger than the older group (Table 4.10).

Table 4.10 The Standardised Mortality Ratios for all-cause mortality by education, men and women aged 20-64

All causes	Men				Women			
20-64	Deaths	Expected	SMR	95% CI	Deaths	Expected	SMR	95% CI
University(>=16yrs)	36893	82565.8	45	44-45	6687	12888.3	52	51-53
High(10-12yrs)	92617	118891.4	78	77-78	24425	32198.4	76	75-77
Middle(7-9yrs)	75573	59787.4	126	126-127	22428	22963.2	98	96-99
Elementary(<=6yrs)	140933	84771.4	166	165-167	82999	68489.1	121	120-122
20-49								
University	19972	50062.7	40	39-40	5345	10343.6	52	50-53
High	54738	70219.1	78	77-79	18363	23901.1	77	76-78
Middle	37496	23083.9	162	161-164	12789	11747.2	109	107-111
Elementary	44747	13588.2	329	326-332	18924	9429.1	201	198-204
50-59								
University	10705	21750.0	49	48-50	958	1886.6	51	48-54
High	26150	34778.8	75	74-76	4283	5945.2	72	70-74
Middle	26190	25419.2	103	102-104	6845	8080.0	85	83-87
Elementary	57479	38575.9	149	148-150	33903	30077.2	113	112-114
60-64								
University	6216	10754.1	58	56-59	384	658.0	58	53-65
High	11729	13893.4	84	83-86	1779	2352.1	76	72-79
Middle	11887	11284.3	105	103-107	2794	3136.0	89	86-92
Elementary	38707	32607.2	119	118-120	30172	28983.8	104	103-105

(2) Cause-specific mortality by educational level

Table 4.11 shows cause-specific mortality rates. All disease groups show higher SMRs for lower educational groups. Specific causes, with particularly high SMRs among those educated to less than elementary level, are: infectious diseases (tuberculosis), mental disorders due to psychoactive substance use, digestive diseases, most injuries, respiratory diseases (asbestos, CWP, asthma) and musculo-skeletal diseases (Table 4.11 and Appendix). We note the similarity between this picture and that for manual workers. For women, the difference in mortality rates between higher and lower educational groups is less notable than among men, although disease patterns are similar. The younger group have higher SMRs for most specific diseases and injuries, but higher PMRs for some conditions: infectious diseases (tuberculosis), mental disorders and respiratory diseases (Table not shown).

Table 4.11 The Standardised Mortality Ratios for cause-specific mortality by education, men and women aged 20-64

	Men					Women				
	Deaths	SMR	95% CI	PMR	95% CI	Deaths	SMR	95% CI	PMR	95% CI
Infections										
University	653	28	26-30	63	58-68	155	37	31-43	71	60-83
High	2219	63	61-66	84	81-88	712	71	66-77	93	86-100
Middle	2270	123	118-128	99	95-103	608	107	98-116	102	94-111
Elementary	5128	201	196-207	119	116-123	1769	141	135-148	106	101-111
Neoplasms										
University	10774	59	58-60	126	124-128	2342	67	65-70	131	125-136
High	22820	83	82-84	109	108-111	8271	87	85-88	118	115-120
Middle	19269	113	112-115	99	98-100	7739	99	96-101	105	103-108
Elementary	37955	136	135-138	91	90-92	25792	111	110-112	92	91-93
Nutrition										
University	1089	49	46-52	106	100-112	91	27	22-33	52	42-64
High	2649	79	76-82	105	101-109	612	66	61-71	89	82-96
Middle	2468	119	115-124	104	100-108	795	93	86-99	101	94-108
Elementary	4822	143	139-147	94	92-97	4183	117	114-121	104	101-107
Mental dis										
University	287	17	15-19	41	36-46	52	28	21-36	53	40-70
High	1356	54	51-57	73	69-77	249	54	48-61	72	63-81
Middle	1523	127	120-133	96	91-101	230	83	72-94	80	70-92
Elementary	3643	260	251-268	137	132-141	1077	158	149-168	123	116-130
Circulatory										
University	6678	52	50-53	112	109-115	718	35	32-37	67	62-72
High	15381	80	79-81	105	104-107	3618	62	60-64	84	81-86
Middle	13347	117	115-119	100	98-102	4897	89	86-91	97	95-100
Elementary	26596	145	143-146	95	94-96	25426	120	118-121	105	105-106
Respiratory										
University	625	35	33-38	74	69-80	111	48	40-58	93	76-112
High	1702	65	62-69	85	81-89	386	64	58-71	85	77-94
Middle	1797	112	106-117	98	93-102	441	94	85-103	98	89-108
Elementary	4674	166	161-171	114	111-117	1951	123	118-129	104	100-109
Digestive										
University	2713	26	25-27	63	60-65	195	34	29-39	66	57-76
High	9246	58	57-60	81	79-82	1022	63	59-66	86	80-91
Middle	10876	125	122-127	102	100-104	1331	90	86-95	99	94-104
Elementary	23289	206	203-209	118	117-120	5690	125	122-128	105	103-108
Musculoskeletal										
University	60	29	29-38	61	47-79	83	62	50-77	119	95-147
High	160	55	46-64	59	59-80	237	78	68-88	100	87-113
Middle	204	118	103-104	88	88-117	165	93	79-108	89	76-103
Elementary	549	181	166-197	114	114-135	701	123	114-132	101	94-109
Injury										
University	11998	42	42-43	97	95-99	2502	58	56-60	111	107-115
High	32466	86	85-87	104	102-105	7614	82	80-84	103	101-105
Middle	20121	157	155-159	101	99-102	4786	112	109-115	99	96-102
Elementary	26871	210	208-213	97	96-98	10813	138	136-141	96	94-98

Infections: Certain Infections and parasitic diseases
Neoplasms: Neoplasms
Nutrition: Endocrine, nutritional and metabolic disease
Mental: Mental disorder
Circulatory: Diseases of circulatory systems
Respiratory: Diseases of respiratory systems
Digestive: Diseases of digestive systems
Musculoskeletal: Diseases of musculoskeletal system and conntective tissue
Injury: Injury, poisoning and certain other consequences of external causes

(3) External-cause mortality by education

For most external causes of injury, men and women educated to less than elementary level have higher SMRs than those who educated to university level (Table 4.12). The particular external causes which have higher SMRs among the less well-educated are: accidental poisoning by, and exposure to, noxious substances, suicide, homicide, fire, drowning and exposure to inanimate mechanical forces. For women, the difference in mortality rates between higher and lower educational groups is not as great as for men, even though the external disease patterns are similar. The younger group exhibit higher SMRs for traffic accidents, accidental poisoning, suicides, homicides, fire, falls, drowning and exposure to inanimate mechanical forces.

Table 4.12 The Standardised Mortality Ratios of external cause mortality by education, men and women aged 20-64

	Men					Women				
	Deaths	SMR	95%CI	PMR	95%CI	Deaths	SMR	95%CI	PMR	95%CI
TA										
University	6462	46	45-47	104	101-107	1022	59	55-62	113	106-120
High	17066	92	91-93	108	107-111	3203	84	81-87	106	102-110
Middle	9379	154	151-157	97	95-99	2108	107	102-112	99	95-103
Elementary	11837	198	194-201	90	88-91	5372	129	125-132	95	93-98
Toxicity										
University	225	26	22-29	59	51-67	92	36	29-44	69	56-85
High	791	66	61-70	81	76-87	416	74	67-82	95	86-104
Middle	783	165	154-177	115	107-123	277	110	97-124	96	85-108
Elementary	1291	241	228-255	123	116-130	709	166	154-179	112	104-121
Suicide										
University	1816	41	39-43	95	90-99	728	63	58-67	120	111-129
High	4817	82	80-85	99	96-102	1979	82	79-86	102	98-107
Middle	3192	163	157-168	103	100-107	1102	119	112-127	98	92-104
Elementary	4294	227	220-234	102	99-105	1948	155	148-162	93	89-98
Homicide										
University	265	38	33-42	87	77-98	88	41	33-50	79	63-98
High	828	90	84-96	107	100-114	384	80	72-88	103	93-114
Middle	493	180	165-197	105	96-115	293	136	121-152	119	106-134
Elementary	534	245	225-266	93	85-101	408	156	141-172	92	84-102
Falls										
University	655	39	36-42	89	83-97	114	74	61-88	141	116-170
High	1869	79	76-83	100	95-104	255	76	67-86	96	84-108
Middle	1453	150	142-158	107	101-112	180	108	93-125	98	85-114
Elementary	2134	194	186-202	100	95-104	489	128	117-140	96	88-105
Fire										
University	216	35	31-40	82	72-94	60	44	34-57	85	65-109
High	674	83	77-98	101	93-109	252	87	76-98	109	96-124
Middle	484	176	161-193	111	101-121	152	130	110-152	108	92-127
Elementary	589	225	207-244	99	91-107	240	150	132-170	91	80-104
Drowning										
University	831	53	50-57	120	112-129	81	54	43-67	103	82-129
High	1755	87	83-91	100	95-105	247	80	70-91	99	87-112
Middle	968	167	156-177	98	92-104	144	112	94-132	95	80-112
Elementary	1099	222	209-235	90	85-96	335	153	137-170	102	92-114

Machine										
University	254	32	29-37	75	66-85	102	86	70-104	164	134-199
High	866	81	75-86	100	93-106	233	103	90-117	122	107-139
Middle	593	143	132-155	99	91-107	63	78	60-100	63	48-81
Elementary	998	225	212-240	111	104-118	141	124	105-147	76	64-89

TA: Transport accidents
Toxic: Accidental poisoning by and exposure to noxious substances
Suicide: Intentional self-harm
Homicide: Assualt
Falls: Falls
Fire: Exposure to smoke, fire, and flames
Drowning: Accidental drowning and submersion
Machine: Exposure to inanimate mechanical forces
Others: Others

(4) Conclusion

The least-educated group suffer higher mortality rates than better educated groups for all-causes of mortality and all specific causes of mortality in Korea. The specific diseases which had higher SMRs than all-cause SMRs in the lower educational group are: infectious diseases (tuberculosis), digestive diseases (liver disease), mental disorders, cardiovascular diseases (hypertension), respiratory diseases (CWP, asthma), injuries due to exposure to noxious substances and injuries due to exposure to inanimate mechanical forces. The differences in mortality for all-cause, as well as specific cause, mortality among poorly- and well-educated groups are higher among younger than older workers.

4.4.2 Combined effect of occupation and education on mortality

4.4.2.1 The relationship of occupation and education with all-cause mortality

Table 4.13 shows the overall relative rate ratios of all-cause mortality by occupational class (manual versus non-manual) with adjustment for the other variables: age, education and rural/urban residence. Manual workers have higher all-cause mortality among both males and females in line with the SMR analysis. After adjusting for age and education, the occupational effect on mortality disappears and even reverses for males, but remains at a reduced level for women.

Table 4.13 also shows that the poorly-educated have higher all-cause mortality rates. This difference in death rates between elementary and university levels is higher for male than female workers. After adjusting for occupation, the effect of education is not reduced.

However, the educational effect is lessened slightly with adjustment for urban/rural residence.

Table 4.13 The age adjusted relative rate ratios of all-cause mortality (and 95% confidence intervals) by occupation and education, men and women aged 20-64

Job	Deaths	Person years	Adjust for age		Adjust for age and education (or occupation)		Adjust for age, education,(or occupation), and area	
Men			RR	95% CI	RR	95% CI	RR	95% CI
Occupation								
Non-manual	82478	28187605	1.0		1.0		1.0	
Manual	165790	27177170	1.65	1.63-1.66	0.94	0.93-0.95	0.90	0.89-0.91
Total								
Education								
University	26006	16470895	1.0		1.0*		1.0**	
High school	66060	24896855	1.68	1.66-1.71	1.73	1.70-1.75	1.72	1.69-1.74
Middle s	54398	7668290	3.29	3.24-3.34	3.43	3.37-3.48	3.36	3.31-3.42
Elementary s	101804	6328735	5.11	5.03-5.18	5.37	5.28-5.46	5.02	4.94-5.11
Total								
Women								
Occupation								
Non-manual	12778	17632345	1.0		1.0		1.0	
Manual	25955	11621740	1.48	1.45-1.52	1.17	1.14-1.20	1.07	1.04-1.10
Total								
Education								
University	2248	5508880	1.0		1.0*		1.0**	
High school	5690	11084745	1.25	1.19-1.32	1.21	1.15-1.27	1.21	1.15-1.27
Middle s	4719	4628040	1.98	1.87-2.09	1.84	1.74-1.94	1.81	1.71-1.92
Elementary s	26076	8032420	3.42	3.24-3.60	3.06	2.90-3.24	2.83	2.67-2.99
Total								

* : adjust with age and occupation
** : adjust with age, occupation, and area

4.4.2.2 The relationship of occupation and education to specific-cause mortality

For each specific cause, as Table 4.14 shows, mortality is higher among manual than non-manual workers. The diseases which have the higher age-adjusted death rates for male manual workers are: infections, mental, respiratory, digestive and musculo-skeletal diseases. For these specific diseases, manual workers have higher death rates after adjusting for education, whereas for other diseases, the occupational effect on mortality disappears, and even reverses, after adjusting for education.

Table 4.14 The age adjusted relative rate ratios of cause-specific mortality (and 95% confidence intervals) according to occupation, men aged 20-64

Job	Deaths	Adjust for age		Adjust for age and education		Adjust for age, education, and urban/rural residence	
All causes		RR	95% CI	RR	95% CI	RR	95% CI
Non-manual	82478	1.0		1.0		1.0	
Manual	165790	1.65	1.63-1.66	0.94	0.93-0.95	0.90	0.89-0.91
Infection							
Non-manual	1631	1.0		1.0		1.0	
Manual	4423	2.23	2.10-2.37	1.05	0.98-1.12	1.10	0.94-1.07
Neoplasm							
Non-manual	24568	1.0		1.0		1.0	
Manual	43209	1.25	1.23-1.27	0.82	0.80-0.83	0.79	0.78-0.81
Nutrition							
Non-manual	2114	1.0		1.0		1.0	
Manual	4279	1.46	1.39-1.55	0.87	0.82-0.93	0.83	0.78-0.89
Mental dis							
Non-manual	606	1.0		1.0		1.0	
Manual	2982	4.53	4.15-4.94	1.77	1.61-1.95	1.72	1.57-1.90
Circulatory							
Non-manual	14666	1.0		1.0		1.0	
Manual	28346	1.44	1.41-1.47	0.88	0.86-0.90	0.85	0.83-0.88
Respiratory							
Non-manual	1442	1.0		1.0		1.0	
Manual	4090	1.95	1.84-2.08	1.03	0.96-1.11	1.00	0.93-1.07
Digestive							
Non-manual	8039	1.0		1.0		1.0	
Manual	23795	2.48	2.42-2.55	1.16	1.13-1.19	1.09	1.06-1.12
Musculoske							
Non-manual	96	1.0		1.0		1.0	
Manual	488	3.46	2.77-4.32	1.65	1.29-2.11	1.59	1.24-2.04
Injury							
Non-manual	25443	1.0		1.0		1.0	
Manual	46788	1.81	1.78-1.84	0.98	0.96-0.99	0.94	0.92-0.96

Infections: Certain Infections and parasitic diseases
Neoplasms: Neoplasms
Nutrition: Endocrine, nutritional and metabolic disease
Mental: Mental disorder
Circulatory: Diseases of circulatory systems
Respiratory: Diseases of respiratory systems
Digestive: Diseases of digestive systems
Musculoskeletal: Diseases of musculoskeletal system and conntective tissue
Injury: Injury, poisoning and certain other consequences of external causes

Female manual workers also have higher mortality rates than non-manual workers for each specific disease. For nutritional, mental and digestive diseases, female manual workers suffer much higher mortality than female non-manual workers. After adjusting for education, the differential between manual and non-manual workers remains for most of the specific diseases except injuries (Table 4.15).

Table 4.15 The age adjusted relative rate ratios of cause-specific mortality (and 95% confidence intervals) according to occupation, women aged 20-64

Job	deaths	Adjust for age		Adjust for age and education		Adjust for age, education, and area	
All causes		RR	95% CI	RR	95% CI	RR	95% CI
Non-manual	12788	1.0		1.0		1.0	
Manual	25955	1.48	1.45-1.52	1.17	1.14-1.20	1.07	1.04-1.10
Infection							
Non-manual	247	1.0		1.0		1.0	
Manual	467	1.95	1.64-2.33	1.37	1.14-1.66	1.19	0.98-1.44
Neoplasm							
Non-manual	3397	1.0		1.0		1.0	
Manual	7740	1.36	1.30-1.41	1.22	1.16-1.28	1.11	1.06-1.17
Nutrition							
Non-manual	190	1.0		1.0		1.0	
Manual	865	2.34	1.97-2.77	1.71	1.44-2.04	1.52	1.27-1.82
Mental dis							
Non-manual	53	1.0		1.0		1.0	
Manual	251	4.15	3.01-5.71	2.36	1.70-3.29	1.99	1.41-2.80
Circulatory							
Non-manual	2092	1.0		1.0		1.0	
Manual	7568	1.86	1.76-1.96	1.44	1.36-1.52	1.32	1.25-1.40
Respiratory							
Non-manual	171	1.0		1.0		1.0	
Manual	505	1.77	1.46-2.14	1.42	1.16-1.74	1.27	1.03-1.57
Digestive							
Non-manual	399	1.0		1.0		1.0	
Manual	1692	2.42	2.16-2.72	1.75	1.55-1.98	1.54	1.36-1.74
Musculoske							
Non-manual	84	1.0		1.0		1.0	
Manual	188	1.79	1.33-2.40	1.58	1.14-2.19	1.44	1.03-2.02
Injury							
Non-manual	5510	1.0		1.0		1.0	
Manual	5265	1.13	1.08-1.17	0.83	0.79-0.86	0.77	0.73-0.81

Infections: Certain Infections and parasitic diseases
Neoplasms: Neoplasms
Nutrition: Endocrine, nutritional and metabolic disease
Mental: Mental disorder
Circulatory: Diseases of circulatory systems
Respiratory: Diseases of respiratory systems
Digestive: Diseases of digestive systems
Musculoskeletal: Diseases of musculoskeletal system and conntective tissue
Injury: Injury, poisoning and certain other consequences of external causes

Table 4.16 shows that all types of specific-cause mortality are higher among the poorly-educated group. The specific diseases which have the highest age-adjusted relative risk ratios for this group, among men and women, are: infection, mental disorder, respiratory, digestive and musculo-skeletal diseases and injuries. No significant change is noted on adjusting for occupation.

Table 4.16 The age adjusted relative rate ratios for specific-cause mortality (and 95% confidence intervals) according to education, men and women aged 20-64

	Men					Women				
	Deaths	Adjust for age		Adjust for age and job		Deaths	Adjust for age		Adjust for age and job	
All disease		RR	95% CI	RR	95% CI		RR	95% CI	RR	95% CI
University	26006	1.0		1.0		2248	1.0		1.0	
High	66060	1.68	1.66-1.71	1.73	1.70-1.75	5690	1.25	1.19-1.32	1.21	1.15-1.27
Middle	54398	3.29	3.24-3.34	3.43	3.37-3.48	4719	1.98	1.87-2.09	1.84	1.74-1.94
Elementary	101804	5.11	5.03-5.18	5.37	5.28-5.46	26076	3.42	3.24-3.60	3.06	2.90-3.24
Infection										
University	413	1.0		1.0		419	1.0		1.0	
High	1256	2.02	1.81-2.26	1.98	1.77-2.22	137	1.41	1.02-1.96	1.30	0.93-1.81
Middle	1316	4.88	4.36-5.46	4.72	4.19-5.32	83	2.42	1.64-3.57	1.99	1.33-2.99
Elementary	3069	9.95	8.93-11.09	9.56	8.49-10.77	445	6.20	4.26-9.04	4.79	3.20-7.18
Neoplasms										
University	8177	1.0		1.0		729	1.0		1.0	
High	16604	1.37	1.34-1.41	1.48	1.44-1.52	1282	0.78	0.71-0.85	0.74	0.67-0.81
Middle	14039	1.99	1.94-2.05	2.26	3.20-2.33	1258	0.92	0.83-1.01	0.83	0.75-0.92
Elementary	28957	2.68	2.61-2.75	3.13	3.04-3.22	7868	1.46	1.33-1.60	1.26	1.14-1.39
Nutrition										
University	643	1.0		1.0		19	1.0		1.0	
High	1432	1.48	1.35-1.62	1.56	1.41-1.71	67	1.27	0.74-2.18	1.12	0.65-1.93
Middle	1424	2.58	2.35-2.83	2.80	2.53-3.10	80	2.93	1.71-5.02	2.10	1.20-3.65
Elementary	2912	3.52	3.22-3.84	3.89	3.52-4.30	889	6.81	4.04-11.48	4.41	2.55-7.60
Mental dis										
University	119	1.0		1.0		5	1.0		1.0	
High	659	3.74	3.07-4.55	2.92	2.39-3.56	28	0.36	0.12-1.06	0.30	0.11-0.86
Middle	804	11.97	9.88-14.57	8.24	6.71-3.56	31	1.80	0.69-4.72	1.02	0.37-2.79
Elementary	2006	34.48	28.51-41.70	22.45	18.33-27.49	240	4.89	1.96-12.18	2.53	0.96-6.66
Circula										
University	4727	1.0		1.0		1957	1.0		1.0	
High	10571	1.51	1.46-1.57	1.58	1.53-1.64	691	1.58	1.35-1.86	1.42	1.21-1.67
Middle	9160	2.48	2.39-2.57	2.68	2.58-2.78	979	2.81	2.39-3.31	2.31	1.95-2.72
Elementary	18554	3.50	3.38-3.62	3.84	3.70-3.99	7795	5.12	4.37-5.99	3.87	3.29-4.56
Respiratory										
University	405	1.0		1.0		31	1.0		1.0	
High	1002	1.63	1.45-1.82	1.60	1.42-1.80	61	1.06	0.68-1.64	0.96	0.62-1.50
Middle	1110	3.29	2.93-3.69	3.21	2.84-3.63	81	2.30	1.45-3.67	1.85	1.15-2.99
Elementary	3015	5.68	5.10-6.33	5.53	4.90-6.23	503	3.29	2.09-5.18	2.34	1.44-3.80
Digestive										
University	1989	1.0		1.0		45	1.0		1.0	
High	6087	2.04	1.94-2.14	1.92	1.82-2.02	129	1.35	1.00-1.90	1.15	0.81-1.62
Middle	7387	5.14	4.89-5.41	4.68	4.44-4.94	191	2.64	1.86-3.74	1.84	1.29-2.63
Elementary	16371	10.48	9.99-11.00	9.38	8.89-9.89	1726	6.53	4.67-9.12	4.06	2.86-5.75
Musculosk										
University	27	1.0		1.0		24	1.0		1.0	
High	83	1.86	1.20-2.88	1.49	0.95-2.36	19	1.26	0.77-2.05	1.09	0.66-1.79
Middle	116	5.53	3.61-8.47	4.00	2.51-6.36	16	1.39	0.65-2.96	0.94	0.42-2.10
Elementary	358	10.70	7.11-16.09	7.36	4.66-11.62	180	2.08	1.01-4.27	1.15	0.52-2.55
Injury										
University	8172	1.0		1.0		1033	1.0		1.0	
High	25341	2.01	1.96-2.06	2.03	1.98-2.08	2922	1.45	1.35-1.56	1.51	1.40-1.62
Middle	16635	4.88	4.75-5.02	4.96	4.82-5.11	1752	2.57	2.36-2.79	2.80	2.56-3.05
Elementary	22083	8.40	8.17-8.63	8.55	8.29-8.82	5068	3.94	3.62-4.29	4.46	4.08-4.89

Infections: Certain Infections and parasitic diseases
Neoplasms: Neoplasms
Nutrition: Endocrine, nutritional and metabolic disease
Mental: Mental disorder

Circulatory: Diseases of circulatory systems
Respiratory: Diseases of respiratory systems
Digestive: Diseases of digestive systems
Musculoskeletal: Diseases of musculoskelctal system and conntective tissue
Injury: Injury, poisoning and certain other consequences of external causes

In summary, we show, in general, that manual workers suffer higher mortality rates for all diseases as well as specific diseases, among both men and women. However, after adjusting for education, the occupational effect is significantly reduced and even disappears for 'all-cause' and for 'several specific causes' (neoplasm, nutritional and circulatory diseases and injury), although for some specific diseases, the occupational effect remains.

4.4.2.3 The role of effect modification by age, education and area in the relationship of occupational class with mortality

There are significant interactions between occupation, education, urban/rural residence, and age with their associations with mortality (see Appendix). To explore how the other factors effected the relationship between occupation and mortality, this study stratifies age, education and urban/rural residence to calculate the adjusted relative rate ratios in each stratum. Specifically, the relationship between education and occupational class is explored in more detail.

(1) The role of effect modification by education on the relationship between occupational class and mortality

Table 4.17 shows the combined effect of occupation and education. Death rates for all-causes are similar between non-manual and manual workers in the same grade of educational group. In particular, for the elementary educated groups, the deaths rates for all-causes are higher both for manual and non-manual workers, compared to those educated above university level. The occupational effect between manual and non-manual workers looks similar for the same educational group. This pattern is slightly different between urban and rural areas. In urban areas, male non-manual workers have slightly higher death rates, compared to male manual workers at the same educational level. However, in rural areas, manual workers have slightly higher death rates, compared to non-manual workers at the same educational level among both men and women.

Table 4.17 Interaction between occupation and education

		Total		Urban		Rural	
Men	Deaths	RR*	95% CI	RR*	95% CI	RR*	95% CI
Non-manual and university	22507	1.00		1.00		1.00	
Non-manual and high	32464	1.73	1.70-1.76	1.70	1.67-1.73	1.66	1.56-1.75
Non-manual and middle	14474	3.46	3.39-3.54	3.39	3.32-3.47	2.82	2.64-3.01
Non-manual and elementary	13033	5.47	5.35-5.59	5.38	5.26-5.51	3.99	3.75-4.25
Manual and university	3499	0.98	0.95-1.02	0.90	0.86-0.94	1.15	1.05-1.25
Manual and high	33596	1.63	1.60-1.66	1.50	1.47-1.53	1.72	1.63-1.81
Manual and middle	39924	3.23	3.17-3.28	2.91	2.86-2.97	3.02	2.87-3.18
Manual and elementary	88771	5.05	4.97-5.13	4.73	4.65-4.81	3.98	3.79-4.19
Women							
Non-manual and university	2161	1.00		1.00		1.00	
Non-manual and high	4311	1.26	1.19-1.33	1.21	1.14-1.28	1.34	1.13-1.58
Non-manual and middle	2291	2.01	1.88-2.14	1.82	1.70-1.95	2.22	1.83-2.69
Non-manual and elementary	4015	2.64	2.48-2.80	2.32	2.17-2.48	2.84	2.38-3.40
Manual and university	87	0.76	0.61-0.94	0.59	0.45-0.76	1.44	0.96-2.14
Manual and high	1379	1.17	1.10-1.26	0.91	0.84-0.99	1.88	1.58-2.24
Manual and middle	2428	1.90	1.79-2.03	1.39	1.29-1.50	2.76	2.33-3.28
Manual and elementary	22061	3.61	3.42-3.82	2.82	2.66-3.00	3.85	3.25-4.55

* RR : age adjusted RR

(2) Combined role of age, urban/rural residence and education as effect modifiers in the relationship between occupation and mortality

Table 4.18 shows that, in rural areas, manual workers have higher mortality among older (50+) and younger (20-49 years) men educated to less than elementary level. For younger workers educated beyond middle school, by contrast, the occupational effect disappears among men in rural areas. In urban areas, the occupational effect on mortality disappears for most age groups (except 50-59 years) and educational groups. In particular, for workers aged 20-49, the occupational effect on mortality disappears in urban areas.

For women, in rural areas, the occupational effect on mortality remains among most of the age and educational groups. For women in urban areas, the occupational effect on mortality disappears in most of the age and educational groups except the older age group (over 50) educated to less than elementary level. In particular, for younger, urban workers educated beyond elementary school, the occupational effect on mortality disappears when compared to the poorly-educated older women workers in rural areas (Table 4.18).

Thus, after stratifying by urban/rural residence, education and age, those groups with a relative rate ratio greater than 1 for all-cause mortality among manual compared to non-manual workers, are: rural, middle- and old-aged men (over 50), young men (aged 20-49) with less than elementary education, most women in rural areas and middle- and old-aged women with elementary education in urban areas. In contrast, those with a relative ratio less than 1 for all-cause mortality among manual workers compared to non-manual workers, are: most young men in urban and rural areas, most middle- and old-aged men over 50 in urban areas, young women in urban areas and most middle- and old-aged women in urban areas. Thus, education seems to have a strong effect on the relationship between occupational class and mortality among the younger group in urban areas.

Table 4.18 The age adjusted relative rate ratios of mortality (and 95% confidence intervals) according to occupation, area, and education with different age groups, men and women aged 20-64

Education	Area	Occupation	20-49 age		50-59 age		60-64 age	
Men			RR*	95% CI	RR*	95% CI	RR*	95% CI
Urban	University	M/NM	0.84	0.80-0.89	1.07	0.99-1.15	0.87	0.79-0.96
	High	M/NM	0.89	0.87-0.91	0.93	0.90-0.96	0.85	0.80-0.90
	Middle	M/NM	0.82	0.79-0.84	0.86	0.83-0.89	0.86	0.81-0.92
	Elementary	M/NM	0.90	0.87-0.93	0.90	0.88-0.93	0.92	0.88-0.97
Rural	University	M/NM	0.88	0.78-1.00	1.36	1.16-1.59	1.17	0.97-1.42
	High	M/NM	0.93	0.89-0.97	1.25	1.16-1.35	1.11	0.98-1.26
	Middle	M/NM	0.98	0.91-1.04	1.12	1.03-1.21	1.12	0.98-1.29
	Elementary	M/NM	1.06	0.99-1.13	1.08	1.01-1.16	0.95	0.86-1.04
Women								
Urban	University	M/NM	0.60	0.45-0.79	0.26	0.11-0.64	0.63	0.23-1.72
	High	M/NM	0.74	0.68-0.80	0.74	0.60-0.92	0.90	0.62-1.33
	Middle	M/NM	0.66	0.60-0.71	0.96	0.84-1.10	0.95	0.72-1.26
	Elementary	M/NM	0.92	0.86-0.99	1.33	1.25-1.41	1.58	1.45-1.74
Rural	University	M/NM	1.44	0.92-2.26	0.48	0.16-1.46	1.86	0.26-13.20
	High	M/NM	1.26	1.11-1.44	2.06	1.36-3.12	0.88	0.45-1.74
	Middle	M/NM	1.22	1.05-1.41	1.24	0.97-1.59	1.39	0.79-2.45
	Elementary	M/NM	1.27	1.13-1.44	1.37	1.23-1.52	1.51	1.28-1.77

*RR : age adjusted RR
NM: Non-manual
M: Manual

(3) Combined role of age, urban/rural residence and occupational class as effect modifiers in the relationship between education and mortality

Table 4.19 shows that the difference in all-cause mortality between lowest and highest educational group is greater among younger groups in both urban and rural areas for both men and women. For younger workers in urban areas, the difference in mortality between the lowest and highest educational groups is larger than for younger workers in rural areas or the older-aged group in rural and urban areas among both men and women. In addition to this, the differences in all-cause mortality between the lowest and highest educational groups are slightly greater for manual compared to non-manual workers in all age groups, and in both urban and rural areas. Thus, the effect of education on mortality seems greater among the younger (manual) workers in urban areas.

Table 4.19 The age adjusted relative rate ratios of mortality (and 95% confidence intervals) according to education, according to urban/rural residence and occupational class with different age group, male and female aged 20-64

			Men				Women			
Residence	Occupation	Education	20-49 age		>50 age		20-49 age		>50 age	
			RR*	95% CI	RR*	95% CI	RR*	95% CI	RR*	95% CI
Urban	NM	Univ	1.00		1.00		1.00		1.00	
		High	1.89	1.85-1.94	1.49	1.45-1.53	1.28	1.21-1.36	0.81	0.70-0.93
		Midd	4.88	4.73-5.04	2.09	2.03-2.16	2.04	1.88-2.21	0.90	0.78-1.03
		Elem	10.10	9.74-10.48	2.96	2.87-3.05	3.40	3.12-3.70	1.05	0.93-1.18
	M	Univ	1.00		1.00		1.00		1.00	
		High	2.04	1.94-2.16	1.32	1.25-1.40	1.56	1.17-2.08	1.78	0.91-3.48
		Midd	5.15	4.88-5.44	1.76	1.66-1.87	2.87	2.15-3.82	2.44	1.26-4.71
		Elem	11.82	11.19-12.48	2.67	2.52-2.82	6.89	5.17-9.19	4.05	2.11-7.79
Rural	NM	Univ	1.00		1.00		1.00		1.00	
		High	1.83	1.70-1.97	1.43	1.30-1.56	1.34	1.12-1.60	0.81	0.47-1.41
		Midd	4.06	3.71-4.43	1.90	1.72-2.10	2.07	1.66-2.59	0.96	0.57-1.62
		Elem	7.11	6.46-7.82	2.37	2.17-2.60	3.01	2.37-3.80	1.00	0.61-1.61
	M	Univ	1.00		1.00		1.00		1.00	
		High	1.89	1.69-2.10	1.32	1.20-1.47	1.26	0.82-1.94	2.04	0.89-4.66
		Midd	3.98	3.57-4.44	1.61	1.46-1.78	2.07	1.35-3.18	1.85	0.83-4.14
		Elem	7.32	6.56-8.16	1.85	1.69-2.04	3.58	2.33-5.49	2.09	0.94-4.66

* RR : age adjusted RR
NM: Non-manual
M: Manual

4.4.2.4 Conclusions

Manual workers have higher all-cause as well as cause-specific mortality among Korean men and women aged 20-64. However, after adjusting for education, the occupational effect of manual work disappears in all-cause and in several specific diseases (neoplasm, circulatory disease) and is reduced in several other specific diseases (mental, digestive and musculo-skeletal disease). After stratification for age, urban/rural area and education, for younger workers aged 20-49 in urban areas the occupational effect on mortality disappears, especially after stratification for education. In addition to this, for these younger urban workers aged 20-49, the educational effect on mortality is stronger.

There is a notable inverse relationship between education and mortality among men and women aged 20-64. This applies particularly to the younger group aged 20-49 in urban areas who have a higher relative rate ratio than other groups among both men and women.

4.4.3. The relationship of occupation, education and deprivation with all-cause mortality, taking account of random variation between areas (men and women aged 20-64 years)

The study area consists of 223 *Census* geographical areas (132 rural and 91 urban), containing a study population of 16,923,772 aged 20-64 between 1993 to 1997. Table 4.20 shows the relationship of occupation, education and the deprivation index with mortality using multilevel extra-Poisson regression both for males and females to allow for area-level variation. There are above zero 'between area' residual variances for all models (Table 4.20). There are also high 'level one' residual variances between age by occupation and by educational groups within areas (not shown).

There is an inverse relationship between deprivation and all-cause mortality for both males and females. After adjusting for occupation and education, the relationship between deprivation and mortality is slightly reduced but remains. The relationship of occupation and education with mortality is similar but weaker than that found in the simple Poisson regression (Table 4.13, without consideration of area variation). The death rates for all causes of death were higher among male and female manual workers. After adjusting for educational level, this relationship between occupation and mortality disappears for both males and females. After adjusting for deprivation index, the relationship between occupation and mortality is little changed for both males and females. The lower educational group has higher death rates for all-causes for both males and females. After adjusting for occupation and deprivation, the relationship between education and mortality is little changed.

In conclusion, there is a strong inverse relationship between deprivation and all-cause mortality, both for men and women. The area-based deprivation indicators and individual socio-economic indicators (occupational class and education) thus make independent contributions to mortality risk for both males and females.

Table 4.20 The relationship of occupation, education, and deprivation index, with all-cause mortality, men and women aged 20-64

	Death[1]	Adjust for age		Adjust for age and education (or occupation)		Adjust for age and deprivation (or education)		Adjust for all variables	
		RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Men									
Deprivation									
Quintiles									
1 Least	28268	1.00		1.00		1.00[3]		1.00	
2	36292	1.33	1.16-1.51	1.28	1.13-1.44	1.14	1.05-1.25	1.15	1.05-1.26
3	41384	1.52	1.34-1.73	1.46	1.30-1.63	1.26	1.15-1.37	1.26	1.16-1.38
4	65719	2.16	1.93-2.42	1.97	1.78-2.18	1.50	1.39-1.62	1.53	1.41-1.65
5	75752	2.44	2.18-2.72	2.19	1.99-2.42	1.60	1.49-1.72	1.63	1.51-1.75
Total	247825								
Between area variance(Ωu^2)		0.051 (p=0.005)		0.034 (p=0.004)		0.019 (p=0.002)		0.020 (p=0.002)	
Occupation									
Non-manual	82136	1.00		1.00		1.00		1.00	
Manual	165689	1.37	1.34-1.40	0.88	0.86-1.12	1.37	1.34-1.41	0.88	0.89-1.16
Total	247825								
Between area variance(Ωu^2)		0.088 (p=0.009)		0.044 (p=0.005)		0.034 (p=0.004)		0.020 (p=0.002)	
Education									
University	25950	1.00		1.00[2]		1.00		1.00	
High school	66060	1.61	1.57-1.65	1.68	1.64-1.73	1.60	1.56-1.65	1.68	1.63-1.73
Middle s	54282	2.97	2.89-3.05	3.20	3.19-3.29	2.95	2.87-3.04	3.18	3.09-3.28
Elementary s	101533	4.22	4.10-4.33	4.60	4.47-4.74	4.19	4.07-4.31	4.58	4.44-4.72
Total	247825								
Between area variance(Ωu^2)		0.041 (p=0.004)		0.044 (p=0.005)		0.019 (p=0.02)		0.020 (p=0.002)	
Women									
Deprivation									
Quintiles									
1	2850	1.00		1.00		1.00[3]		1.00	
2	3946	1.19	1.08-1.54	1.27	1.08-1.51	1.18	1.01-1.38	1.18	1.01-1.38
3	5093	1.48	1.25-1.74	1.45	1.24-1.70	1.32	1.14-1.53	1.32	1.14-1.53
4	11235	2.14	1.84-2.48	2.05	1.78-2.37	1.76	1.55-2.01	1.77	1.55-2.02
5	15428	2.38	2.06-2.75	2.27	1.98-2.60	1.92	1.69-2.18	1.93	1.70-2.19
Total	38552								
Between area variance(Ωu^2)		0.072 (p=0.008)		0.065 (p=0.007)		0.055 (p=0.006)		0.055 (p=0.006)	
Occupation									
Non-manual	12688	1.00		1.00		1.00		1.00	
Manual	25864	1.16	1.12-1.20	0.99	0.96-1.02	1.16	1.12-1.20	0.99	0.95-1.02
Total	38552								
Between area variance(Ωu^2)		0.128 (p=0.013)		0.099 (P=0.011)		0.065 (p=0.007)		0.055 (p=0.006)	
Education									
University	2207	1.00		1.00[2]		1.00		1.00	
High school	5634	1.21	1.14-1.28	1.21	1.14-1.28	1.20	1.13-1.28	1.20	1.13-1.28
Middle s	4685	1.77	1.65-1.89	1.78	1.66-1.90	1.75	1.62-1.88	1.75	1.63-1.89
Elementary s	26026	2.59	2.42-2.77	2.60	2.43-2.79	2.55	2.37-2.73	2.57	2.38-2.76
Total	38552								
Between area variance(Ωu^2)		0.099 (p=0.011)		0.099 (P=0.011)		0.055 (p=0.006)		0.055 (p=0.006)	

1) Deaths number were a little bit smaller as several deaths (624) were not matched with the census data set
2) Adjust with age and occupation
3) Adjust with age, occupation, and area

4.5. Discussion

4.5.1 Limitations of the present study

4.5.1.1 Data validity: the variables

Several variables (occupation, education and causes of death) from the national death data of the National Statistics Office are compared to those of injury death data from WELCO (Chapter 8). The Kappa index of the occupational variable – manual and non-manual workers - is 0.48, 0.32 for the educational variable and 0.68 for cause of death. It appears that the Kappa index for education is quite low, but it seems reasonably matched for the manual/non-manual occupational group (Landis and Koch, 1977). For causes of death, it is well matched for injury and cardiovascular disease. In summary, a comparison of the variables (occupation, education and causes of death) between the national death data and death data due to workplace injury suggests that there might be considerable bias due to the misclassification of variables.

4.5.1.2 The exclusion of those not in the labour market (non-economically active status): housewives, the unemployed and retired

Excluding the economically inactive, including the unemployed, from the study population may lead to an underestimation of mortality rates for lower social class groups (Davey Smith, 1994). The unemployed may more closely mirror the condition of manual workers, as opposed to non-manual workers. Also, the exclusion of retired people, those coded as 'unknown occupation', housewives and students, may distort the relationship between mortality rates and socio-economic class. This is important as Marmot and Shipley (1996) mention that socio-economic differences in mortality persist beyond retirement age and increase in magnitude with age.

4.5.1.3 Women's occupation

In this study, women are classified by occupation; a procedure that is not without drawbacks. The most significant problem of using occupational variable in the socio-economic classification of women is that many cannot be classified by their own occupation. Some have also argued that using their own and their spouse's social class are of limited applicability and relevance (Davey Smith, 1994). Arber (1989) suggests that the most appropriate measure is 'household', rather than individual, class; a term based on the occupation of the economically-dominant spouse.

The number of economically active women, those who have a full- or part-time job, is small in Korea. The percentage of women aged 20-64 who have been employed is only 42.5% in the *Census*. Therefore, it is impossible to classify the socio-economic status of those recorded as housewives. Hence the exclusion of women who have no formal occupation from this study may effect the relationship between occupational class and mortality when occupation is considered as an socio-economic indicator.

4.5.1.4 Numerator/denominator bias

In this study, numerators (from the NSO death data) and denominators (from the *Census*) are not linked at the individual level. In particular, there are severe variations in the SMRs among nine different occupational groups. This could imply some numerator-denominator bias due to differential misclassification between the two surveys. During data processing, the numerator-denominator bias might appear at several points. One possibility may originate from different recording systems - for example, for occupation - between death certificates and *Census*. Also, information about economic inactivity is not clearly defined in the NSO death data, unlike the *Census*. Thirdly, the death data may be biased in the reporting of occupation by the deceased's relatives and in the encoding process carried-out by civil officers. Fourthly, through the validity test, some individuals in the death data were found to have been promoted from manual workers to higher grades of occupation (see Appendix). Occupation seems to be 'promoted' when informants report deaths. In Korea, this promotion may be more significant than in other countries as non-manual work is seen as superior. In Britain, the longitudinal study provides only a limited basis for identifying examples of deliberate promotion by the informant reporting a death (*OPCS*, 1978). Nevertheless, Britain also has some evidence of promotion of occupation among coal miners (Heasman et al, 1958) on death certificates and a strong tendency for the promotion of social class from IV and V to I and II, in death registrations than in the *Census* (*OPCS*, 1978).

To reduce the numerator-denominator bias, two broader categories of occupation- manual and non-manual - are used in the present study. Townsend et al (1986) note that this distinction "helps to diminish some of the criticisms which have been made about changes in the classification of specific occupations, inconsistencies in the classification at the *Census* and death registrations (*OPCS*, 1986, p43), and 'serious bias' in the calculation of the SMRs for social class V" (p44).

In Britain, despite awareness of numerator-denominator bias, some longitudinal studies have proved that their main results are not distorted by it. Furthermore, against the criticism of numerator-denominator bias, Fox et al (1985) use the *OPCS Longitudinal Study* to show that selective health-related mobility between social classes causing numerator-denominator bias does not contribute to differentials in mortality. The *OPCS Longitudinal Study* (1978) suggests that differences in the coding of social class between death certificates and the *Census* are unlikely to account for mortality differences.

Davey Smith et al (1991b) compare the relationship between cancer and socio-economic position using three different data sources: the *Whitehall Study* of London civil servants, the *OPCS Longitudinal Study*, and the Registrar General's *Decennial Supplement*. They find that the association between cancer and socio-economic position are similar in all three studies and suggest that their results make it very unlikely that this could be due to artefacts. However, in Korea, the size and seriousness of any numerator-denominator bias remains to be estimated, primarily through longitudinal studies of the kind carried-out by Davey Smith et al.

4.5.2 Main findings

4.5.2.1 The relationship between occupational class and mortality

Our study shows that manual workers' age-adjusted overall relative rate ratio is 1.65 (1.63-1.66) among men and 1.48 (1.45-1.52) among women, using simple Poisson regression. This is somewhat reduced when area variation is taken into account, using multilevel extra Poisson regression. Compared to the rate ratios for all-causes of mortality by occupational class obtained in Europe, the Korean results are at the higher end of the scale. Mackenbach et al (1997) finds that the rate ratios for all-causes of mortality among manual occupations, compared to non-manual occupations, are between 1.33 and 1.71 for men aged 45-59 in the eleven European countries from 1985 to 1992[2]. In Britain, according to Marmot and McDowall (1986), the ratio of the SMR between non-manual and manual groups among men aged 20-64 is 1.30 (1970-72) and 1.45 (1979-83). In England and Wales, the ratio of SMRs for social class V (unskilled workers)/I (professionals) among men is 1.61 in 1970-1972 (*Black Report*, 1982) and 2.86 men aged 20-64 in 1991-1993 (Drever and Whitehead, 1997).

We show that the specific diseases which have highest age-adjusted relative risk ratios for manual workers are: infections, mental disorders, respiratory and digestive diseases, external causes of death and musculo-skeletal diseases. These results show some similarities and differences when compared to European countries. For example, Kunst et al (1998b) find that:

> Mortality from Ischemic Heart Disease is strongly related to occupational class in England and Wales, Ireland, Finland, Sweden, Norway and Denmark, but not in France, Switzerland, and Mediterranean countries. In the latter countries, cancers other than lung cancer and gastrointestinal diseases made a large contribution to class differences in total mortality (p1636).

In the UK, increasing mortality with declining social class is clearly demonstrated for stroke, Ischemic Heart Disease, lung cancer, accidents and suicide in England and Wales during the years 1991-1993 (Drever and Whitehead, 1997). A similar pattern between Korea and some other Mediterranean countries is that gastro-intestinal disease contributes to differences in mortality among different social classes. This study raises the interesting point that manual workers had still higher mortality for infectious diseases, gastro-intestinal and respiratory diseases in Korea. These are also the main causes of death among the whole Korean population.[3] Another similarity is that manual workers have higher mortality for external causes such an injury and toxicity. This suggests that working conditions for manual workers are more hazardous than those for non-manual workers.

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[2] Finland 1.53 (1.49-1.56), Sweden 1.41 (1.38-1.44), Norway 1.34 (1.30-1.39), Denmark 1.33 (1.30-1.36), England and Wales 1.44 (1.33-1.56), Ireland 1.38 (1.30-1.46), France 1.71 (1.66-1.77), Switzerland 1.35 91.29-1.39), Italy 1.35 (1.28-1.42), Spain 1.37 (1.34-1.39), and Portugal 1.36 (1.31-1.40) among men aged 45-59.

[3] In Korea, the most frequent causes of death are cardiovascular diseases (24.6%), neoplasms (21.7%), external causes of death (injury) (14.5%), gastric diseases (7.0%), and respiratory diseases (4.5%)

However, the pattern of Ischemic Heart Disease (IHD) in Korea is quite different from European countries. In Korea, the relative rate ratio of deaths due to IHD among manual workers is 0.90 (0.89-0.91) for men and 0.95 (0.93-0.98) for women, compared to non-manual workers, even though manual workers have higher mortality for hypertension and cerebrovascular disease (see Appendix). Marmot (1999) notes that:

> In many European countries and the USA, as coronary heart disease became a mass disease, it rose first in higher socio-economic groups and subsequently in lower, to the extent that the social distribution changed to the now familiar pattern of an inverse social gradient: higher rates as the social hierarchy is descended.

However, in Korea, there is still no clear pattern in terms of an inverse social gradient on coronary heart disease.

Manual workers suffer higher death rates due to neoplasms, but this rate is less than for other causes of death among manual workers (Tables 4.6, 4.7 and 4.8). As for specific cancers, we show that manual workers have higher mortality for stomach, liver and lung cancers, compared to non-manual workers among men and women aged 20-64 (see Appendix). This pattern is similar to other studies. As for socio-economic differences in cancer incidence and mortality, Faggiano et al (1997) review the published data among 21 countries from 1966 and 1994 using a Medline search, and conclude that reasonably consistent excess risks in men from the lower social strata were observed for all respiratory cancers (nose, larynx and lung) and cancers of the oral cavity and pharynx, oeophagus, stomach and, with a few exceptions, the liver, as well as for all malignancies taken together. For women, excess deaths among lower social classes were consistently encountered for cancers of the oesophagus, stomach, cervix, uteri and less consistently, the liver. Men in higher social strata displayed excesses in colon, brain and skin cancers; whereas upper-class women displayed excess deaths for colon, breast, ovary and skin cancers. Davey Smith (1991b) also states that "...lung, stomach, and oesophageal cancer have been consistently associated with lower socio-economic position in the UK".

In summary, manual workers suffer higher mortality than non-manual workers in Korea and this differential is slightly higher in Korea than in European countries. As for specific disease patterns, manual workers have higher mortality due to infections, mental

external causes of death (injury) (14.5%), gastric diseases (7.0%), and respiratory diseases (4.5%)

disorders, respiratory and digestive diseases, external causes of death and musculo-skeletal diseases, than non-manual workers in both Korean males and females. Our study has an acknowledged limitation in that differential mis-classification due to the promotion of occupation may bias the relationship between occupational class and mortality in Korea.

4.5.2.2 The inverse relationship between education and mortality

There is a strong inverse relationship between education and mortality. Several studies show this. Valkonen (1993), for example, shows that there are marked differences in mortality between educational groups. Pappas et al (1993) also find increased mortality in poorly-educated and lower income groups than in higher-income and better-educated groups.

The educational effect on mortality seems higher in Korea than in European countries. This study shows that age-adjusted relative rate ratio among the elementary, compared to the university, level educational group is 5.11 (5.03-5.18) among men, and 3.42 (3.24-3.60) among women from the simple Poisson regression (Table 4.13). In the USA, the relative risks of all-cause mortality among the least educated (0-7 years), compared to the most educated (12 or more years) are 1.96 for middle-aged (45-64) men and 1.47 for middle-aged (45-64) women, between 1971 and 1984 (Feldman et al, 1989). In the UK, the ratio of SMRs for non-educated versus degree level educated people is 1.75 among men aged 15-64 and 1.55 among women aged 15-64 in 1971-81 in England and Wales (The *Black Report*, 1980). With slightly different indicators, Kunst et al (1994) find that the 'total inequality estimates'[4] among 35-44 years old men, between 1970 and 1982 in European countries and the USA, are between 0.72 and 2.62.[5]

This study has a limitation in that there may be differential and non-differential mis-classification in the numerators from the NSO death data and denominators from the *Census*. The educational variable is poorly-matched between the two surveys and some

[4] The total inequality estimate represents the proportional mortality increase moving from the top to the bottom of the educational hierarchy, thus, at least approximate Relative rate ratio is about 1 + 'total inequality estimate' from the top to the bottom of the educational hierarchy.
[5] 0.72 (0.51-0.95) in Netherlands, 1.17 (1.02-1.33) in Denmark, 1,02 (0.89-1.16) in Norway, 1.20 (1.02-1.41) in Sweden, 1.49 (1.32-1.68) in Finland, 1.04 (0.43-1.92) in England & Wales, 1.97 (1.60-2.39) in France, 1.85 (1.75-1.97) in Italy, 2.62 (1.26-4.78) in USA.

promotion, as well as demotion, to adjacent educational grades is shown in the national death data (Chapter 8). This may cause non-differential and differential bias and there may be some consequent over-estimation of the educational effect on mortality. Nevertheless, a strong inverse relationship between education and mortality and deaths due to workplace injuries is shown in Chapters 4 and 6.

In Korea, this kind of strong inverse relationship may have a different meaning from that in more developed countries. Why is the educational effect so strong in the urban and younger age group (20-49) in Korea? Perhaps because educational level has a stronger effect on occupational position as well as material well-being in Korea. Since the Korean War, Korean people have survived economically in the dual exploitative systems of domestic capitalism and imperialism through major investment in education (Heide, 2000). Therefore, education is an important qualification and instrument for obtaining a better job in Korea (Heide, 2000). This seems to be related to social differences in mortality. Education is strongly associated with occupation and mortality in Korea. As lack of education tends to act as a barrier to obtaining certain kinds of work, this could result in occupational class differences as well as differences in health. As Davey Smith et al (1998a) suggest:

> ...different educational levels differ in observable ways, including having time preferences favorable to long term investment in their future', also, 'education may act through allowing for favorable employment opportunities with higher income levels and more favourable living conditions throughout adult life... (p158).

The likely scenario, therefore, is that children from lower occupational classes have less access to education, they tend to remain in the same socio-economic class as their parents, which in turn affects their material circumstances and health.

4.5.2.3 The role of education in the relationship between occupational class and mortality

This study shows that the manual workers have higher mortality than non-manual workers for all-causes as well as for most specific diseases when age is adjusted for. However, after adjusting for education, the occupational effect of manual work disappears for all-causes and for several specific diseases (neoplasm and cardiovascular disease) or is reduced in other specific diseases (mental disorders, digestive and musculo-skeletal diseases). Given the same education, mortality does not differ by occupational class. In particular, for both male and female younger workers aged 20-49, the educational effect on mortality is stronger. The occupational effect on mortality seems weaker, therefore, than among older workers. On the other hand, this study shows that education had a direct effect on mortality, not simply through occupation as occupation had no effect.

There may be several reasons for these findings: firstly, education may be closely correlated to occupation, the occupational effect on mortality disappearing when education is adjusted for. As Tables 4.21 and 4.22 show, the proportion of manual workers aged 20-64 among the group with university level education is 14.41% for males and 4.81% for females, whereas the proportion of manual workers aged 20-64 in the elementary education group is 86.86% for males, and 76.64% for females. Therefore, education seems to predetermine or correlate with occupational class; this ensures a close relationship between education and the occupational effect on mortality.

Table 4.21 Proportions of study population from the *Census** by occupation according to education, men and women aged 20-64 in Korea

		Men				Women			
Census		University	High school	Middle School	Elementary School	University	High School	Middle School	Elementary school
20-64									
	NM	85.59	45.78	24.25	13.14	95.19	75.19	47.06	23.36
	M	**14.41**	**54.22**	**75.75**	**86.86**	**4.81**	**24.81**	**52.94**	**76.64**
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

*This table was tabulated from the raw data the Census, 1995
NM: Non-manual
M: Manual

Secondly, why is the educational effect so strong in urban areas compared to rural areas? The proportions of industrial workers as well as service and retail workers are higher in urban than in rural areas (Table 4.22). Thus, the educational effect on mortality may be stronger in the former than in the latter. On the other hand, the higher proportion of poorly-educated people in urban areas having a job as service and shop/market sales workers may dilute the occupational effect for manual work, as they are included in the non-manual group (Table 4.22).

Table 4.22 The distribution of occupation in urban and rural area from the *Census*, men and women

(unit %)

	Lower educated male (less than elementary level people)		Lower educated female (less than elementary level people)	
Occupation	Urban	Rural	Urban	Rural
Legislators, Senior officials & managers	1.19	0.34	0.13	0.03
Professionals	0.12	0.07	0.06	0.05
Technicians & Associate Professionals	1.68	0.63	0.58	0.16
Clerks	1.55	0.77	0.89	0.23
Service workers & shop and Market Sales	12.51	4.55	30.62	9.92
Skilled Agricultural & fishery workers	28.50	75.75	34.77	80.35
Craft & related Trades Workers	22.20	6.21	12.32	2.75
Plant & Machine Operators & Assemblers	12.41	4.62	6.13	2.29
Elementary Occupations	19.84	7.05	14.52	4.22
All	100%	100%	100%	100%

* This table was tabulated from the raw data the Census, 1995

Thirdly, why then does the younger, urban group demonstrate a greater educational effect and a lesser occupational effect (Tables 4.18 and 4.19)? From Table 4.23, we note that the distribution of non-manual work is quite high (18.50%) in the younger, elementary educated group in urban areas. They may be in lower grade occupations such as service workers or clerical workers. The occupations of the less well-educated, younger group, may not differ between manual and non-manual categories in terms of either socio-economic class or occupational hazards. The occupational effect may not be so strong, then, for the less well-educated, younger group.

Table 4.23 Proportions of study population from the *Census* by occupation according to education, and area, men and women aged 20-64

		Men				Women			
Census		University	High school	Middle School	Elementary school	University	High school	Middle school	Elementary school
20-64									
Urban	NM	86.36	47.17	26.33	17.06	95.48	76.53	50.58	32.27
	M	**13.64**	**52.83**	**73.77**	**82.94**	**4.52**	**23.47**	**49.42**	**67.73**
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Rural	NM	74.28	35.32	15.84	6.37	90.48	64.32	31.32	10.40
	M	**25.72**	**64.68**	**84.16**	**93.63**	**9.52**	**35.68**	**68.68**	**89.60**
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
20-49									
Urban	NM	86.02	46.34	25.05	18.50	95.56	76.73	50.11	37.47
	M	**13.98**	**53.66**	**74.95**	**81.50**	**4.44**	**23.27**	**49.89**	**62.53**
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Rural	NM	74.99	35.18	16.07	8.82	90.98	64.83	32.21	15.11
	M	**25.01**	**64.82**	**83.93**	**91.18**	**9.02**	**35.17**	**67.79**	**84.89**
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
50-59									
Urban	NM	89.74	54.70	29.60	16.81	92.92	71.41	54.23	30.47
	M	**10.26**	**45.30**	**70.40**	**83.19**	**7.08**	**28.59**	**45.77**	**69.53**
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Rural	NM	73.05	39.62	16.13	5.89	72.09	52.62	27.25	8.98
	M	**26.95**	**60.38**	**83.87**	**94.11**	**27.91**	**47.38**	**72.25**	**91.02**
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
60-64									
Urban	NM	84.90	48.47	29.07	13.05	90.87	66.63	46.56	20.03
	M	**15.10**	**51.53**	**70.93**	**86.95**	**9.13**	**33.37**	**53.44**	**79.97**
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Rural	NM	60.75	25.35	12.13	3.44	70.34	34.44	19.65	5.26
	M	**39.25**	**74.65**	**87.87**	**96.56**	**29.66**	**65.56**	**80.35**	**94.74**
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

NM: Non-manual
M: Manual

Several arguments can therefore be given for the strong correlation between education, occupation and mortality in Korea. Firstly, in the lower educational group, the risk factors of occupation between manual and non-manual work are likely to have a similarly strong impact on mortality. Secondly, even though non-manual workers are assumed to have higher socio-economic status than manual workers, the location of the boundary of non-manual work among the less-educated group might differ from the non-manual workers among the highly educational group.

Several studies have discussed the relationship of education and occupation with mortality. Davey Smith et al (1998a) find that occupational class and education are both strongly associated with mortality in middle-aged men in Glasgow. In particular, occupational/social class is more strongly associated with overall and non-cardiovascular mortality than are educational measures, whereas the educational measure is more strongly associated with cardiovascular mortality than with other causes of death in Glasgow (Davey Smith et al, 1998a). Winkleby et al (1992) argue that education as a factor is more strongly associated with cardiovascular disease than is income or occupation. Kunst et al (1998a) suggest that the measures of educational level (elementary and lower secondary vs higher) and occupational status (manual vs non-manual) are strongly correlated, and that occupation and education are strongly correlated in relation to mortality.

On the other hand, comparing education and occupation as a single indicator of socio-economic status, Davey Smith et al (1998a) suggest that, as a single indicator of socio-economic position, occupational social class in adulthood is a better discriminator of socio-economic differentials in mortality and smoking behaviour than education. In contrast, several American researchers and statisticians suggest that education is more appropriate than occupation or income because it is reliable, easy to code and generally stable over the course of an adult's lifetime (Ries, 1991).

In summary, the Korean situation may be somewhat different from that of Western countries and it might resemble more Third World (or Developing) countries. In Korea, which has been rapidly industralising under the conditions of both domestic and world or imperialistic capitalism, people compete with each other to survive. Education may therefore be a strong instrument for economic survival, which in turn is strongly related to their occupation. Also, this strong correlation between education and occupation may exist over generations. Therefore, the educational effect is strongly correlated with occupational class for mortality.

4.5.2.4 The role of deprivation in the relationship of occupation, education, with mortality

This study shows that deprivation has a strong inverse relationship with mortality in Korea. The relative rate ratios of all-causes of mortality among the most deprived group (5^{th} quintile) is 2.44 (CI: 2.18-2.72) for male and 1.94 (CI: 1.68-2.24) for female, compared to the least deprived group (1^{st} quintile). These results are a little higher than those found in other studies. Carstairs and Morris (1989a) state that the corresponding mortality rates in the most deprived category[6] are around twice those in the most affluent areas (SMR of most affluent area (1^{st}) among 20-64 aged men: 64 and most deprived (7^{th}): 129) in 20-64 year old men (1980-82) in Scotland. Davey Smith et al (1998) show that the relative rate of mortality among lower categories (deprivation category[7] 6-7) is 1.47 (CI: 1.28-1.68), compared to higher categories (1-3) among men in Scotland. Sloggett and Joshi (1994) find that mortality risk increases by a factor of 1.04 in men and by 1.05 in women for each unit increase in the deprivation score.[8] Townsend et al (1988) show that the association between poor health and overall material deprivation index[9] is highly significant statistically (with a correlation of 82 percent between overall health and deprivation indices) and is relatively consistent. This study also finds that area-based deprivation indicators and individual level socio-economic factors (occupation or education) independently impact on all-cause mortality. Davey Smith et al (1997) also

[6] Carstairs' deprivation index: overcrowding, unemployment among men, low social class, and not having a car

[7] Deprivation category is defined by Carstairs and Morris to be ascertained, using 1981 *Census* data. Deprivation category varies from 1 (least deprived) to 7(most deprived) and is calculated from the deprivation score based on Carstairs' index

[8] Deprivation is assessed with an index based on those of Townsend and Carstairs. Also, deprivation score is from –8.4 to 13.4 and treated as a continuous variable.

[9] Townsend deprivation index: unemployment, non-ownership of a car, non-ownership of a home, and overcrowding

contributions to mortality risk. Carstairs and Morris (1989a) show that mortality gradients by deprivation category remain after standardising for differences in social class composition.

In summary, we show that area-based deprivation inversely relates to all-cause mortality for both males and females. Also, deprivation and other socio-economic factors (occupation or education) contribute independently to all-cause mortality among men and women in Korea. However, this study had a limitation that the level 1 variance was over-dispersed.

4.5.2.4 The association between occupation, education and deprivation index

This chapter suggests that occupational class is one of the leading causes of differences in mortality. Education, too, is a strong causal factor in differences in mortality rates and is strongly associated with occupation. In addition, deprivation also has an inverse relationship with mortality.

As explanatory variables, occupation, education, income, and deprivation are related to each other in Korea. Those who are less educated seem to go on to do manual work for both males and females (Tables 4.21 and 4.22). There is also evidence that lower occupational groups, such as labourers, as well as lower educational groups, have lower incomes than other groups (The Ministry of Labour, Korea 1995-7). Labourers have a third of the wages of the managerial group and those educated below middle-school earn almost half the wages of those educated above university level (The Ministry of Labour, Korea 1995-7).[10] Deprivation is also strongly associated with occupation and education among our study population. That is, manual workers and the less well-educated groups have higher deprivation scores than other groups (Table not shown, see Appendix).

With such relationships between occupation, education and deprivation, these variables can be used together to investigate risk factors for differentials in mortality. First of all, occupational class has been used for many years as a convenient indicator of the standard of living and way of life of different groups and has been used to represent 'social' class (The *Black Report*, 1982). For several reasons, an educational variable can be very useful. It allows us properly to include women in the study population. It can be a reasonable

[10] Survey report on wage structure, 1997, Korea, The Ministry of Labour

It allows us properly to include women in the study population. It can be a reasonable socio-economic indicator for the unemployed, as the variable of occupation includes only those currently employed.

We show that an area-based deprivation index can overcome the limitation of relying upon an occupational class variable. This index is one of the indicators measuring material[11] resources. Townsend et al (1986) show that a material deprivation index, as well as occupational class, make a significant contribution to explaining the variations in overall health. As they say:

> Occupational class is clearly of major importance in explaining inequalities in health, but, just as clearly, there is a need to go beyond occupational class (at least as ordinarily interpreted) in explaining those inequalities. Broadly speaking, either there are factors independent of occupational class which contribute in substantial measure to any further explanation of excess deaths, or occupational class includes systematic variations in the experience of material deprivation which need to be revealed if a further large number of the observed excess deaths are to be explained (p142).

Davey Smith et al (1998b) suggest that:

> Area-based measures will provide additional information on the socio-economic characteristics of residents within the area, independent of the individual socio-economic circumstances of these people (p404).

In conclusion, this study shows that occupation is an indicator of social class and can be used to explain social differentials in mortality in Korea. This study also shows that education and a deprivation index can overcome the limitation of using occupational class to explain these differentials.

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[10] Survey report on wage structure, 1997, Korea, The Ministry of Labour

[11] Carstairs and Morris (1991) mentioned that the each of Carstairs' deprivation indices represents or is determinant of material disadvantage.

4.5.2.5 Conclusion

This chapter explores the relationship of occupation, education and deprivation to mortality across the economically-active, Korean population. Our conclusions are as follows:

> Firstly, manual workers have higher death rates for all-cause mortality, compared to non-manual workers, among Korean men and women aged between 20 and 64 years. The effect of occupational class on differentials in mortality is higher in Korea than in European countries.
>
> Secondly, there is a strong inverse relationship between education and all-cause mortality for this group. After adjusting for education, the occupational effect on mortality disappears and is even reversed. This educational effect is higher than that found in European studies. It suggests that occupation may be more strongly related to education in terms of inequalities in mortality in Korea.
>
> Thirdly, there is an inverse relationship between deprivation and all-cause mortality. The deprivation effect on mortality is a little bit higher than that found in European countries. After adjusting for occupation and education, deprivation still has an impact on mortality differential. After adjusting for deprivation, the occupational and educational effect on mortality remain. Thus, area-based deprivation indicators and individual socio-economic factors make independent contributions to mortality risk.

4.6 Implications and suggestions

This study is the first attempt to explore the social differentials in mortality, focusing on occupational class across the working population in Korea. The results show that occupation, education and deprivation can be used as a proxy for socio-economic factors and differential material conditions. Nevertheless, we note several limitations. Further improvements for future research will be needed: firstly, in the *Census* and NSO death reports, the variables for the measurement of social class need to be improved.

Occupation is categorised using the *Korean Standard Classification of Occupations*[12] in both the *Census* as well as the NSO death data. However, this classification scheme is not geared towards social class or hierarchy, but for categorising types of work.[13] It therefore tends to blur social class relations rather than clarifying and classifying them. To continue using this system, then, several items related to social hierarchy need to be added. These include: detailed job tasks, position within an organisation, the ownership of assets and skills. The *Black Report* also suggests, in relation to the *General Household Survey*, that steps should be taken to develop a more comprehensive measure of income, or command over resources, through either (i) some means of modifying such a measure with estimates of total wealth or at least some of the most prevalent forms of wealth, such as housing and savings, or (ii) the integration of income and wealth, employing a method of, for example, annuitization.

Secondly, methods for the collection of death and *Census* information need to be improved. In particular, the occupational variable needs to be neatly defined and more clearly specified in both surveys. For example, there needs to be sharper differentiation between economically active and inactive (unemployed, student, housewives and retired). Along with this, clarification of full- and part-time work is needed in the reportage of deaths. To do this, more detailed instructions for both death reports and *Census* are needed for use by informants and reporters. In addition to this, regular validity tests for variables such as occupation and education in the NSO death report need to be established. To reduce mis-classification, a training and inspection system for the process of data collection and encoding in Civil Offices needs to be established. To allow correspondence with the *Census* data, it would be a good idea if the data collection and encoding systems used by both surveys were to converge.

4.7 Need for further study

4.7.1 Need for the longitudinal studies in Korea

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[12] In Korean Standard Classification of Occupations, classification of occupations defines a systematic classification of individual people's job, which has been performing for the people's income or economic activity

[13] In Korean Standard Classification of Occupations, job defines a duty or business, which has been performed by individual people who are economically active. Thus occupation means the collection of similar jobs.

A longitudinal cohort study is needed to overcome the limitations of the existing data, for example the possibility of numerator-denominator bias, in Korea. A cohort of a 1% sample of the whole population needs to be established for longitudinal study on mortality. Another possibility would be linking deaths and population, through the utilisation of social security numbers. These approaches would be helpful in investigating further the differentials and major determinants of health. A longitudinal study would also aid the exploration of the detailed mechanisms or pathways which affect ill health as well as progressive or cumulative effects over whole lifespans (Davey Smith, 1994).

4.7.2 Investigation of the effect of occupation and other variables on health differentials

Further study is needed to explore the relationship between occupation and other socio-economic variables and mortality. We therefore need to use combined measures to understand the full scope of socio-economic differentiation and adequately to control for possible confounding factors and effect modifiers (Davey Smith, 1998b; Lundberg, 1991). To locate the exact relationship between mortality, occupation and other explanary variables, we need to include all the variables and understand their interactions in depth. To overcome the limitation of the occupational variable, as a single indicator we need a study relating variables such as occupation, education, income, deprivation and other potential socio-economic factors.

Chapter 5: Occupational class, chronic disease and perceived general health

5.1 Introduction

The previous chapter has shown that manual workers have higher mortality than non-manual workers, and that there is a strong inverse relationship between education and mortality rates among the Korean population. This chapter examines the differentials of chronic disease and perceived general health among different Korean occupational, educational and income groups aged 20-64.

The aims of this chapter are threefold: firstly, to show how socio-economic factors (occupation, education and income) are related to morbidity, focusing especially on occupational class. Many studies have considered occupational class (social class) as the main proxy indicator of socio-economic status in differentials of morbidity (Lundberg, 1986; Stronks et al, 1997; Suadicani et al, 1997; Cavelaara et al, 1998; Tuchsen and Endahl, 1999). However, little research has been carried-out into occupational and socio-economic class (income and education) as risk factors of morbidity in Korea.

Secondly, this chapter explores the extent to which inequalities in mortality are present also in morbidity. Several studies have suggested that large inequalities in mortality are to be related to fairly small inequalities in morbidity. This is due to the fact that high absolute mortality rates, with deaths occurring principally among people with poor health, leave the surviving population healthy (Sihvonen et al, 1998). Others have argued that inequalities in mortality and inequalities in morbidity have common determinants (Ibid., 1998). Therefore, it is expected that large inequalities in more severe forms of morbidity would be related to large inequalities in mortality (Ibid., 1998). The present study explores whether the relationships between socio-economic factors (occupational class, education and income) and morbidity and mortality shadow each other.

Thirdly, this chapter considers health behaviours as confounders in the relationship between occupational class and morbidity and examines how health behaviours effect this relationship. Since the *Black Report*, a consensus has emerged that health behaviours contribute to class differences in health and that such behaviours may be rooted in material conditions or structural position (Macintyre, 1997). Little work concerning the role of health behaviours in social differentials for health in Korea has been developed. In summary, this chapter focuses on the relationship between occupational class and morbidity with consideration given to other socio-economic factors - education and income - and health behaviours - smoking, alcohol, diet and exercise.

5.2 Hypothesis and objectives

The hypothesis of this chapter is that morbidity differentials exist across groups according to occupational class, income and education in Korea. The objective of this chapter is to examine inequalities in morbidity among different occupational classes and educational groups while controlling for health behaviours.

An expected causal pathway in the relationship between occupational class, socio-economic class (education and income) and health behaviours with morbidity is as follows: occupation, education and income may directly effect morbidity rates. Educational level also influences occupation, which in turn has an influence on income and thus on health. For example, membership of a low-level educational group may ensure that a person becomes a manual worker and therefore have a lower income, which effects health. Differentials in health behaviours may be derived from differentials in socio-economic factors (education, occupation and income).

5.3 Methods

5.3.1 Data sources

General Household Survey data from 1995 was obtained from the Korean Institute for Health and Social Affairs. In this survey, the study population was selected by a two-stage, stratified, systemic, randomised sampling among Korean households based on the 1990 *Census*. Among 7577 households the survey was completed in 6791 (89.6%). After excluding the 311 households who had no family members aged 15~69, the 6480 people were selected by randomised sampling and surveyed. In all, 5805 (89.6%) people completed the survey. The target study population in this survey was therefore 5805 in number. The survey was based on a self-reporting questionnaire with attending interviewers. When participants did not understand the questionnaire the interviewer was on hand with explanations.

The explanatory variables used were: demographic factors (age, sex and married status); socio-economic factors (occupation, education, income and employment position); geographical factors (administration area); social support factors; main health behaviours (smoking, alcohol, diet, exercise and BMI index). Health outcome variables employed were 'chronic diseases' and 'perceived general health'. 'Chronic diseases' were defined as those which continued for more than two weeks. Also, 'perceived general health' was selected as a variable of health outcome as it can serve as a proxy of general well-being.

5.3.2 Completeness of data

The study population was defined into those aged 20-64[1] who were currently employed and therefore were currently working. This definition corresponded to that given in Chapter 4, adding greater coherence to the study and allowing comparison between results. The study population was defined as 3441 people out of the original 5805. There were no missing values for age, sex, education, occupation, smoking, marriage and diet.

[1] The study populations of all data in this thesis - mortality (Chapter 4), morbidity (Chapter 5) and cohort injury data (Chapter 7) – are defined as people who are aged 20-64 and have a current job. For national injury deaths (Chapter 6), study population is defined as those who are aged over 20 and have a current job.

The variable of exercise had 73 missing values (2.12%), 456 (13.25%) for BMI variable, 22 (0.64%) for the income variable and 464 (13.48%) for 'happiness'.

5.3.3 The definition of variables

5.3.3.1.The indicators of morbidity: chronic conditions (diseases) and perceived general health

(1) Chronic disease (conditions)

In the *General Household Survey* questionnaire, questions concerning morbidity were set as follows. The interviewer usually showed lists of causes of illness to participants, who were able to select the illness category. Thus:

> **Question 1: During one year (from 1994 July until now), have you had any chance to have a disease as follows? (Table: Nos. 1-25)**
> **Question 2: During two weeks, have you had any diseases or symptoms as follows (Table Nos. 30-79)?**
> **Question 3: Have doctors diagnosed your disease or symptom?**
> **Question 4: If not from doctors, from whom have you taken the diagnosis?**
> **Question 5: When did you notice this disease? (how long have you had this disease?)**

'Chronic disease' was selected from among the answers given to *Question 1*; and those which lasted more than two weeks, from answers given to *Question 5*.

'Medically confirmed chronic disease' was defined as those cases which were diagnosed by doctors. Thus, these cases were selected from answers given to *Question 1* and *Question 3*; and those which were sustained for more than two weeks, *Question 5*.

(2) Perceived general health

'Perceived general health' was defined as 'healthy' and 'unhealthy' from the question:

> **Question: How do you think your health compares to other's who are your age?**
> **Very healthy/healthy/normal/unhealthy/very unhealthy**

'Healthy' was re-grouped with these three categories: very healthy/healthy/normal
'Unhealthy' was re-grouped with the remaining two categories: unhealthy/very unhealthy.

(3) Summary of the categorisation of morbidity

Table 5.1 shows the disease categories used in this study. Our indicators were: chronic diseases, medically confirmed chronic conditions or diseases, perceived general health, diabetes mellitus, digestive diseases, respiratory diseases and musculo-skeletal diseases.

Table 5.1 Morbidity indicators included in this study

Morbidity indicator	Definition (or categories)
Diseases	
1. Chronic conditions or diseases	Mention one or more chronic diseases if people have at least one disease lasting more than two weeks
2. Medically confirmed Chronic conditions or diseases	Among the above chronic diseases (1), those cases which were medically confirmed
3. Perceived general health	Consider their present state of "not healthy" or "not very healthy"
4. Specific diseases	Selected from the lists in the questionnaire
4.1. DM	DM
4.2. Circulatory diseases	Hypertension, CVA, and Heart failure.
4.3. Digestive diseases	Gastric ulcer, and Gastritis
4.4. Respiratory diseases	Chronic obstructive pulmonary disease, Chronic cough.
4.5. Musculoskeletal diseases	Include arthritis, HIVD, and other musculoskeletal diseases.

5.3.3.2 Possible risk factors

The explanatory variables used in this chapter are: demographic factors: age, sex; social behavioural factors: smoking, alcohol, diet, BMI; socio-economic factors: income, education. Occupational groups (class): manual/non-manual, 9 large classification of the variables; geographical variable: area.

The characteristics of the variables in detail are as follows:

(1) Socio-economic variables: occupation, education and income

Re-grouping criteria of occupation and education were carried-out as per Chapter 4. Occupation was sought as follows and ticked in the blanks of the lists of 14 categories based on the Korean National Occupational System. The occupational categories are laid-out in Table 5.2.

> **Question: What kind of work have you been doing?**
> **(Interviewer asks about the job and locates the appropriate categories using the classification of Korean Occupational System and ticks the questionnaire.)**

The unemployed, house-workers and students were excluded. Occupation was then re-grouped into nine categories and two broad categories: *manual* and *non-manual* (Table 5.2). The 8 categories of the educational variable were regrouped into four: *less than elementary, middle school, high school* and *beyond university level.* These groups are the same as those used for the mortality data (Table 5.2). Total income per each household was re-grouped into four categories: *less than 500,000 won, 51-1,000,000 won, 101-1,500,000 won* and *more than 1,500,000 won* (Table 5.2).

(2) Health behaviours: BMI, smoking, alcohol consumption, exercise and diet

Four kinds of health behaviours: smoking, alcohol, diet and Body Mass Index (BMI) were employed in this study.

Body Mass Index was calculated (Table 5.2) using height and weight, and re-grouped into two categories following the references of the Korean Institute for Health and Social Affairs (Nam J 1996): *normal* (when the BMI is less than 25 kg/m^2) and *over-weight* (when the BMI is more than 25 kg/m^2).

The smoking variable was categorised in terms of: *none smoker, ex-smoker* and *present smoker.* Three categories of alcohol variable were employed in the final analysis: *non-drinker, ex-drinker* and *present drinker* (Table 5.2).

The exercise variable was classified into three groups: *none, mild* and *adequate.* Those who were seen as 'well exercised' were those who reported more than two periods of exercise per week of more than 20 minutes per session.

Poor diet behaviours were considered in terms of two categories: *missing breakfast* and *irregular* (Table 5.2).

(3) Demographic variable: sex, age, marriage state and geographical area

Age variable was regrouped into 5-year age bands, leaving four groups: *20-39, 40-49, 50-59* and *60-64*. These were categorised according to similar degrees of disease prevalence (Table 5.2). The marriage variable was coded into 4 groups: *single, married, bereaved,* and *divorced* and regrouped into three groups: *single, married,* and *bereaved or divorced.* This brings the categories into line with those covered in the mortality analysis developed in Chapter 4.

The administrative areas were classified using the same coding system as the Census and National Death Data used in Chapter 4. The area variable was classified into two groups: *urban* and *rural* area (Table 5.2).

(4) Other variables: social support variables

As social support variables, we considered four categories: *confidentiality, being help, being love, happiness*. The questions were as follows:

Question 1: Do you have any one to confide in?
Question 2: Do you have any people who can help you when you confront difficulties?
Question 3: Do you feel loved by those around you?
Question 4: How do you feel about your life during the past year?

We included each variable in the data analysis, and added four variables, making other variables the indicators of social support. In conclusion, the categorisation and re-grouping of the variables are in table 5.2.

Table 5.2 The categories of variables and re-grouping of the variables

	Information	Categories of variables and re-grouping of variables	
	Variable	Categories of variables	Re-grouping
Occupational variable	Occupation	0 Unknown 1 Legislators, Senior officials & managers 2 Professionals 3 Technicians & Associate Professionals 4 Clerks 5 Service workers & shop and Market Sales Workers 6 Skilled Agricultural & fishery workers 7 Craft & related Trades Workers 8 Plant & Machine Operators & Assemblers 9 Elementary Occupations 10 Army 11 Students 12 Housewife 13 Unemployment	- Manual/non-manual 1-5 : Manual 6-9 : Non-manual - 9 Occupational groups 1-9 (10-13 : excluded)
Other Socioeconomic variables	Education	1 not start to be educated 2 Unschooled 3 Elementary school 4 Middle school 5 High school 6 College 7 University 8 Post graduated	1 : University 2 : High school 3 : Middle school 4 : less than elementary level
	Income	1. less than 500,000won 2. 51-1,000,000won 3. 101-1,500,000won 4. 151-2,000,000won 5. 201-2,500,000won 6. more than 2,500,000won	1. more than 1,500,000won 2. 101-1,500,000won 3. 51-1,000,000won 4. less than 500,000won
Health behavioural variables	Smoking	<The type of smoking> 1 Non smoker 2 Ex-smoker 3 Present smoker	<The type of smoking> 1 Non smoker 2 Ex-smoker 3 Present smoker
	Alcohol	<The type of alcohol> 1 Non drinker 2 Ex- drinker 3 Present drinker	<The type of alcohol> 1 Non drinker 2 Ex- drinker 3 Present drinker
	Exercise	<Exercise> 1 None 2 Less than twice per week or less than 20 minutes 3 more than twice per week and more than 20 minutes <Duration of exercise> -> Continuous variable	<Exercise> 1 more than twice per week and more than 20 minutes 2 Less than twice per week or less than 20 minutes 3 None
	Diet	<Regular breakfast> 1 Yes 2 No <Regular diet> 1 Yes 2 No	<Regular breakfast> 1 Yes 2 No <Regular diet> 1 Yes 2 No
Geographical factors	Area	Administrative area of 1995	City/County
Demographic factors	Age	Calculated from the formula; death date - birth date informed in the social certificate number	- 5-band category : - 20-39/40-49/50-59/60-64
	Marriage	1 : Single 2 : Being married 3 : Divorced 4 : Bereavement	1 Single 2 Being married 3 Bereavement or Divorced
Social support	Confidentiality	1: 3 people, 2: 2 people, 3: one, 4:none	4 categories
	Being help	1: 3 people, 2: 2 people, 3: one, 4:none	4 categories
	Being love	1 (no)----------------------------------5 (a lot)	3 categories
	Happiness	1 (very unhappy)----------------------7 (very happy)	4 categories

5.3.4 Final study population

The target population in the *General Household Survey* was 5805. The study population was defined as those who were aged between 20 and 64 years and excluded all the missing values of age, sex, education and occupation (See also 5.3.3). Unemployed people and house-workers were excluded. The final study population was 3441 men (57.7%) and 1454 women (42.3%).

5.3.5 Statistical analysis: logistic regression

The dependent variable was state of health (chronic disease and perceived general health), dichotomous variables (sick/not sick). The independent variables were sex, age education, income, occupation and health behaviours. Age was treated as a confounder. Education and income variables were treated as confounders as well as possible effect modifiers in the relationship between occupation and morbidity. Health behaviours (smoking, alcohol, exercise, diets, BMI) were considered as confounders which distort the relationship between morbidity and occupation, education and income.

Univariate analysis was employed to examine the association of the outcome with each exposure of interest, ignoring all other variables. Multivariate logistic regression modelling was employed with occupational class, all other variables believed a priori to be confounders, and any other variables thought to be possible confounders that appear from the data to have an appreciable confounding effect, as described below. For adjusting variables, at first, we adjusted for age, as it might be the main confounder on estimates of occupational class, education and income group. Marriage and area variables did not confound the relationship between occupational class and morbidity. Therefore, these variables were excluded from the analysis. Social support variable was also found not to be significant in the logistic model of the relationship between occupational class and morbidity. Health behaviours were adjusted in the relationship between socio-economic factors - occupation, education and income - and morbidity. Then each socio-economic factor - occupation, education and income – was fed into the model. Interactions between particular exposure variables and between exposure variables and confounders with chronic disease and subjective illness were investigated.

5.4 Results

5.4.1 Socio-economic and behavioural characteristics according to occupation, education and income group

Tables 5.3-5.6 show data on socio-economic as well as behavioural risk factors according to occupation, education and income, among men and women aged 20-64. For the socio-economic factors, manual workers had especially low income and educational achievement among both male and female (Tables 5.3 and 5.4). Also, the lower education group had higher percentage of lower income levels among both male and female workers. It suggests that lower occupational class is closely related to lower income. These socio-economic variables - occupation, education, and income- are therefore related to each other.

The lower socio-economic group (manual workers, lower educational levels and lower income group) exhibited higher levels of bad health behaviours, especially for smoking and exercise than the higher socio-economic group both men and women. For drinking, there was little difference among different socio-economic classes among men. However, among women, the lower socio-economic group drank more. For diet, little difference was exhibited among different socio-economic classes for both men and women (Tables 5.3-5.6).

In addition to this, the lower socio-economic group (manual workers, lower educational levels and lower income group) had higher divorce rates and higher rates of unhappiness for both men and women (Table 5.3-5.6).

Table 5.3 Population characteristics according to occupational group among men aged 20-64

	Non-manual				Manual					Total
	Mana	Prof	Tech	Cler	Serv	Agri	Craf	Mach	Labo	Total
Total population	30	107	87	286	318	432	348	188	191	1987
Age (mean)	45.4	40.4	35.5	36.2	38.7	50.9	36.9	36.2	40.7	40.7
Socioeconomic and health behavioural characteristics										
BMI (mean, kg/m^2)	23.3	23.2	22.6	23.1	23.4	23.0	23.1	22.9	23.2	23.1
Never smoked(%)	18.4	26.2	20.1	21.6	16.5	17.7	18.4	16.2	14.9	18.9
Ex-smokers(%)	15.9	23.1	30.2	15.7	13.4	15.7	11.9	12.4	8.5	16.3
Current-smokers(%)	65.7	50.7	49.7	62.7	70.1	66.5	69.7	71.5	76.5	64.9
Never drinkers(%)	35.4	46.9	36.3	32.2	39.4	30.5	28.9	36.9	28.7	34.9
Ex- drinkers(%)	6.0	8.90	6.8	8.3	6.6	15.2	7.8	7.4	11.5	8.8
Current-drinkers(%)	58.7	44.2	56.9	59.5	54.0	54.3	63.3	55.7	59.9	56.3
Ever exercised(%)	45.2	70.2	57.6	55.9	46.1	17.4	40.0	43.3	30.4	45.0
Never Exercised(%)	54.8	29.9	42.4	44.1	53.9	82.6	60.0	56.7	69.6	55.0
Diet-eating breakfast (%)	96.7	92.4	92.8	92.5	91.8	99.7	91.2	89.8	89.0	92.8
Diet-not eating breakfast(%)	3.3	7.6	7.2	7.6	8.2	0.3	8.8	10.2	11.0	7.2
Single	0.0	9.5	16.5	12.6	13.5	19.5	16.2	13.7	23.4	14.2
Married	100.0	89.7	81.5	86.6	82.9	76.1	78.1	82.0	67.9	82.4
Divorced or bereaved	0.00	0.8	2.0	0.8	3.6	4.4	5.7	4.3	8.7	3.5
Unhappiness in life (%)	16.9	17.1	17.6	13.5	18.8	15.7	16.0	19.8	29.8	18.4
Household Income>1,000,000	98.1	87.6	83.9	88.3	63.1	29.2	60.5	68.0	34.2	67.4
Household Income<=1,000,000	1.9	12.4	16.1	11.7	36.9	70.8	39.6	32.0	65.8	32.6
More than middle school (%)	100.0	100.0	98.9	95.3	73.8	34.8	61.9	59.14	36.7	72.7
Less than middle school (%) (middle+elementary)	0.0	0.0	1.1	4.7	26.2	65.2	38.1	40.9	63.3	27.3

Occupation:
Mana: Legislators, Senior officials & managers
Prof: Professionals
Tech: Technicians & Associate Professionals
Cler: Clerks
Serv: Service workers & shop and Market Sales Workers
Agri: Skilled Agricultural & fishery workers
Craf: Craft & related Trades Workers
Mach: Plant & Machine Operators & Assemblers
Labo: Elementary Occupations

BMI: Body Mass Index

More than middle school (%):More than middle school of education
Less than middle school (%):Less than middle school of education

Table 5.4 Population characteristics according to occupational groups among women aged 20-64

	Non-manual			Manual					Total
	Ma+Pr	Tech	Cler	Serv	Agri	Craf	Mach	Labo	Total
Number	63	52	128	393	494	93	15	216	1454
Age (mean)	34.3	28.4	25.7	38.5	51.4	35.2	36.7	45.5	42.0
Socioeconomic and health behavioural characteristics									
Body Mass Index (mean, kg/m^2)	21.8	22.0	21.6	22.3	23.5	22.5	21.4	22.5	22.3
No smokers(%)	98.1	97.7	95.4	83.8	94.6	86.9	96.5	81.6	91.3
Ex- smokers(%)	0.0	0.4	1.2	1.8	0.4	2.8	3.5	5.6	2.0
Current-smokers(%)	1.9	1.5	3.4	14.4	5.0	10.3	0.0	12.8	6.7
Non-drinkers(%)	82.7	82.7	82.2	78.2	94.1	87.3	76.9	79.2	83.9
Ex- drinkers(%)	3.0	1.5	2.1	4.0	1.4	0.7	0.0	4.3	2.3
Current-drinkers(%)	9.3	15.8	15.7	17.8	4.5	12.1	23.1	16.5	13.8
Ever Exercised(%)	51.6	46.9	23.0	26.5	3.7	13.7	33.0	13.8	25.8
Never exercised(%)	48.4	53.1	77.0	73.5	96.3	86.3	67.0	86.9	74.2
Diet-eating breakfast (%)	85.8	82.1	78.2	84.6	96.1	90.9	100.0	88.3	88.2
Diet-not eating breakfast(%)	14.2	17.9	21.8	15.4	3.9	9.1	0.0	11.7	11.8
Single	21.3	27.3	49.9	14.9	3.3	13.6	21.1	12.8	19.3
Married	58.0	55.4	35.1	59.8	86.6	62.7	67.1	58.7	61.1
Divorced or bereaved	20.7	17.4	15.0	25.3	10.1	23.7	11.8	28.5	19.6
Unhappiness in life (%)	10.6	17.0	11.0	17.4	8.2	22.1	19.6	29.0	16.9
Household Income>1,000,000	73.9	74.1	74.7	50.9	30.7	46.1	94.8	40.9	58.3
Household Income<=1,000,000	26.1	25.9	25.3	49.1	69.3	53.9	5.2	59.1	41.7
More than middle school (%)	95.4	69.4	98.6	47.9	20.5	23.2	36.8	26.1	50.9
Less than middle school (%) (middle+elementary)	4.6	30.6	1.4	52.1	79.5	76.8	63.2	73.9	49.1

Occupation:

Mana : Legislators, Senior officials & managers : No women was in the manager group in this study population
Prof: Professionals
Tech: Technicians & Associate Professionals
Cler: Clerks
Serv: Service workers & shop and Market Sales Workers
Agri: Skilled Agricultural & fishery workers
Craf: Craft & related Trades Workers
Mach: Plant & Machine Operators & Assemblers
Labo: Elementary Occupations

BMI: Body Mass Index

More than middle school (%):More than middle school of education
Less than middle school (%):Less than middle school of education

Table 5.5 Population characteristics according to education among men and women aged 20-64

	Men					Women				
Education	Univ	High	Midd	Elem	Total	Univ	High	Midd	Elem	Total
Number	457	803	321	406	198 7	175	384	243	657	145 4
Age (mean)	37.3	36.5	41.8	52.0	40.7	29.9	31.7	39.8	52.2	42.0
Socioeconomic and health behavioural characteristics										
BMI(mean, kg/m^2)	23.0	23.2	23.1	23.5	23.2	21.9	22.3	22.6	23.2	22.5
Never smoked(%)	21.0	17.3	14.4	16.9	17.4	97.3	87.5	81.5	86.7	88.2
Ex-smokers(%)	18.7	16.1	9.4	9.5	14.8	1.00	2.2	0.9	7.1	2.8
Current-smokers(%)	60.3	66.6	76.2	73.7	69.1	1.7	10.3	17.6	6.3	9.00
No drinkers(%)	37.3	35.1	30.7	27.0	32.6	89.4	82.7	83.3	79.4	83.7
Ex- drinkers(%)	9.5	8.1	7.9	6.6	8.0	1.8	2.7	0.7	1.7	1.7
Current-drinkers(%)	53.2	56.8	61.4	66.4	59.4	8.8	14.6	16.0	19.0	14.6
Ever exercised(%)	59.0	45.7	33.6	27.7	41.6	63.6	22.3	14.7	17.1	29.4
Never Exercised(%)	41.0	54.3	66.5	72.3	58.4	36.4	77.7	85.3	82.9	70.6
Diet-eating breakfast (%)	93.3	91.8	89.3	95.7	92.5	86.9	81.1	90.8	80.6	84.8
Diet-not eating breakfast(%)	6.7	8.2	10.7	4.3	7.5	13.1	19.0	9.2	19.4	15.2
Single	14.1	14.6	16.9	21.4	15.4	22.8	17.2	13.5	14.7	17.1
Married	85.0	83.0	77.9	65.6	78.0	60.8	70.4	64.7	64.6	65.1
Divorced or bereaved	0.9	2.4	5.2	13.0	5.3	16.4	12.4	21.8	20.6	17.8
Unhappiness in life (%)	13.8	19.2	22.2	24.5	19.8	8.5	18.6	14.2	22.6	16.0
Household Income>1,000,000	85.7	66.9	44.1	25.8	56.0	76.1	65.3	45.0	25.7	53.0
Household Income<=1,000,000	14.4	33.1	55.9	74.2	44.0	23.9	34.7	55.0	74.3	47.0
Non-manual (%)	85.4	45.0	14.5	9.8	39.0	97.4	70.7	36.9	18.6	55.9
Manual (%)	14.6	55.0	85.5	90.2	61.0	2.6	29.3	63.1	81.4	44.1

Education:
Univ: University, High: High school, Midd: Middle school, Elem: less than elementary level

More than middle school (%):More than middle school of education
Less than middle school (%):Less than middle school of education

BMI: Body Mass Index

Table 5.6 Population characteristics according to income group among men and women aged 20-64

	Men					Women				
	>=150	100-149	50-100	<50	Total	>=150	100-149	50-100	<50	Total
Number	610	540	574	248	1972	369	273	441	364	1447
Age (mean)	39.5	38.3	40.7	49.0	40.7	35.8	37.1	41.4	52.7	42.0
Socioeconomic and health behavioural characteristics										
BMI (mean, kg/m^2)	23.2	23.0	23.0	23.0	23.1	22.3	22.4	23.0	22.3	22.5
Never smoked(%)	21.1	15.3	15.7	18.3	17.6	93.7	92.0	91.4	85.3	90.6
Ex- smokers(%)	17.8	13.9	13.6	14.5	15.0	1.5	1.6	1.8	1.0	1.5
Current-smokers(%)	61.1	70.8	70.7	67.2	67.4	4.8	6.4	6.9	13.7	7.9
No drinker(%)	38.1	34.2	31.0	32.2	33.9	85.1	79.1	83.5	80.3	82.0
Ex- drinkers(%)	8.6	7.0	9.1	10.1	8.7	2.0	3.7	2.0	5.7	3.3
Current-drinkers(%)	53.4	58.9	59.9	57.7	57.5	12.9	17.2	14.5	14.0	14.7
Ever Exercised(%)	50.9	44.2	32.9	25.2	38.3	26.7	19.5	17.9	12.0	19.0
Never exercised(%)	49.1	55.8	67.1	74.8	61.7	73.3	80.5	82.1	88.9	81.0
Diet-eating breakfast (%)	94.2	91.7	89.8	93.7	92.4	88.3	90.4	89.0	88.0	88.9
Diet-not eating breakfast(%)	5.8	8.3	10.2	6.3	7.7	11.7	9.6	11.0	12.0	11.1
Single	13.7	12.5	17.4	27.5	17.8	15.7	14.6	19.1	10.0	17.4
Married	85.5	84.8	77.4	60.9	77.1	74.1	76.5	64.8	47.1	65.6
Divorced or bereaved	0.9	2.7	5.2	11.5	5.1	10.2	8.9	16.1	32.8	17.0
Unhappiness in life (%)	12.2	18.1	21.6	26.6	19.6	12.5	13.4	13.0	36.7	18.9
Occupation : non-manual (%)	63.0	45.7	26.8	17.7	37.8	59.1	41.2	40.4	30.0	42.7
Occupation : manual (%)	39.0	54.3	73.2	82.3	62.2	40.9	58.8	59.6	70.0	57.3
More than middle school (%)	81.12	71.1	50.4	32.4	58.7	58.53	36.7	32.7	24.9	38.2
Less than middle school (%) (middle+elementary)	18.88	28.9	49.6	67.6	41.3	41.47	63.3	67.3	75.1	61.8

Income level (unit : 10000 won) : >=150 : above 1500000 won, 100-149 : between 1000000 and1490000 won
50-100 : between 500000 and 1000000 won , <50 : below 500000 won

More than middle school (%):More than middle school of education
Less than middle school (%):Less than middle school of education

BMI: Body Mass Index

5.4.2 The relationship between occupation, chronic disease and perceived general health

5.4.2.1 The relationship between occupation, education, and income with chronic disease and perceived general health

Table 5.7 presents odds ratios for morbidity among different age groups. The older group exhibits higher morbidity rates for both men and women. After adjusting for health behaviours, education, income and occupation, the relationship between age group and morbidity remained but was reduced among both male and female workers.

Table 5.8 shows the relationship of occupation (manual/non-manual), education, income, and health behaviours to chronic disease. Age adjusted odds ratios for chronic disease were higher for manual workers, the lower educational level group and the lower income group, for both sexes. Adjusting for health behaviours made little difference to the relationships between occupational class, educational level and income and chronic disease. This suggests that health behavioural factors do not effect the relationship between socio-economic factors - occupation, education, and income - and chronic disease.

To investigate the combined association of occupation, education and income with chronic disease, the variables were adjusted by applying others one-by-one to the model. After adjusting for education, the odds ratio for manual workers decreased to below one. With nine groups of occupational categories, the relationship between occupation and chronic disease was lessened by adjusting for education, but this association was not statistically significant with the log likelihood test and had a wider confidence interval of odds ratios. The odds ratio of chronic disease for manual workers lessened after adjusting for income, but only slightly. Also, adjustment for occupation and education attenuated the association between income and chronic disease. On the other hand, income and occupation seemed to have little effect on the relationship between education and chronic disease. There were no statistically significant interactions among risk factors.

Table 5-9 presents the relationship between occupation (manual/non-manual), education, income, and health behaviours with the category 'Medically confirmed chronic disease'.

For these, the odds ratio for manual workers was higher than that for non-manual workers. These results were similar to those for 'Chronic disease', but the differences between lower and higher socio-economic status was greater.

Table 5-10 shows the relationship between occupation (manual/non-manual), education, income, and health behaviours with 'Perceived general health'. Manual workers felt unhealthy than non-manual workers for both men and women. Also, lower educated group and lower income group had more subjective feeling of ill health than higher educated and income group. The socio-economic difference for 'Perceived general health' was greater than that for either 'Chronic disease' or 'Medically confirmed Chronic Disease'. Adjusting for health behaviours slightly attenuated the association between socio-economic factors and 'Perceived general health'. For the relationship between occupation, education and income with 'Perceived general health', after adjusting in turn for education and income, the association between occupational class and 'Perceived general health' attenuated and seemed to have disappeared.

On the other hand, the relationship between the nine groups of occupational class and differentially perceived general health remained after adjusting for education, with the significant log likelihood test, even though the odds ratios for chronic diseases lessened. In particular, the occupational groups which continued to exhibit higher morbidity rates after adjusting for education were sales workers, agricultural workers, machine operators and labourers. The educational effect looked somewhat greater than the income effect in the relationship between occupation and 'Perceived general health'. After adjusting for occupation and income, the differential between education and 'Perceived general health' narrowed but remained. The same outcomes were noted after adjusting in turn for occupation and education.

In conclusion, these results suggest that the lower socio-economic class (manual workers, less well-educated and lower income) suffered higher morbidity rates than the higher socio-economic class. Health behaviours had little effect on socio-economic differentials. No inter- relationship between occupation, education and income with morbidity was noted.

Table 5.7 Odds ratios (and 95%confidence intervals) of chronic diseases according to age among men and women aged 20-64

Job	Total Numbers	Cases	Crude Prevalence (%)	Adjust for age		Adjust for age and Health behaviours		Adjust for age, education, and health behaviours[1]		Adjust for age, income, and health behaviours	
Men											
Chronic Dis				OR	CI	OR	CI	OR	CI	OR	CI
20-39	1038	215	20.71	1.00		1.00		1.00		1.00	
40-49	483	140	28.99	1.56	1.22-2.00	1.52	1.17-1.98	1.35	1.03-1.77	1.51	1.15-1.96
50-59	329	133	40.43	2.60	1.99-3.39	2.48	1.85-3.33	2.02	1.48-2.78	2.28	1.69-3.07
60-64	137	79	57.66	5.21	3.60-7.55	5.34	3.44-8.30	4.05	2.52-6.50	4.60	2.92-7.23
Total	1987	567	28.54								
Med Chro D											
20-39	1038	138	13.29	1.00		1.00		1.00		1.00	
40-49	483	99	20.50	1.68	1.27-2.23	1.64	1.21-2.22	1.46	1.07-2.00	1.63	1.20-2.21
50-59	329	109	33.13	3.23	2.41-4.32	2.96	2.15-4.08	2.50	1.76-3.54	2.69	1.94-3.74
60-64	137	59	43.07	4.93	3.36-7.23	4.33	2.74-6.85	3.48	2.11-5.74	3.63	2.26-5.83
Total	1987	405	20.38								
Per Gen H											
20-39	1034	70	6.77	1.00		1.00		1.00		1.00	
40-49	482	56	11.62	1.81	1.25-2.62	1.50	1.01-2.25	1.17	0.77-1.77	1.49	0.99-2.24
50-59	323	67	20.74	3.60	2.51-5.18	2.70	1.81-4.04	1.58	1.10-2.49	2.29	1.51-3.47
60-64	136	42	30.88	6.15	3.97-9.53	3.81	2.24-6.49	1.78	0.97-3.26	2.54	1.45-4.47
Total	1975	235	11.90								
Women											
Chronic Dis											
20-39	680	167	24.56	1.00		1.00		1.00		1.00	
40-49	279	122	43.73	2.39	1.78-3.20	2.27	1.62-3.18	1.72	1.19-2.48	1.12	1.50-2.98
50-59	341	213	62.46	5.11	3.86-6.77	4.27	2.99-6.11	2.94	1.93-4.48	3.44	2.35-5.03
60-64	154	113	73.38	8.47	5.69-12.60	7.55	4.32-13.18	5.00	2.70-9.26	5.14	2.82-9.39
Total	1454	615	42.30								
Med Chro D											
20-39	680	109	16.03	1.00		1.00		1.00		1.00	
40-49	279	89	31.90	2.45	1.77-3.39	2.35	1.62-3.40	1.76	1.17-2.63	2.21	1.51-3.21
50-59	341	175	51.32	5.52	4.11-7.42	4.64	3.18-6.77	3.14	2.01-4.90	3.89	2.60-5.82
60-64	154	94	61.04	8.21	5.59-12.04	6.87	4.02-11.73	4.46	2.44-8.15	5.32	2.95-9.58
Total	1454	467	32.12								
Per Gen H											
20-39	679	88	12.96	1.00		1.00		1.00		1.00	
40-49	279	71	25.45	2.29	1.61-3.25	2.01	1.33-3.04	1.48	0.95-2.33	1.86	1.22-2.83
50-59	334	143	42.81	5.03	3.68-6.87	4.05	2.69-6.08	2.59	1.59-4.21	3.12	2.01-4.83
60-64	152	75	49.34	6.54	4.43-9.65	5.66	3.26-9.83	3.42	1.82-6.42	3.54	1.91-6.56
Total	1444	377	26.11								

1)Health behaviour variables: smoking, alcohol, exercise, diet, BMI
2) adjusted with occupation and health behaviours
Chronic Dis: Chronic conditions or diseases
Med Chro D: Medically confirmed Chronic conditions or diseases
Per Gen H: Perceived general health

Table 5.8 Age adjusted odds ratios (and 95% confidence intervals) of chronic diseases according to occupational class, education, and income, among men and women aged 20-64

Job	Numbers	Cases	Crude Prevalence (%)	Adjust for age		Adjust for age and Health behaviours		Adjust for age, education, and health behaviours[1)]		Adjust for age, income, and health behaviours	
Men				OR	CI	OR	CI	OR	CI	OR	CI
Occupation											
Non-manual	828	195	23.55	1.00		1.00		1.00		1.00	
Manual	1159	372	32.10	1.24	1.00-1.53	1.24	0.99-1.56	0.94	0.72-1.23	1.20	0.95-1.53
Total	1987	567	28.54								
Mana+Prof	137	32	23.36	1.00		1.00		1.00		1.00	
Tech	87	16	18.39	0.92	0.47-1.82	1.01	0.51-2.01	0.94	0.47-1.88	0.98	0.48-1.98
Clerks	286	63	22.03	1.13	0.69-1.86	1.11	0.67-1.84	0.99	0.59-1.66	1.12	0.67-1.87
Sales	318	84	26.42	1.30	0.81-2.10	1.38	0.85-2.25	1.03	0.60-1.76	1.43	0.87-2.35
Agri	432	188	43.52	1.80	1.14-2.84	1.91	1.17-3.12	1.18	0.66-2.09	1.86	1.10-3.14
Craft	348	85	24.43	1.26	0.78-2.03	1.29	0.79-2.11	0.88	0.50-1.55	1.34	0.81-2.22
Operators	188	44	23.40	1.20	0.70-2.03	1.35	0.78-2.33	0.93	0.51-1.71	1.36	0.78-2.37
Labourers	191	55	28.80	1.35	0.81-2.26	1.34	0.78-2.32	0.84	0.45-1.56	1.39	0.79-2.45
Total	1987	567	28.54								
Log-likeli				11.99	P=0.1009	11.32	P=0.1251	3.47	P=0.8386	8.41	P=0.2981
Education											
>University	457	90	19.69	1.00		1.00		1.00 [2]		1.00	
High	803	189	23.54	1.27	0.96-1.69	1.29	0.96-1.73	1.32	0.93-1.86	1.30	0.96-1.76
Middle	321	111	34.58	1.89	1.36-2.64	2.04	1.43-2.91	2.07	1.34-3.21	2.07	1.43-3.01
<elementary	406	177	43.59	1.86	1.33-2.62	2.02	1.39-2.94	1.96	1.23-3.12	2.04	1.35-3.07
Total	1987	567	28.54								
Income											
>1,500,000	610	167	27.38	1.00		1.00		1.00		1.00[2]	
100-150	540	123	22.78	0.82	0.62-1.07	0.84	0.63-1.11	0.78	0.58-1.04	0.79	0.59-1.05
50-99	574	162	28.22	0.98	0.75-1.27	1.01	0.76-1.34	0.82	0.61-1.11	0.89	0.66-1.19
<50	248	112	45.16	1.48	1.06-2.06	1.45	1.01-2.10	1.10	0.74-1.64	1.15	0.76-1.73
Total	1972	564	28.60								
Women											
Occupation											
Non-manual	636	193	30.35	1.00		1.00		1.00		1.00	
Manual	818	422	51.59	1.14	0.88-1.48	1.19	0.89-1.60	1.01	0.72-1.40	1.08	0.80-1.47
Total	1454	615	42.30								
Mana+Prof	63	19	30.16	1.00		1.00		1.00		1.00	
Tech	52	10	19.23	0.81	0.33-2.01	0.82	0.32-2.08	0.72	0.28-1.86	0.81	0.32-2.07
Clerks	128	21	16.41	0.78	0.37-1.67	0.77	0.35-1.67	0.57	0.23-1.40	0.73	0.34-1.59
Sales	393	143	36.39	1.04	0.57-1.91	1.03	0.55-1.93	0.69	0.30-1.58	1.00	0.53-1.88
Agri	494	290	58.70	1.27	0.69-2.37	1.44	0.74-2.80	0.83	0.34-2.04	1.22	0.61-2.43
Craft	93	31	33.33	1.10	0.54-2.27	1.23	0.58-2.62	0.73	0.28-1.91	1.14	0.53-2.44
Operators	15	6	40.00	1.29	0.39-4.32	1.40	0.41-4.77	0.86	0.22-3.39	1.47	0.43-5.00
Labourers	216	95	43.98	0.95	0.50-1.81	0.83	0.42-1.67	0.50	0.20-1.23	0.75	0.40-1.51
Total	1454	615	42.30								
Log likeli				5.06	P=0.6531	8.84	P=0.2643	7.28	P=0.4003	7.05	P=0.4241
Education											
>University	175	36	20.57	1.00		1.00		1.00 [2]		1.00	
High	384	96	25.00	1.17	0.75-1.83	1.17	0.74-1.87	1.39	0.74-2.64	1.15	0.72-1.84
Middle	243	98	40.33	1.57	0.96-2.55	1.61	0.95-2.73	1.91	0.93-3.90	1.59	0.93-2.72
<elementary	652	385	59.05	1.78	1.10-2.89	1.84	1.08-3.15	2.11	1.00-4.47	1.60	0.91-2.82
Total	1454	615	42.30								
Income											
>1,500,000	369	110	29.81	1.00		1.00		1.00		1.00[2]	
100-150	273	87	31.87	1.02	0.72-1.46	0.98	0.67-1.44	0.91	0.61-1.35	0.95	0.64-1.41
50-99	441	178	40.36	1.22	0.89-1.67	1.23	0.87-1.73	1.12	0.78-1.61	1.19	0.83-1.71
<50	364	237	65.11	1.93	1.34-2.76	1.97	1.28-3.03	1.76	1.12-2.76	1.83	1.16-2.89
Total	1447	612	42.29								

1 Health behaviour variables: smoking, alcohol, exercise, diet, BMI

2 Adjusted with occupation and health behaviours

Log-likeli: log likelihood test for heterogeneity of occupation variable

Table 5.9 Age adjusted odds ratios (and 95% confidence intervals) of medically confirmed chronic diseases according to occupational class, education, and income among men and women aged 20-64

Job	Total Numbers	Cases	Crude Prevalence (%)	Adjust for age		Adjust for age and health behaviours		Adjust for age, education and health behaviours[1]		Adjust for age, income and health behaviours	
Men				OR	CI	OR	CI	OR	CI	OR	CI
Non-manual	828	129	15.58	1.00		1.00		1.00		1.00	
Manual	1159	276	23.81	1.34	1.05-1.71	1.30	1.00-1.69	0.98	0.72-1.32	1.22	0.92-1.61
Total	1987	405	20.38								
Mana+Prof	137	21	15.33	1.00		1.00		1.00		1.00	
Tech	87	10	11.49	0.92	0.41-2.09	1.02	0.45-2.34	0.94	0.41-2.17	0.95	0.40-2.23
Clerks	286	42	14.69	1.20	0.67-2.14	1.22	0.67-2.21	1.05	0.57-1.94	1.21	0.66-2.20
Sales	318	56	17.61	1.32	0.76-2.14	1.37	0.78-2.43	0.97	0.52-1.82	1.37	0.77-2.44
Agri	432	145	33.56	1.93	1.15-3.26	1.93	1.10-3.38	1.14	0.59-2.22	1.70	0.94-3.10
Craft	348	65	18.68	1.54	0.89-2.67	1.63	0.93-2.88	1.04	0.54-1.99	1.64	0.92-2.91
Operators	188	24	12.77	0.98	0.52-1.87	1.06	0.55-2.05	0.68	0.32-1.41	1.01	0.52-1.98
Labourers	191	42	21.99	1.59	0.88-2.86	1.52	0.81-2.83	0.91	0.44-1.85	1.48	0.78-2.83
Total	1987	405	20.38								
Log-likeli				14.90	P=0.0373	10.70	P=0.1523	4.45	P=0.7271	7.60	P=0.3691
Education											
>University	457	56	12.25	1.00		1.00		1.00[2]		1.00	
High	803	130	16.19	1.40	1.00-1.96	1.39	0.98-1.98	1.44	0.95-2.18	1.36	0.95-1.95
Middle	321	83	25.86	2.13	1.45-3.13	2.30	1.53-3.45	2.35	1.42-3.89	2.20	1.44-3.38
<elementary	405	136	33.50	2.02	1.37-2.98	1.94	1.26-2.98	1.93	1.13-3.30	1.80	1.13-2.87
Total	1987	405	20.38								
Income											
>1,500,000	610	109	17.87	1.00		1.00		1.00		1.00[2]	
100-150	540	85	15.74	0.91	0.66-1.25	0.94	0.68-1.31	0.88	0.63-1.23	0.89	0.64-1.24
50-99	574	121	21.08	1.15	0.86-1.55	1.14	0.83-1.57	0.94	0.67-1.32	1.00	0.71-1.41
<50	248	87	35.08	1.66	1.16-2.38	1.70	1.14-2.54	1.36	0.88-2.09	1.41	0.90-2.21
Total	1972	402	20.39								
Women											
Occupation											
Non-manual	636	131	20.60	1.00		1.00		1.00		1.00	
Manual	818	336	41.08	1.24	0.94-1.63	1.35	0.99-1.86	1.18	0.83-1.68	1.29	0.93-1.79
Total	1454	467	32.12								
Mana+Prof	63	11	17.46	1.00		1.00		1.00		1.00	
Tech	52	6	11.54	1.00	0.33-3.03	0.90	0.29-2.75	0.85	0.27-2.64	0.91	0.30-2.80
Clerks	128	12	9.38	0.98	0.38-2.49	0.85	0.33-2.19	0.80	0.27-2.33	0.84	0.33-2.16
Sales	393	102	25.95	1.31	0.63-2.69	1.09	0.52-2.28	0.96	0.36-2.51	1.09	0.52-2.29
Agri	494	239	48.38	1.73	0.84-3.58	1.88	0.88-4.02	1.47	0.53-4.09	1.77	0.80-3.88
Craft	93	24	25.81	1.62	0.70-3.75	1.59	0.67-3.75	1.27	0.42-3.83	1.56	0.65-3.73
Operators	15	4	26.67	1.46	3.74-5.66	1.33	0.34-5.29	1.10	0.23-5.20	1.48	0.37-5.93
Labourers	216	69	31.94	1.15	0.54-2.44	8.78	0.39-1.95	0.70	0.25-1.99	0.85	0.38-1.92
Total	1454	467	32.12								
Log-likeli				8.73	P=0.2724	15.27	P=0.0327	11.79	P=0.1078	12.86	P=0.0756
Education											
>University	175	23	13.14	1.00		1.00		1.00[2]		1.00	
High	384	61	15.89	1.12	0.66-1.90	1.04	0.60-1.80	1.01	0.48-2.11	1.02	0.59-1.79
Middle	243	72	29.63	1.57	0.90-2.74	1.49	0.82-2.71	1.36	0.61-3.07	1.54	0.84-2.85
<elementary	652	311	47.70	1.82	1.05-3.15	1.74	0.95-3.17	1.47	0.63-3.41	1.65	0.87-3.11
Total	1454	467	32.12								
Income											
>1,500,000	369	78	21.14	1.00		1.00		1.00		1.00[2]	
100-150	273	59	21.61	0.94	0.63-1.39	0.87	0.56-1.34	1.02	0.59-1.79	0.80	0.51-1.25
50-99	441	137	31.07	1.25	0.88-1.76	1.18	0.81-1.73	1.54	0.84-2.85	1.08	0.72-1.60
<50	364	191	52.47	1.71	1.17-2.50	1.63	1.04-2.56	1.65	0.87-3.11	1.36	0.84-2.20
Total	1447	465	32.14								

1 Health behaviour variables: smoking, alcohol, exercise, diet, BMI

2 Adjusted with occupation and health behaviours

Log-likeli: log likelihood test for heterogeneity of occupation variable

Table 5.10 Age adjusted odds ratios (and 95% confidence intervals) of perceived general health according to occupational class, education, and income, among men and women aged 20-64

Job	Total Numbers	Cases	Crude Prevalence (%)	Adjust for age		Adjust for age and health behaviours		Adjust for age, education and health behaviours[1]		Adjust for age, income and health behaviours	
Men				OR	CI	OR	CI	OR	CI	OR	CI
Occupation											
Non-manual	828	57	6.88	1.00		1.00		1.00		1.00	
Manual	1147	178	15.52	1.93	1.40-2.67	1.41	1.00-2.00	0.97	0.65-1.47	1.11	0.76-1.61
Total	1975	235	11.90								
Mana+Prof	137	8	5.84	1.00		1.00		1.00		1.00	
Tech	87	3	3.45	0.71	0.18-2.79	0.66	0.17-2.60	0.62	0.16-2.44	0.67	0.17-2.65
Clerks	286	9	3.15	0.64	0.24-1.70	0.58	0.22-1.58	0.55	0.20-1.49	0.52	1.89-1.46
Sales	318	37	11.64	2.34	1.06-5.20	2.15	0.96-4.83	1.85	0.76-4.49	1.93	0.85-4.40
Agri	422	107	25.36	4.04	1.89-8.64	2.64	1.19-5.85	1.69	0.66-4.30	1.68	0.72-3.91
Craft	347	24	6.92	1.41	0.61-3.25	1.10	0.47-2.60	0.96	0.36-2.50	1.00	0.42-2.39
Operators	187	14	7.49	1.55	0.63-3.83	1.41	0.56-3.53	1.16	0.42-3.22	1.33	0.52-3.38
Labourers	191	33	17.28	3.46	1.54-7.80	2.22	0.95-5.24	1.54	0.58-4.10	1.75	0.72-4.26
Total	1975	235	11.90								
Log-likeli				56.70	P=0.0000	31.22	P=0.0001	15.67	P=0.0283	17.74	P=0.0132
Education											
>University	456	26	5.70	1.00		1.00		1.00[2]		1.00	
High	801	57	7.12	1.27	0.79-2.06	1.19	0.72-1.96	0.93	0.52-1.66	1.14	0.68-1.90
Middle	316	33	10.44	1.73	1.00-2.97	1.58	0.89-2.81	1.10	0.56-2.19	1.32	0.72-2.43
<elementary	402	119	29.60	4.77	2.90-7.84	3.80	2.20-6.56	2.43	1.24-4.77	2.76	1.51-5.05
Total	1975	235	11.90								
Income											
>1,500,000	610	41	6.72	1.00		1.00		1.00		1.00[2]	
100-150	540	39	7.22	1.15	0.73-1.82	1.04	0.65-1.66	0.97	0.60-1.56	0.98	0.60-1.58
50-99	571	76	13.31	2.03	1.36-3.05	1.67	1.09-2.56	1.33	0.84-2.09	1.37	0.87-2.16
<50	239	78	32.64	4.79	3.09-7.43	3.53	2.18-5.72	2.46	1.45-4.15	2.69	1.57-4.60
Total	1960	234	11.94								
Women											
Occupation											
Non-manual	636	97	15.25	1.00		1.00		1.00		1.00	
Manual	808	280	34.65	1.58	1.18-2.13	1.47	1.04-2.09	1.23	0.84-1.81	1.34	0.93-1.92
Total	1444	377	26.11								
Mana+Prof	63	7	11.11	1.00		1.00		1.00		1.00	
Tech	52	9	17.31	2.48	0.82-7.43	2.36	0.79-7.09	1.90	0.62-5.83	2.39	0.80-7.17
Clerks	128	12	9.38	1.36	0.49-3.82	1.08	0.38-3.08	0.65	0.19-2.25	1.05	0.37-2.99
Sales	393	69	17.56	1.42	0.60-3.32	1.14	0.48-2.71	0.60	0.19-1.90	1.14	0.48-2.73
Agri	484	185	38.22	2.11	0.90-4.92	1.60	0.66-3.90	0.70	0.21-2.31	1.37	0.55-3.41
Craft	93	23	24.73	2.72	1.06-6.97	2.38	0.91-6.24	1.10	0.31-3.90	2.24	0.84-5.94
Operators	15	6	40.00	5.20	1.37-19.75	5.26	1.37-20.13	2.46	0.51-11.94	5.78	1.50-22.26
Labourers	216	66	30.56	2.04	0.85-4.87	1.32	0.53-3.30	0.60	0.18-2.03	1.17	0.46-2.98
Total	1444	377	26.11								
Log-likeli				15.19	P=0.0337	14.78	P=0.0390	13.26	P=0.0659	14.44	P=0.0439
Education											
>University	175	17	9.71	1.00		1.00		1.00[2]		1.00	
High	384	48	12.50	1.26	0.70-2.29	1.23	0.66-2.27	1.76	0.73-4.21	1.25	0.67-2.32
Middle	241	48	19.92	1.75	0.93-3.30	1.63	0.82-3.23	2.23	0.85-5.89	1.70	0.84-3.42
<elementary	644	264	40.99	3.01	1.63-5.58	2.33	1.18-4.61	3.18	1.18-8.58	2.15	1.05-4.42
Total	1444	377	26.11								
Income											
>1,500,000	369	56	15.18	1.00		1.00		1.00		1.00[2]	
100-150	273	45	16.48	1.03	0.66-1.59	0.86	0.53-1.39	0.78	0.47-1.27	0.79	0.48-1.30
50-99	437	103	23.57	1.34	0.92-1.95	1.05	0.69-1.60	0.92	0.59-1.42	1.06	0.68-1.64
<50	358	171	47.77	2.61	1.75-3.89	1.95	1.21-3.14	1.60	0.97-2.66	1.90	1.14-3.17
Total	1437	375	26.10								

1 Health behaviour variables: smoking, alcohol, exercise, diet, BMI

2 Adjusted with occupation and health behaviours

Log-likeli: log likelihood test for heterogeneity of occupation variable

5.4.2.2 The relationship between socio-economic class and specific conditions

We investigated the relationships of socio-economic class (occupation, education, and income) and health behaviours with several specific chronic conditions: musculo-skeletal diseases, gastric ulcers, chronic obstructive pulmonary diseases, hypertension and diabetes mellitus (Table not shown). The specific conditions which were shown to have higher odds ratios among manual workers, the less well-educated and those on the lowest income were: musculo-skeletal diseases, injuries (wider CI), gastric ulcers (wider CI) and chronic obstructive pulmonary diseases (wider CI) for both men and women. However, for most specific conditions except musculo-skeletal disease a wider confidence interval was observed; the tables are not, therefore, presented here.

The relationship of socio-economic factors and health behaviours with musculo-skeletal diseases was similar to that with other categories such as 'chronic disease', 'medically confirmed chronic disease' or 'perceived general health'. In addition to this, socio-economic differences for musculo-skeletal diseases were greater than those for 'chronic disease' or 'medically confirmed chronic diseases'.

On the other hand, for hypertension (wider CI) and diabetes mellitus (wider CI), the odds ratios were lower among manual workers, the less well-educated and those earning relatively little, among both men and women. For female workers, the odds ratio of diabetes mellitus was higher among this group but it had wider confidential intervals. For women, the odds ratio for hypertension was also higher among this group.

Adjusting for health behaviours had little effect on the relationship between socio-economic factors - occupation, educational level and income - and specific diseases. While adjustment for education reduced the relationship between occupation and morbidity, income did not have as great an effect as education. On the other hand, adjusting for occupation had little impact on the relationship between both education and income and morbidity. There were no statistically significant interactions between socio-economic factors (occupation, education and income) and morbidity.

5.4.2.3 The prevalence of morbidity according to health behaviours

Our study shows that the prevalence of certain harmful health behaviours such as smoking, lack of exercise and bad diet bares a strong relationship to the social class of the individuals involved (Tables 5.3 to 5.6). However, health behaviours do not confound the relationship between socio-economic class and morbidity. To investigate how such health behaviours effect morbidity, age adjusted odds ratios for chronic disease according to health behaviours were calculated (Table 5.11). For both men and women, those who drank, smoked and exhibited a higher BMI, had higher morbidity odds, with wider confidence intervals for males who smoked and for females who smoked, drank and had higher BMI. After adjusting for occupation, education and income, odds ratios for morbidity were little changed for both genders. The patterns for other outcomes were much the same as for all chronic disease perhaps with the exception of BMI (See Appendix).

Table 5.11 Age adjusted odds ratios (and 95% CI) of chronic disease according to health behaviours

		Adjust for age		Adjust for age and occupation		Adjust for age and education		Adjust for age and income	
Men	Case*	RR	CI	RR	CI	RR	CI	RR	CI
Smoking									
None	84	1.00		1.00		1.00		1.00	
Ex-smoking	94	1.32	0.92-1.89	1.31	0.91-1.88	1.36	0.95-1.95	1.33	0.93-1.90
Present	389	1.30	0.98-1.72	1.27	0.96-1.68	1.26	0.95-1.67	1.28	0.97-1.70
Total	567								
Log-likelihood		3.70	p=0.1572	3.17	P=0.2047	3.38	P=0.1849	3.38	P=0.1847
Alcohol									
None	192	1.00		1.00		1.00		1.00	
Ex-drinking	69	1.53	1.06-2.19	1.49	1.03-2.14	1.52	1.06-2.19	1.53	1.06-2.20
Present	306	0.92	0.74-1.14	0.90	0.72-1.12	0.90	0.72-1.12	0.91	0.73-1.13
Total	567								
Log-likelihood		9.15	P=0.0103	9.14	P=0.0103	9.89	P=0.0071	9.91	P=0.0070
BMI									
<25	405	1.00		1.00		1.00		1.00	
>=25	108	1.32	1.02-1.72	1.36	1.04-1.77	1.35	1.03-1.75	1.34	1.03-1.75
Total	512								
Log-likelihood		4.28	P=0.0386	5.03	P=0.0249	4.81	P=0.0283	4.73	P=0.0296
Exercise									
Heavy	93	1.00		1.00		1.00		1.00	
Moderate	111	0.88	0.63-1.72	0.87	0.62-1.21	0.87	0.63-1.21	0.87	0.62-1.20
No exercise	349	0.87	0.66-1.16	0.77	0.58-1.04	0.76	0.56-1.01	0.83	0.62-1.10
Total	553								
Log-likelihood		0.92	P=0.6298	2.98	P=0.2251	3.72	P=0.1560	1.65	P=0.4373
Diet									
Yes	531	1.00		1.00		1.00		1.00	
No	35	0.94	0.63-1.42	0.99	0.66-1.48	0.93	0.62-1.39	0.97	0.65-1.46
Total	560								
Log-likelihood		1.89	P=0.1693	2.03	P=0.1547	1.77	P=0.1837	1.94	P=0.1637
Women									
Smoking									
None	538	1.00		1.00		1.00		1.00	
Ex-smoking	14	1.94	0.87-4.35	1.99	0.89-4.47	1.95	0.87-4.37	1.90	0.84-4.31
Present	63	1.30	0.86-1.96	1.31	0.87-1.98	1.27	0.84-1.92	1.19	0.79-1.81
Total	615								
Log-likelihood		3.95	P=0.1391	4.19	P=0.1232	3.73	P=0.1553	2.88	P=0.2367
Alcohol									
None	518	1.00		1.00		1.00		1.00	
Ex-drinking	17	1.56	0.79-3.08	1.61	0.81-3.20	1.56	0.79-3.10	1.45	0.73-2.90
Present	80	1.33	0.98-1.95	1.44	1.02-2.04	1.38	0.98-1.94	1.39	0.98-1.96
Total	615								
Log-likelihood		4.62	P=0.0991	5.66	P=0.0591	4.52	P=0.1045	4.21	P=0.1221
BMI									
<25	345	1.00		1.00		1.00		1.00	
>=25	77	1.15	0.81-1.63	1.10	0.78-1.57	1.11	0.78-1.57	1.16	0.82-1.65
Total	422								
Log-likelihood		0.61	P=0.4358	0.31	P=5796	0.34	P=0.5619	0.72	P=0.3946
Exercise									
Heavy	31	1.00		1.00		1.00		1.00	
Moderate	50	1.00	0.56-1.77	0.99	0.56-1.76	1.01	0.57-1.79	1.04	0.58-1.84
No exercise	530	1.06	0.66-1.71	1.00	0.62-1.64	0.94	0.57-1.53	1.00	0.62-1.62
Total	611								
Log-likelihood		0.15	P=0.9285	0.00	P=0.9976	0.17	P=0.9195	0.04	P=0.9820
Diet									
Yes	544	1.00		1.00		1.00		1.00	
No	71	2.10	1.45-3.04	2.24	1.54-3.26	2.21	1.52-3.21	2.10	1.44-3.05
Total	615								
Log-likelihood		15.13	P=0.0001	17.55	P=0.0000	17.04	P=0.0000	14.88	P=0.0001

Log likelihood : log likelihood test for heterogeneity of health behaviours, Case* : morbidity cases

5.5 Discussion

5.5.1 Data completeness and limitations

5.5.1.1.Potential for information bias: self-reported data

We may note several limitations on data completeness concerning the *National General Household Survey in Korea*, which was employed in this study. Firstly, as this survey was based on a self-reported questionnaire, information bias may occur in the reporting of diseases. Whereas some people may take a condition or symptom very seriously and therefore reply to the question which refers to it, others may not. Also, for some mild symptoms, the report would be especially dependent upon the participant's subjective feeling. Subjective differences may have the effect of diluting the data on socio-economic differences for morbidity. Such et al (1997) note that individuals diagnosed with the same chronic condition might experience dramatically different levels of disease severity, rates of progression and likelihood of disability. Moreover, access to health care, social services and peer support - all of which affect one's ability to cope with a chronic medical condition - can vary tremendously among persons with the same diagnosis.

Secondly, bias in responses to self-reported questions may also occur in the information concerning other variables: occupation, education, household income and other risk factors. There might, for example, be under-reporting of lower socio-economic status: lower educational achievement, lower income and job status. The occupational variable might show less bias than that based on information taken from death certificates, however, as lists of occupation are given, allowing participants to choose. Yet even with this method, the potential for mis-classification remains due to the vagueness of the definitions given in the *Korean Standard Classification of Occupations*. For example, participants may not feel that their occupations match those in the lists of the *KSCO*. As far as the education and income variables are concerned, there might well be under-reporting for those in the 'lower' groups; a fact which may also dilute socio-economic differences of morbidity. Thus, differential information bias might attenuate the relationship between social class based on occupation, education and income and morbidity.

5.5.1.2 The vagueness of meaning of health behavioural factors in the questionnaire of *General Household Survey* in Korea

There might be some vagueness regarding the information on health behaviours in the Korean survey used in this chapter. The *Black Report* also notes such vagueness concerning the question of individual health behaviours in the *UK General Household Survey* (The *Black report*, 1982). This kind of vagueness is also a problem for researchers hoping to utilise the *General Household Survey* in Korea. Thus, the questionnaire concerning 'exercise' in the latter is a model of vagueness. It asks: 'How many times do you exercise to the point of sweating and becoming breathless?' In this question, no distinction is made between exercise considered as a hobby or seen as a normal consequence of work related activity. Such a lack of clarity evidently introduces a potential for bias into the information. The *Black Report* also notes that manual workers who describe themselves as spectators rather than players of sport include those who exert physical strength and agility as part of their everyday occupational activity.

Information pertaining to diet was gathered for the Korean *General Household Survey* in Korea using the questions: 'Do you eat breakfast?' and 'Do you eat meals regularly?' However, it may not show whether people take the daily nutrition adequately or not. *Black Report* also notes that "people who eat one type of food to excess may make up for that disadvantage in some other respect" (p112).

In addition to this, the variable of social support may not be enough to get accurate information concerning social support. The *General Household Survey* includes four questions on social support: number of contacts, number of people to whom individuals can appeal for help, number of loved ones, feelings regarding personal happiness and fulfilment. Vagueness at this level may well cause non-differential error or misclassification in the exposure of health behaviours. This could result in a downward effect regarding differentials (Armstrong, 1998). In this light, we contend that valid measurement criteria for health behaviours ought to develop if we are to reduce residual confounding of results due to information bias.

5.5.1.3 A problem concerning the definition of morbidity

Morbidity is defined in the Survey as a 'chronic disease or condition' which has existed for more than two weeks. This way of limiting the definition may help to avoid potential information bias due to self-reporting. The category of 'medically confirmed chronic disease' was used in order to separate the less serious from the more serious conditions. The results from these different disease categories imply that the differentials for socio-economic class and morbidity were greater for severe diseases than for all, including mild, conditions. It is our contention, however, that including all minor occurrences in the morbidity analysis may dilute the socio-economic differentials. This is because the lower socio-economic group may have less access to health care facilities than the higher socio-economic class. Consequently, minor or trivial symptoms which effect those in the lower socio-economic class may not be picked-up by an analysis of morbidity. Several researchers have argued that the definition of morbidity should be clarified. Johansson (1992) agrees that the concept of morbidity or sickness as it is currently used in the literature is too vague to permit the meaningful measurement of historical trends. Clearly, at the very least, the definition of morbidity stands in need of clarification. Thus, we feel justified in focusing on chronic conditions in our study rather than on all occurrences of morbidity.

However, the definition of 'chronic disease' may still not be clear enough as an indicator of health outcomes in this study. Several researchers suggest the following definition of chronic diseases: Johansson (1992) suggests that approaching sickness and disease as purely biological phenomena which can be analysed demographically must measure four separate dimensions: frequency, duration, severity and depth (or co-morbidity). Brownson et al (1993) state that chronic diseases have been variously referred to as 'chronic illnesses', 'non-communicable diseases' and 'degenerative diseases'. They also point out that chronic diseases are generally characterised by uncertain aetiology, multiple risk factors, long latency periods, a prolonged course of illness, non-contageous origins, functional impairment or disability and incurability. Given these characteristics, they define as chronic those diseases that have a prolonged course, that do not resolve spontaneously and for which a complete cure is rarely achieved. Such et al (1997) argue that chronic disease is likely to be characterised by recurring episodes of exacerbation and remission in the shorter term and progressive descent over the longer term. We therefore acknowledge that our study may exhibit a certain limitation as we do not define chronic conditions according to the frequency, severity or depth of morbidity, but only by duration.

5.5.2 Main findings: the relationship of occupational class, education, income and health behaviours with morbidity

5.5.2.1 The relationship between occupational class and morbidity

The central hypothesis of the present chapter is that differentials of morbidity (chronic and subjective conditions) exist between occupational class, socio-economic status, income and educational level. We argue that manual workers have higher chronic disease rates and are more prone to feeling ill than non-manual workers. It is also shown that health behaviours have little effect on the relationship between occupational class (manual and non-manual class) and chronic disease (or conditions). After adjusting for education, odds ratios for chronic disease and occupational group were reduced or eliminated. This result corresponds to that arrived at in the previous chapter.

It may be argued that educational level has a stronger impact on chronic disease and perceived general health among manual workers than among non-manual workers. One reason for this could be that less well-educated, manual workers may have lower socio-economic status and have more hazardous jobs than those in the better-educated group. Another reason could be that educational status among the young might impact on the adult's later health status. On the other hand, it could be due to residual confounding or some other bias. After adjusting for income, the odds ratio for occupational class (manual and non-manual workers) decreased, but this effect was not as notable as that for the educational variable. The results were similar for men and women.

In this study, the age adjusted odds ratio for chronic disease among manual workers was 1.24 (CI: 1.00-1.53) for men and 1.14 (CI: 0.88-1.48) for women. In terms of perceived general health, the odds ratio among manual workers was 1.93 (CI: 1.40-2.67) for men and 1.58 (CI: 1.18-2.13) for women. These results exhibit similar patterns to other studies on the relationship of chronic diseases, long-term disability and long-standing health problems to occupational class (Cavelaara et al, 1998; Vagero and Lundberg, 1989; Mackenbach et al, 1997). The relative prevalence ratio of long-term illness among social class V was 2.65 in Britain and 1.52 in Sweden compared to social class I (Vagero and Lundberg, 1989). Cavelaara et al (1998) discovered that morbidity differences between manual workers and the class of administrators and professionals are more or less equally large in seven countries and that these differentials are similar for four morbidity indicators: perceived general health, long term disability, chronic conditions and long-standing health problems. The odds ratio for chronic conditions among manual workers compared to managers and professionals is: 2.51 (CI: 2.00-3.14) in Sweden; 1.63 (CI: 1.36-1.95) in the Netherlands; and 1.84 (CI: 1.56-2.16) in Germany. The odds ratio for perceived 'less than good' health among manual workers compared to managers and professionals is: 2.79 (CI: 2.13-3.65) in Sweden; 2.19 (CI: 1.56-3.08) in Denmark; 2.32 (CI: 2.03-2.65) in Britain; 2.40 (CI: 2.00-2.88) in Netherlands; 1.63 (CI: 1.43-1.87) in Germany; 2.12 (CI: 1.75-2.57) in Switzerland; and 2.24 (CI: 1.77-2.83) in France. However these studies compared lowest and highest social classes.

The specific conditions having higher odds ratios for manual workers were musculo-skeletal diseases, gastric ulcers and chronic obstructive pulmonary diseases. However, the odds ratios for results other than for musculo-skeletal diseases show a wider confidence interval. In particular, for musculo-skeletal diseases, the age adjusted odds ratio among manual workers is 1.88 (CI: 1.15-3.08) for men and 1.43 (CI: 0.98-2.10) for women. Lahelma and Valkonen (1990) show that the relative risk for chronic musculo-skeletal disease among blue-collar workers was 2.5 among men and 2.17 among women. Our study therefore shows some similar results to other studies.

5.5.2.2 The role of other socio-economic variables: education and income

(1) Education

Our study suggests an inverse relationship between education and all outcomes studied. Health behaviours only slightly confounded the relationship between education and morbidity. After adjustment for, in turn, occupation and income, the relationship between education and morbidity was hardly affected. These results correspond to other studies. In an US study of racial differences in disability and morbidity in the last years of life, it has been shown that for both blacks and whites, educational attainment is inversely related to disability and morbidity indices (Liao et al, 1999). Valkonen et al (1997) show that life expectancy as well as disability-free life expectancy is systematically related to educational level: the higher the level of education, the higher the life expectancy and disability-free life expectancy.

In addition, differences in morbidity rates between less well- and better-educated groups looked higher than those of other European countries. In this study, the age adjusted odds ratios for chronic disease among lower than elementary level educated workers compared to those educated to university level are 1.86 (CI: 1.33-2.62) among men and 1.78 (CI: 1.10-2.89) among women. In relation to perceived general health, the ratios are 4.77 (CI: 2.90-7.84) among men and 3.10 (CI: 1.63-5.58) among women. In other studies, Mackenbach et al (1997) find that odds ratios for chronic conditions among those educated to less than secondary level are between 1.44 and 1.85; and, for perceived general health, between 1.55 and 2.57 in 11 European countries, when compared to upper secondary and higher levels of education. These results may be open to challenge given the contested nature of the term 'chronic' in any study. Nevertheless, we contend that educational achievement has a greater impact on chronic disease rates in Korea than in other countries.

(2) Income

Among both men and women, lower income groups have higher odds ratios for morbidity than higher income groups. Adjustment for health behaviours does little to confound the relationship between income and morbidity. After adjusting for occupation and education, we find that the relationship between income and morbidity attenuates. In this study, the age adjusted odds ratios for chronic disease among the lower income groups, those earning less than 500,000 won per household compared to households earning more than 2,000,000 won, is 1.48 (CI: 1.06-2.06) for men and 1.93 (CI: 1.34-2.76) for women.

Such results are similar to those obtained in other studies. Nam et al (1996) shows that membership of lower income groups is one of the greatest risk factors for chronic disease in Korea. They also note that the highest risk groups for chronic disease are those Koreans who are female, aged, earning least, living in rural areas, who smoke, do not take exercise, lack sleep and suffer from stress. In other studies, there has also been some attention paid to the inverse relationship between income and chronic disease morbidity. Stronks et al (1997) focus on the relatively strong association between income and health which can largely be interpreted in terms of an interrelationship between employment status, income and health. Lahelma and Valkonen (1990) show that the relative risk of self-reported chronic illness among the lowest 20% income group was 1.80 in 1964, 1.95 in 1968 and 1.70 in 1976 compared with the highest 20% income group in Finland.

In summary, our results lead us to believe that occupational differentials expressed in terms of manual and non-manual workers can justifiably be used as a proxy of social class. They also suggest that education and income effect the relationship between occupational class and morbidity in Korea. In particular, education acts strongly as a proxy for social class or material condition.

5.5.2.3 The role of health behaviours: smoking and alcohol in the relationship between occupational class and morbidity

In this study, health behaviours such as smoking, drinking, the taking of exercise and diet have been shown to have little influence on the relationship of chronic diseases to occupational class. These results correspond to those obtained in other studies suggesting that health behaviours have little effect on the association between occupational class and morbidity (Marmot, 1984; Van Loon et al, 1995; Davey Smith et al, 1990; 1991a; 1994a; 1997). Marmot (1984) and Davey Smith (1990) deny that health behaviours provide a sufficient explanation for morbidity rates as, even after controlling for them, gradients in mortality persist. Van Loon et al (1995) show an inverse association between lung cancer risk and high level of education is still apparent after adjustment for age, smoking, dietary intake of vitamin C, beta-carotene and retinol. Davey Smith et al (1990) note that simultaneous consideration of a range of risk factors (including smoking, blood pressure, cholesterol levels and prevalence of cardio-respiratory disease) fails to account for grade differences in cardiovascular and non-cardiovascular mortality.

According to several Korean studies, the higher risk factors for chronic disease are as follows: being old, overweight and stressed for cardiovascular diseases; being old, smoking and overweight for chronic respiratory diseases; being old, overweight and stressed for DM. However, until now, no consideration of socio-economic class in studies related to Korean health promotion strategies. That is, socio-economic factors are omitted from every analysis of the relationship between health behaviours and illness. It is no surprise, therefore, that only those health promotion strategies which focus on health behavioural changes are adopted.

Our study suggests that health behaviours are themselves best understood in terms of their relation to, or even expression of, socio-economic class, education and income (Tables 5.3 - 5.6). A rule of thumb seems to be: the lower the occupational class, the more likely to find harmful health behaviour. Thus, some health behaviours - such as alcohol drinking and Body Mass Index - seem to have only a very weak impact on morbidity according to our study (Table 5.11). Such findings give us a clue that differences in health behaviours may originate in differences of social class. Indeed, several other studies find this to be the case. Some concern the manner in which poverty is linked intimately to a variety of harmful behaviours - such as smoking, drinking and drug-taking - rather than merely focusing on them as individual behaviours expressing personal choice (Javis and Wardle, 1999; Bennet et al, 1996).

Several studies also show how health-related behavioural factors such as diet, smoking, leisure time physical activity and excessive alcohol consumption are dependent on the financial, material, and psycho-social conditions of life (Sooman et al, 1993; Lobstein, 1995; Department of Health, 1996; Dowler, 1996; Travers, 1996; Cameron and Jones, 1985; Graham, 1988). For example, it has long been acknowledged that smoking has a major bearing on observed differences in death rates by social class (Javis and Wardle, 1999). In the *General Household Survey* (Bennet et al, 1996), the odds on being a smoker are shown to be significantly increased among those: (i) in lower occupational class groups; (ii) living in rented housing; (iii) without access to a car; (iv) who are unemployed; (v) who live in crowded accommodation. Javis and Wardle (1999) point out that in both 1973 and 1996 and for both men and women, there was an approximately linear increase in cigarette smoking with increasing deprivation. Javis et al (1999) discuss the reasons why deaths caused by tobacco consumption have dropped far more steeply in social classes I and II than in social class V, paralleling changes in smoking prevalence and cessation in these groups. Stellman and Resnicow (1997) note that in most industrialised societies, cigarette smoking is currently more prevalent in lower than in higher income groups and that the proportion of current smokers has fallen more rapidly in higher than in lower income groups in the US and many other countries.

In the inter-relationship between behavioural and socio-economic factors and mortality rates, the significant element, according to Davey Smith (1994), appears to be the relationship between smoking and socio-economic position. Davey Smith and Shipley (1991a) note that "smoking is more prevalent in lower social classes, whose mortality is higher than that of higher social classes independently of smoking, and that relationship between mortality and smoking may therefore be overestimated if socio-economic position is not taken into account" (Macintyre, 1997, p739). Therefore, Davey Smith (1997) asserts that the need for health promotion strategists to recognise such practices as not simply 'lifestyle choices' if the overall pattern of health inequalities produced by the differential adoption of behaviours is to be altered.

In summary, we suggest that negative health behaviours, especially smoking and alcohol intake, are directly related to lower social class. Even though health behaviours are shown to be associated weakly with morbidity and do not confound the relationship between social class and morbidity, this relationship may also be understood as originating in differentials of social class. The material situation of the lower classes may therefore make their behaviour different to that of the upper classes. Thus, repeating the mantra of 'vigorous exercise' cannot be adequate as a strategy geared toward the removal of class-based health differentials.

5.5.3 Conclusions

The conclusions from this chapter are as follows:

1. Manual workers, those less well-educated and those on a lower income suffer higher morbidity rates than those in higher socio-economic classes.

2. Health behaviours do not confound the relationship between occupational or social class and morbidity. In particular, health behaviours seem likely to be the themselves derived factors from differences of occupational or social class.

3. After adjusting for education, the association between occupational class, chronic disease and perceived general health was reduced or even reversed among both men and women. This result corresponds with results arrived at concerning mortality in Chapter 4. After adjusting for income, the odds ratios of chronic diseases among manual workers lessened. Thus, education is seen to be strongly related to occupation.

5.5.4 Suggestions for health policy

5.5.4.1 Completeness of data in the *General Household Survey*

During data processing, the Korean *General Household Survey* was found wanting as regards information on socio-economic factors as well as on health behaviours (Section 5.5.1). We suggest that the information concerning risk factors - health behaviours (diet, exercise, smoking and alcohol intake) and socio-economic considerations (occupation, education and income) - need to be revised. A number of specific recommendations can be made in this regard. Firstly, health behavioural factors need to be re-conceived in order more accurately and precisely to be measured. There also needs to be more detailed information concerning income, occupational class and educational achievement. To ensure greater completeness of the occupational data, information on workplace position, technical tasks and social position need to be included. The sample sizes in the present Korean *General Household Survey* need to be enlarged. We discovered, for example, that the morbidity data rested on such a small base that no legislators, senior officials or managers were included in the female study population. Along with this, we note that only one case is specified concerning the state of 'subjective ill-health' among legislators, senior officials and managers among male workers. Therefore, wide confidence intervals were found in most odds ratios for morbidity according to the Survey's nine categories of occupation. These findings suggest that larger sample size is needed if further analysis is to be made more trustworthy.

5.5.4.2 The change of 'health behaviour oriented prevention strategy'

This research shows that health behaviours have little effect upon the relationship between occupational class, chronic disease and subjective illness in Korea. We therefore conclude that health promotion strategies which focus principally on health behaviours should be reoriented around an understanding of health differentials which addresses the issue of social inequalities.

5.5.5 Need for further research

5.5.5.1 Clarifying the definition of social class

More accurate and precise methods for the definition of 'social class' need to be developed in research for future editions of the *General Household Survey* as well as other Korean health surveillance studies. To define and investigate class relations in health surveys, therefore, at the very least, more detailed questionnaires for collecting methods for occupation, income and education are needed. In addition to this, other information such as conditions of employment and degrees of material deprivation is needed if a truly representative measure of social class is to be possible.

5.5.5.2 The inter-relationship between risk factors and mechanisms of health inequality

In health studies, methods which enable the analysis of relations between classes and health need to be developed if it is to be possible to identify how inequality in health operates at different levels: individual, local and national. More precisely, we need to define the main determinants of health if we are to remove health inequality. To uncover causal pathways and thereby to locate the social points of vulnerability among the general population, those marks which consistently open the door to health inequalities, detailed studies of mechanisms are needed; studies which deploy both qualitative and quantitative methodologies.

Chapter 6: The role of occupation, education and income in deaths due to workplace injury in Korea

6.1 Introduction

Previous chapters examined the relationship of occupational class, education, income, and deprivation to mortality and morbidity rates. Our main finding so far is that manual workers have higher mortality and morbidity rates relative to non-manual workers in Korea. We also propose that education has a stronger inverse relationship to mortality and morbidity rates in Korea than in European countries (Chapter 4). A strong link is also established (Chapters 4 and 5) between lower level of education and occupational class (especially for manual workers or labourers). Deprivation has been shown to have an inverse relationship with mortality in Korea. On the other hand, health behaviour was not seen as a factor which served to confound the relationship between occupational class and morbidity rates (chapter 5). These findings suggest that socio-economic factors - occupation, educational level, income and deprivation - are more closely related to inequalities in health among the Korean population than has previously been suspected.

As an extension of our findings so far, the present chapter focuses on how fatal workplace injuries are related to occupation, education and income. Why has so little research been undertaken on the relationship between socio-economic factors and fatal workplace injuries? In Korea, only one report on crude national injury rates according to industry and factory size has been published by the Ministry of Labour. However, these results were not adjusted for age and sex. Moreover, no explicit link was made between socio-economic factors and injury rates. The central objective of this chapter, therefore, is to explore the relationship between socio-economic factors as well as occupation and fatal workplace injury rates among Korean industrial workers.

6.2 Hypothesis and objectives

This chapter focuses primarily on industrial workers and their working conditions. The following hypotheses are pursued:

(i) Injury rates are linked to occupational class, income and education;

(ii) Smaller factories have more deaths due to workplace injuries.

Our broad aim is to explore the relationship of occupation and other socio-economic factors - educational level, income and workplace size - to deaths due to occupational injuries. Our specific objectives are as follows:

(i) To examine the relationship of occupational group to death rates due to occupational injury;

(ii) To analyse the role of other socio-economic factors such as educational background, income and factory size in the observed connection between occupational group and death rates due to workplace injury.

6.3 Data sources

6.3.1 Numerators

As numerators, the raw data of the annually reported national injuries from 1995 to 1998 were obtained from the Korea Labour Welfare Corporation[1](WELCO). Reported injuries are those cases which receive compensation from the Government's industrial insurance organisation[2]. Korean law states that it is compulsory for factories which have more than 5 workers to register and report workplace injuries if they are to receive compensation from WELCO. However, for factories employing less than 5 workers, the registration and reporting of injury cases has only been voluntary since 1992 (Ministry of Labour, 1996).

[1] WELCO (Korean Labour Welfare Corporation): a Korean government organisation established in 1995, for the compensation of workplace injuries and other welfare systems, mainly focusing on industrial workers.

[2] All establishments employing more than 5 workers must register for social insurance to cover the compensation of workplace injuries, a scheme organised by WELCO. The establishments which had to register in 1964 were those mining and manufacturing workplaces which employed more than 500 workers. This has since been extended (1988) to cover most establishments employing more than 5 workers and, since 1991, applies to agriculture, fishing, forestry, wholesale and retail trade, real estate and other personal services. Since 1996, the education, health and social work sectors have been incorporated.

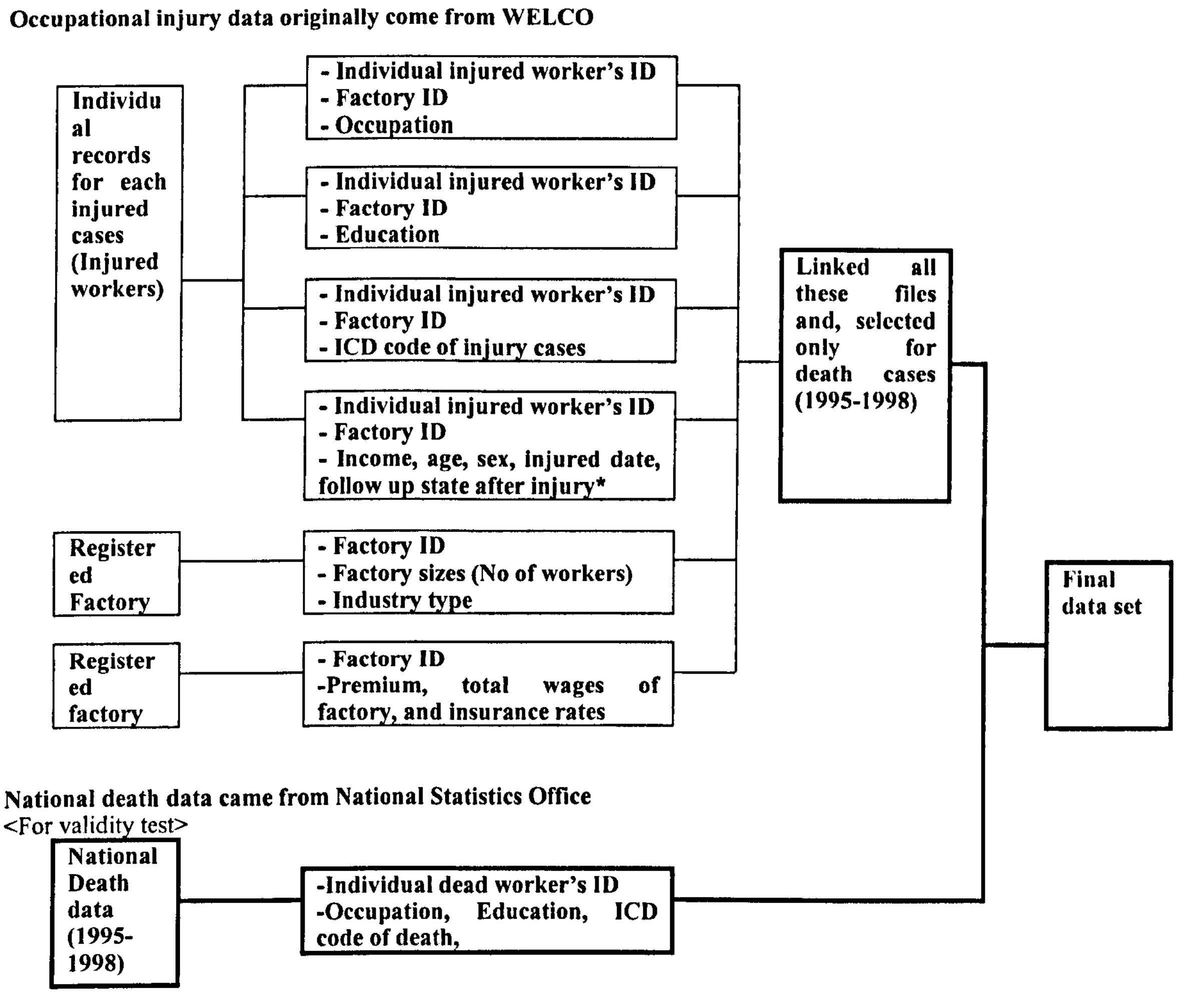
It is possible, indeed likely, then, that there has been some under-reporting[3] of injuries or rejected injuries for compensation from WELCO, especially for the minor injuries.

To obtain information on each injury, several variables from six separate data sets of injury occurrences were collected: four separated data sets of workplace injuries and two data sets of information on registered establishments (Figure 6.1). The first four files were linked using, as unique identifiers, individual workers' social security numbers (13 digits, ID), incidence date of injuries and industry registration numbers (Figure 6.1). To match the injured individuals with two data sets of information on establishments, where they were working when the injury occurred, industry registration numbers were used. Other identifiers enabling verification of linkage included the date of injury and the injured workers' postcode (Figure 6.1).

The study is restricted to deaths due to workplace injury between 1995 and 1998 in order to avoid the problem of under-reporting of minor workplace injuries. As data for this period was obtained at the beginning of 1999, when certain administrative procedures were still under way, a number of workers who were injured before 1999, but received their compensation only after 1999, are not included in our Tables. Thus, 930 persons injured between 1997 and 1998 are missing from our study population compared to the official statistics of the Korean Government.

[3] There might be under-reporting of workplace injuries, especially for minor injuries, because employers might not want to reveal their hazardous working conditions to WELCO. Also, the higher the rate of workplace injuries, the higher the premiums which employers have to pay the following year. Insurance premiums are based on the total wage bill for the total number of workers and the injury rates for previous years.

Figure 6.1 Data sources of the death cases due to occupational injury for the numerators in this study



Factory ID: Industry identification numbers given by WELCO for organising registered establishments
Individual dead worker's ID: Unique social security numbers (13 digits) given by Korean Government to each individual
* Follow up state after injury consists as follows: death, complete recovered, continuing, transferred, interrupted, finished treatment

6.3.2 Denominators

After investigating several possibilities, denominators were taken from the tabulated data given in the *Survey Report on Wage Structure* (see Appendix). As the raw data set from this survey could not be obtained, the tabulated data is employed from the report itself. The survey is based on data collected by the Ministry of Labour since 1968 with the objective of obtaining information on workers' incomes, working hours and other general conditions and is classified according to industry and occupation. The survey is undertaken annually during one month in the middle of year, information being supplied by individual workplaces employing more than 10 workers. Sampled industries are drawn by stratified systematic sampling from the *Annual National Survey on Establishment*

Labour Conditions (see Appendix), which includes all the workers in most industries, excepting several sectors: agriculture and fisheries, public administration, national defence, social security administration, housework and international organisations. The variables employed in this study are: age, sex, occupation, education and factory size. As these denominators were obtained from pre-tabulated data, the inter-relationships between occupation, education, income and firm size with injury deaths could not be fully investigated.

Information was entered into SAS (STATA) data sets from published tables as follows:

1) number of workers by firm size, education, sex and age

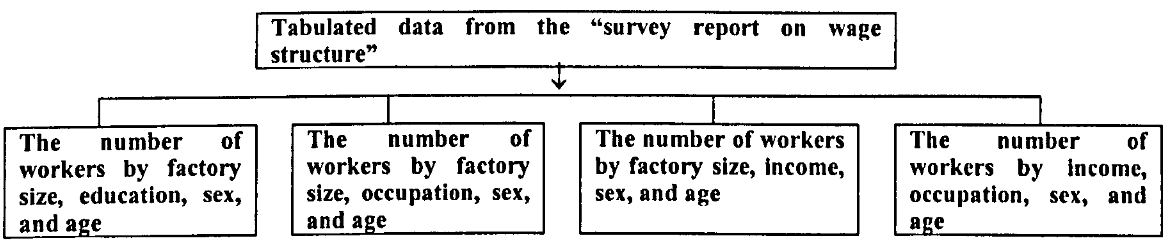
2) number of workers by firm size, occupation, sex and age

3) number of workers by firm size, income, sex and age

4) number of workers by firm, occupation, sex and age

These data sets were linked with injury death cases and analysed using Poisson regression (Table 6.2).

Figure 6.2. The data source of denominators



6.3.3 Completeness and validity of data

6.3.3.1 Completeness of numerators

(1) Missing values of the main variables

Numerators are limited to deaths from 1995 to 1998 in order to avoid problems which follow from the absence of values for our main variables in earlier data. Quite a large amount of missing information for the coded variables of occupation, ICD code, and educational level is to be noted, even though the data set is limited to the period between

1995 and 1998 (Table 6.1). Fortunately, the written information for 'cause of injury' and 'occupation' remained intact even though the coded values for this information were missing. There were missing values (20.3%) in the already coded variable of occupation by WELCO, whereas only a small number of missing values (0.3%) were noted in the described information of dead worker's occupation among the data set from 1995 to 1998. Therefore, instead of using the already-encoded occupational variable given by WELCO, the occupational variable using the described information of occupation was re-coded according to *Korean Standard Classification of Occupations* (National Statistics Office, 1999).

Also, causes of death were re-coded using the ICD 9. For the 990 missing values of the variable of 'cause of death' from 1995 to 1998, the information for the ICD code of the national death data from National Statistics Office replaced these missing values, after individually matching both data sets using social security numbers. This can be justified because the ICD codes between national death data from National Statistics Office and injury death data from WELCO were well-matched as a whole (See Chapter 8). However, the educational variable continued to be missing a significant number of values in the period from 1995 to 1998 (Table 6.1).

Table 6.1. Missing values among main variables in the injury death cases due to workplace injury in each year (Unit: Number, %)

Variables\Year	1998		1997		1996		1995	
	Before1)	After2)	Before1)	After2)	Before1)	After2)	Before1)	After2)
Total deaths	1625	886	2400	1360	2616	1319	2683	1356
Income	1	1	2	2	8	8	644	288
Occupation	350	0	453	0	546	0	722	0
Education	728	394	746	432	368	185	124	71
ICD code	70	0	92	0	878	0	800	0
No of workers in employment unit	397	0	620	0	689	0	635	0

Data source : law data of annual injury deaths from WELCO, 1995-1998

1) Original numbers of deaths and missing values of coded variables

2) After correction of some missing values using the original information in the injury data set and limitation of data set (injury deaths among the factories more than 10 workers and more than 20 years of age), with which used in this study.

(2) Estimating workplace size

Information concerning the number of workers in each employment unit is considered in order to measure firm size. For workers employed throughout the year, information concerning the 'average number of workers per usual day' is used. For those employed irregularly, in 'irregularly operated factories' such as construction factories, tables covering the 'average numbers of workers per day' are used. These are calculated by WELCO using total numbers of workers for one year and the time during which the factories were in operation.

To deal with the 435 missing values for the variable of factory size among 5123 injury death cases from 1995 to 1998, the number of workers is estimated according to the 'total wages per year' divided by 'one worker's average wage per year'. The data source for 'total wages per year' in each firm came from the injury death data; for 'one worker's average wage per year', the Report on Monthly Labour Survey[4] published by the Korean Ministry of Labour. Details concerning this method are given in the Appendix. The Kappa indices between estimated firm size and real firm size categories for deaths which were available are between 0.51 and 0.63 (Appendix).

(3) Validity of the variables

To explore the validity of the variables for occupation, educational level, causes of death, age and sex, the variables from injury death cases reported to WELCO are individually matched and compared to those of the national death data from the National Statistics Office using the deceased person's social security number. A detailed account of this method is given in Chapter 8.

For the validity of the occupational data, the Kappa index of occupational group is 0.48, where occupational groups are categorised as manual and non-manual; and 0.36, where

[4] The data for the Monthly Labour Survey is collected from the Korean Ministry of Labour. This survey covers: (i) whole industries excluding agriculture, forestry, hunting and fishing; (ii) establishments employing ten or more persons. The term 'regular employees' refers to workers whose term of employment lasts for one month or more, and who worked for more than 45 days during the three months previous to the reporting date. Monthly earnings include overtime and bonus payments, as well as basic pay.

the occupational groups are collated into 8 large classifications. These classifications exclude agricultural workers (see the table 6.3). The Kappa index is 0.32 in the three-category classification for educational background: university, high school and less than middle school levels. The educational categories were noted to be slightly promoted as well as demoted to neighbouring categories. In particular, the educational variable from this data, national injury deaths from WELCO looked promoted, compared to the national death data from National Statistics Office (Chapter 8). Regarding 'causes of death', the Kappa index is 0.68 for the 3 categories of *Injury, Cardiovascular disease* and *Other*. The Kappa indices for the 5-year band is 0.99; it is, therefore, closely matched. There is no disagreement for gender.

6.3.3.2 Completeness of denominators

Our estimates concerning the working population from the *Survey Report on Wage Structure* are based on the *Survey Report on Establishment Labour Conditions*[5]. To explore the completeness of this data set, the number of workers from several national surveys, as well as those from establishments registered with WELCO, are compared (Tables 6.2 and 6.3). Some important differences that should be noted here are:

1. The proportion of construction workers among the total working population is between 8% and 9% according to the national surveys but 30.1% according to WELCO (Table 6.3). This may be because national surveys collect data during a short period taken as a cross-sectional sample.

2. Definitions of 'employed workers' differ between surveys. Most censuses and surveys - *Census, Economically Active Population Survey, Census on the Basic Characteristics of Establishments, Survey of Establishment Labour Conditions* - include regularly employed workers as well as temporarily employed workers. The *Survey of Establishment Labour Conditions* includes regularly employed workers, those employed for more than 45 days during 3 months, as well as the temporarily employed and those employed less than 45 days during 3 months, among the establishments employing more than 5 workers. However, in the *Survey for Wage Structure*, the data set used in this study, only regularly

[5] This survey is undertaken annually by Ministry of Labour in Korea to obtain the distribution of industries which employ more than 5 workers in Korea and the whole working population in those industries.

employed workers in establishments employing more than 10 workers were sampled and used to estimate the total working population, based on those included in the results of the *Survey for Establishment Labour Conditions*. Whereas, WELCO[6] figures include all temporary part-time workers as well as regularly employed full-time workers, especially for construction workers. This may lead to a larger than expected proportion of construction workers in the tables for establishments registered with WELCO. Temporary part-time workers in construction industries tend to take other kinds of part-time work when there is no construction work[7]. Therefore, such workers may be included in the categories of labourers or the industrial reserve army.

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[6] The officer in WELCO mentioned that WELCO includes all part-time as well as full-time workers during one year. This organisation's main task is to collect premiums covering potential insurance claims. It therefore includes temporary construction workers in its calculations.

[7] When the author interviewed unemployed workers, part-time construction workers said that they work in the construction workplace only during the spring and summertime. When there is no work for construction workers in winter, they do other work, for example, in restaurants, repairing houses, plumbing or other part-time work.

Table 6.2 The distribution of the number of workers according to the industry type in different surveys

(Unit: in persons, %)

	Census>=all (1995)	EAP>=all (1995)	Welco>=5 (1996)	BCE >=5 (1995)	ELC>=5 (1996)
Agriculture, hunting and forestry	2720077 (15.1)	2541000 (12.5)	29220 (0.4)	13300 (0.2)	17318 (0.3)
Fishing	135053 (0.8)	117000 (0.6)	3440 (0.04)	24422 (0.3)	16557 (0.3)
Mining and quarrying	36034 (0.2)	66000 (0.3)	30944 (0.4)	39931 (0.5)	25065 (0.4)
Manufacturing	4278880 (23.8)	4773000 (23.4)	2908099 (35.7)	3267768 (37.2)	2844099 (45.6)
Electricity, gas and water supply	82292 (0.5)	*	58602 (0.7)	43960 (0.5)	45772 (0.7)
Construction**	1538066 (8.6)	1896000 (9.3)	2453923 (30.1)	803587 (9.2)	505616 (8.1)
Wholesale and retail	2992948 (16.6)	*	*	968376 (11.0)	582466 (9.3)
Hotels and restaurants	1123622 (6.2)	*	*	294750 (3.4)	107183 (1.7)
Transport, storage and communications	956368 (5.3)	*	711363 (8.7)	550826 (6.3)	572318 (9.2)
Financial intermediation	638207 (3.5)	*	*	613527 (7.0)	395056 (6.3)
Real estate, renting and business activities	772795 (4.3)	*	*	465165 (5.3)	586536 (9.4)
Public administration and defence	687193 (3.8)	*	*	555107 (6.3)	142124 [1)](2.3)
Education	928043 (5.2)	*	*	575703 (6.6)	184608 (3.0)
Health and social work	311962 (1.7)	*	*	223904 (2.6)	211543 (3.4)
Other community, social and personal service activities	710671 (4.0)	*	*	340923 (3.9)	Included in public ad~
Private households with employed persons	60646 (0.3)	*	*		
Extra-territorial organisation and bodies	14810 (0.1)	*	*		
Others *	-	10860000 (53.3)	1961303 (24.0)		
Total	17987667 (100.0)	20377000 (100.0)	8156894 (100.0)	8780421 (100.0)	6236261 (100.0)

* These numbers of workers are included in 'Others *'

** WELCO discriminate these construction workers as temporary part time workers

1) include both Public administration and defence and Other community, social and personal service activities

Census: the definition of 'employed' used in the Census is those working full-time as well as part-time (or temporarily) during one month for wages or profit. It includes the self-employed, for example, agricultural farmers or fishermen, as well as wage workers in all kinds of industries

Economically Active Population Survey (EAP): This sampled survey covers the economically active population - employed as well as unemployed - aged 15 years and over. 'Employed' covers workers who work more than one hour for wages or profit during the survey. It includes the self-employed - for example, agricultural farmers or fishermen - as well as wage workers in all kinds of industries

WELCO: The number of workers of who work full-time as well as part-time in industries employing more than 5 workers. WELCO takes construction workers as temporarily employed, on daily contracts. WELCO does not include the self-employed.

Census on the Basic Characteristics of Establishments (BCE): This census covers all establishments which existed in the territory as of 31st December 1994. It excludes establishments engaged in agriculture, forestry and fishery owned by an individual, those in military service, those in domestic service, private extra-territorial organisations and simple stores without fixed facilities and business premises. The enumeration unit is 'the establishment', which is defined as a physical unit engaged in industrial activities. The BCE does not include self-employed people and only calculates workers in establishments employing more than 5 workers.

Survey of Establishment Labour Conditions (ELC): This survey is undertaken for all establishments employing more than 5 workers who have been regularly employed for more than 45 days per three months or temporarily employed for less than 45 days per three months. The ELC survey excludes self-employed workers (See Appendix).

The Survey for Wage Structure, which was used in our study, takes its samples and estimates from the Survey for Establishment Labour Conditions, but targets only regularly employed workers in establishments employing more than 10 workers.

Probably due to the discrepancy mentioned above, concerning the unusual proportion of construction workers, there is a big difference in the distribution of workers according to firm size. In particular, the number of workers in large factories (those employing more than 500 workers) in the WELCO tables was greater than those given by the other two national surveys (Table 6.3).

Table 6.3 The distribution of the number of workers among the different size of establishments from different possible source denominators

(Unit: person, %)

Size	BCE (1995)		ELC (1995-1998)		WS (1995-1998)		WELCO (1995-1998)	
	Persons	%	Persons	%	Persons	%	Persons	%
>500	1767647	23.3	4907961	21.7	4670335	22.7	10123256	34.0
300-499	550162	7.3	1556628	6.9	1489951	7.2	2232971	7.5
100-299	1378801	18.2	4567978	20.2	4154067	20.2	6066015	20.4
30-99	3874030 1)	51.2	6125032	27.1	5507553	26.7	6478628	21.8
10-29	*		5421671	24.0	4786240	23.2	4839763	16.3
Total	7572640	100.0	22579270	100.0	20608146	100.0	29740633	100.0

1) The number of workers who are employed in less than 100 employing firms

* 'The number of workers who are employed in 10-29 employing firms' are included in 1)

BCE: See previous table

ELC: data from the report of [Survey report on Establishment Labour Conditions], The Ministry of Labour, from 1995-1998

WS: data from the number of workers from the [Survey report on Wage Structure], The Ministry of Labour, from 1995-1998

WELCO: Annual occupational injury report, the Ministry of Labour, 1995-1998 : published report

In sum, the distribution of the Korean working population across industries, in particular for the construction industry, differs according to data source. Hence, a certain caution as regards the interpretation of these results is called-for. The workforce needs to be estimated by 'the number of hours worked' rather than measuring the number of workers employed in a limited time frame or by including all temporary part time workers with little consideration for their working hours.

6.3.4 Final study population

The final study population is the total of those working in factories which employed more than 10 workers as denominators from 1995 to 1998 and deaths due to workplace injury in these factories during the same period. The study population is limited to those over 20 years of age, as people are usually expected to find a job only on reaching 20 years of age in Korea. Agriculture workers are excluded, as these are excluded in the denominators as well. The variable of 'industry type' has been dropped, as the distribution of the total number of workers by industry type is quite different according to different data sources.

Note, for example, differences between the *Survey Report on Establishment Labour Conditions* and the tables given by WELCO (Tables 6.2 and 6.3). Tables 6.3, 6.4 and 6.5 show the total study population and deaths due to occupational injury.

Figure 6.3 The distribution of the denominators

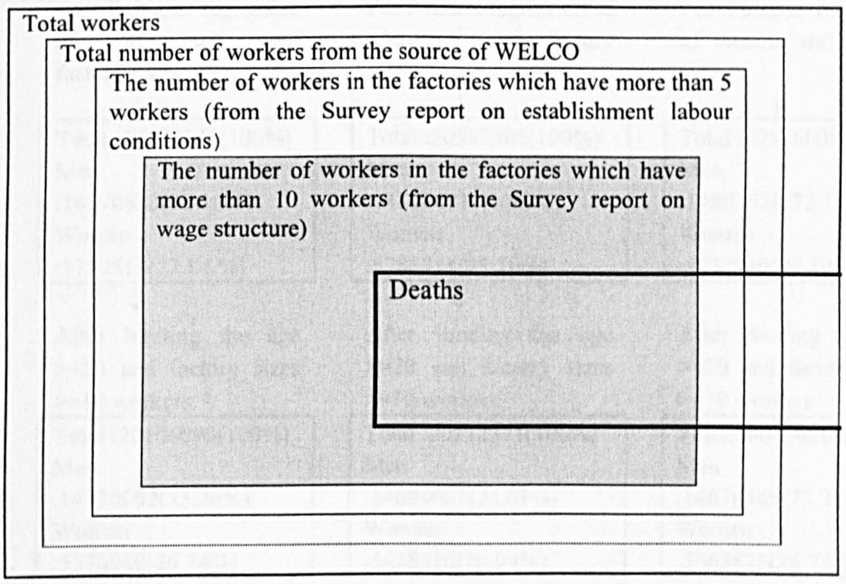


Figure 6.4 Final population of deaths due to occupational injury from 1995 to 1998

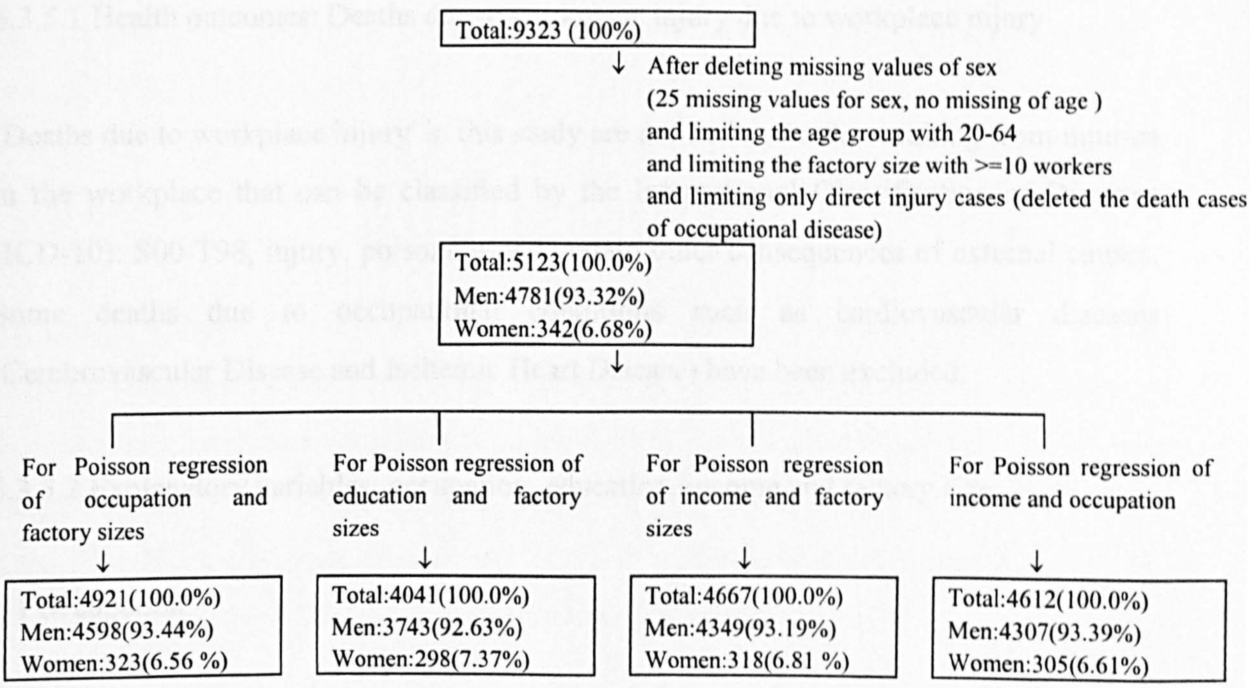
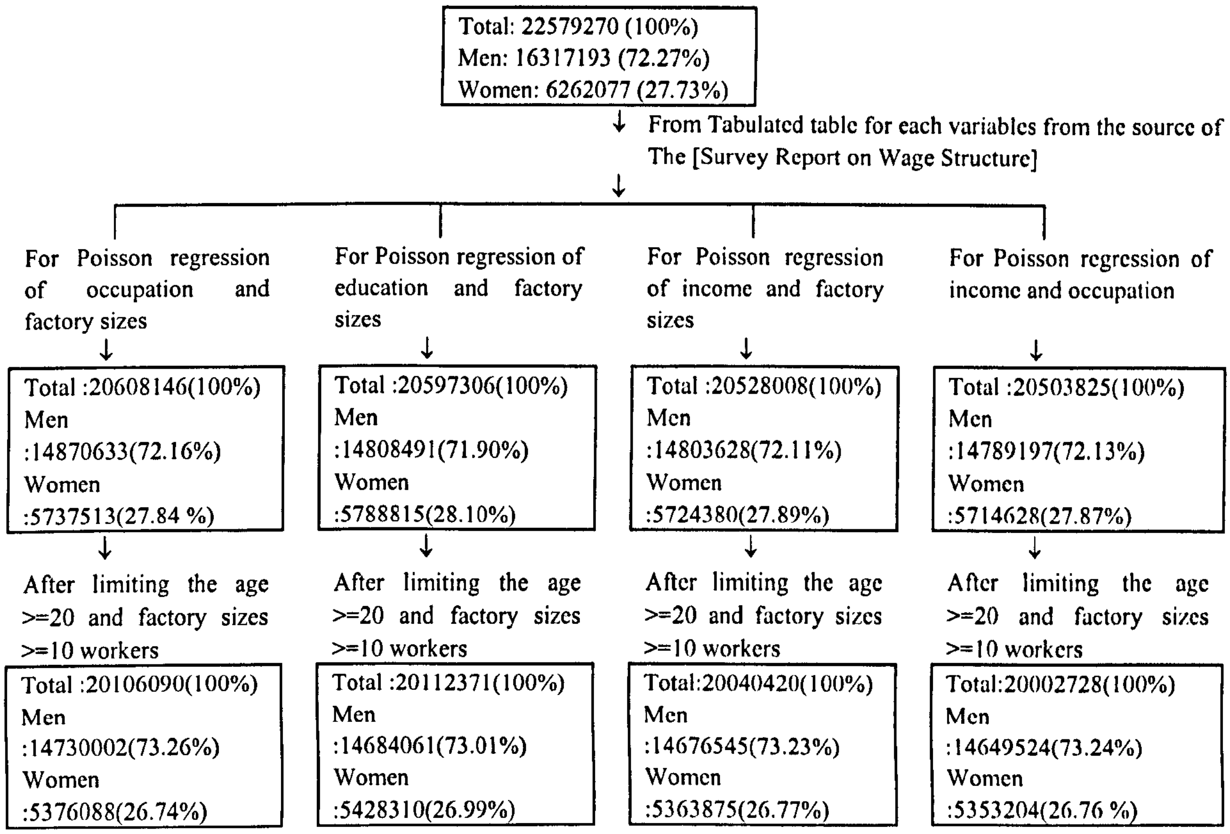


Figure 6.5 Final working population of denominators from 1995 to 1998



6.3.5 Definition of variables and grouping of variables

6.3.5.1 Health outcomes: Deaths due to workplace injury due to workplace injury

'Deaths due to workplace injury' in this study are defined as deaths resulting from injuries in the workplace that can be classified by the International Classification of Diseases (ICD-10): S00-T98, injury, poisoning and certain other consequences of external causes. Some deaths due to occupational conditions such as cardiovascular diseases (Cerebrovascular Disease and Ischemic Heart Disease) have been excluded.

6.3.5.2 Explanatory variables: occupation, education, income and factory size

(1) Occupation

Written information concerning occupation has been re-coded into 3 digits, then re-grouped into 9 large occupational categories according to the *Korean Standard Classification of Occupations*, published in 1993. These 9 categories of worker are re-grouped into two broad categories: non-manual and manual; and three categories: managers, professionals and technicians; clerks and service workers; and industrial workers (Table 6.4). For some cases which did not fit cleanly into our categories, advice from professionals in the National Statistics Office was obtained. The variable for agriculture is excluded from injury death as well as denominator tables, as agriculture is not included in the 'official' denominator data.

(2) Educational level

The educational level variable has been re-grouped according to three categories: less than middle school, high school and more than college.

(3) Income

Information concerning income for injury death cases was taken daily over three months for injured workers immediately before he or she was injured. This was then re-calculated as an average monthly income. The income variable for the denominator took tables for the average monthly income during one year. To focus on associations between the extremely poor and higher income groups and death rates due to workplace injury, income was divided into 5 groups: less than 400,000; 400,000-999, 999; 100,000-149,999; 150,000-1,999,999; and more than 2,000,000 won.

(4) Factory size

As Table 6.4 shows, there are some discrepancies in the distribution of workers according to factory size between different sources of data. In particular, discrepancies are noted in data covering large factory sizes (those employing more than 500 workers). This may suggest some numerator-denominator bias in the use of denominators from the *Survey Report on Wage Structure* (Table 6.4). To reduce this discrepancy categories were re-grouped as follows: 10-29; 30-99; and more than 100 workers.

(5) Age group

Age is categorised into 5-year bands: under 20; 20-24; 25-29; 30-34; 35-39; 40-44; 45-49; 50-54; 55-59; and over 60. We also compared the age groups 20-39 and over 40.

Table 6.4 The definition and re-grouping of the variables

		Grouping	Re-grouping
Occupation	Injury Deaths	0 Unknown or Inadequately described occupation (not enough information to code) 1 Legislators, Senior officials & managers (001-131) 2 Professionals (002-246) 3 Technicians & Associate Professionals (003-348) 4 Clerks (004-422) 5 Service workers & shop and Market Sales Workers (005-523) 7 Craft & related Trades Workers (007-744) 8 Plant & Machine Operators & Assemblers (008-834) 9 Elementary Occupations (009-933)	<Manual/nonmanual> 1-5 : Non-manual 7-9 : Manual <Three group> 1-3:Managers,Professionals, Technicians 4-5 : Clerks and sales 7-9 : Industrial workers
	Denominators	0 Unknown or Inadequately described occupation (not enough information to code) 1 Legislators, Senior officials & managers 2 Professionals 3 Technicians & Associate Professionals 4 Clerks 5 Service workers & shop and Market Sales Workers 7 Craft & related Trades Workers 8 Plant & Machine Operators & Assemblers 9 Elementary Occupations	<Manual/nonmanual> 1-5 : Non-manual 7-9 : Manual <Three group> 1-3:Managers,Professionals, Technicians 4-5 : Clerks and sales 7-9 : Industrial workers
Age	Injury Death	Calculated from their real birth date minus the present date	- 5 year band age group - 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60~
	Denominators	Calculated from their real birth date minus the present date	- 5 year band age group - 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60~
Education	Injury Death	Seven groups: 1. Primary school, 2 Middle school, 3 High school, 4 College, 5 University, 6 Post graduate 7 Unknown	1 Middle school, 2 High school, 3 over College level
	Denominators	Four groups: 1. Middle school, 2 High school, 3 College, 4 University	1 Middle school, 2 High school, 3 over College level
Factory sizes	Injury Death	As a continuous variable	10-29, 30-99, 100~
	Denominators	Five groups : 10-29, 30-99, 100-299, 300-499, 500~	10-29, 30-99, 100~
Income	Injury deaths	Continuous variable	5 categories less than 400000 400000-999999 100000-1499999 150000-1999999 200000-
	Denominators	24 categories : -299.2 300.0-399.9 ~	5 categories less than 400000 400000-999999 100000-1499999 150000-1999999 200000-
Cause of disease	Injury Deaths	ICD 9,10	-Re-grouping with main diseases, cancers, and occupational diseases

6.4 Statistical methods

Checking and editing of data sets were carried out before statistical analysis. The independent effects of occupation, educational level, factory size and income on death rates are investigated using Poisson regression. In cases of strong interaction between exposure variables, stratified tables of rate ratios are presented. STATA 6.0 is used for the Poisson regression.

6.5 Results

6.5.1 The relationship of workplace injury death rate ratios with occupation, educational level, income, and factory size

6.5.1.1 Male workers

Men and women are analysed separately. This is due to the fact that the proportion of deaths due to workplace injures for women aged over 20 (516; 6.90%) is smaller relative to that for men (7011; 93.1%). The overall crude death rate due to workplace injury among men in Korea is 31.22 per 100,000 persons in this study.

Table 6.5 shows the death rates due to workplace injuries among male workers. This result has an important limitation: not all combinations of variables among occupation, education, income are possible. For example, only age and factory size can be adjusted in the relationships among occupation, education, income, factory size and age with death rates due to workplace injuries. Death rates due to workplace injury among manual workers - craft and related trade workers, plant, machine operators and assemblers and elementary occupations - are higher than those for non-manual workers. Death rates are especially high among elementary workers and craft and related trade workers compared to managers and professionals. The confounding effects of age and factory size on the relationship between occupational group and injury rates are not substantial, whereas age and factory size act as effect modifiers (interaction) on the relationship between occupational group and death rates. The relative risks of deaths due to workplace injury among the occupational groups after adjusting for age group and factory size are similar to those without adjustment. However, after adjusting for income, death rates among manual workers, especially elementary workers, become considerably higher compared to any other occupational group. This suggests that elementary workers have a tendency to suffer a much higher rate of death due to workplace injury than managers and professionals, at the same level of income (Table 6.5).

Death rates due to workplace injury among the lower educational group are higher than for the more highly educated group among male workers. After adjustment for factory size, there is little change in the death rates among different educational groups. Occupational variables are not adjusted in the relationship between education and injury deaths due to already noted limitations in the information serving as denominators (Section 6.3.2).

The lowest income group - those earning less than 400,000 won per month - have higher death rates than those of the higher income groups among male workers (Table 6.5). On the other hand, for the middle income group - those earning between 400,000 and 1,990,000 won per month - death rates are lower than among the highest income group - those earning more than 2,000,000 won per month. This relationship between income and death rates remains after adjusting for factory size. However, after adjusting for occupation, the difference in death rates due to workplace injury among different income groups disappears and even the death rates within the lower income group become lower than those among the higher income group (Table 6.5).

Table 6.5 shows that small factories - those employing between 10-29 workers - have higher death rates due to workplace injury among male workers than other workplaces. After adjusting for age or occupation, the relationship between factory size and death rates remains intact. Even after adjusting for income, the death rate among smaller factories rises. However, it reduces after adjusting for education.

Older male workers suffer higher death rates due to workplace injury than their younger co-workers. After adjusting for occupational group, this differential is reduced. Factory size does not significantly confound the relationship of deaths due to workplace injury to age group. After adjusting for education or income the differential of deaths due to workplace injury among different age group is reduced.

Table 6.5 Injury deaths in the workplace (and 95% confidence intervals) according to occupation, education, income, and factory sizes among men aged more than 20

Job	Injury Deaths	Person years	Crude Death rates (10^5)	Adjust for age		Adjust for age and factory sizes (or occupation)		Adjust for age and income (or occupation)	
Occupational groups									
1. Legislators +2 Profe	118	2495426	4.73	1.00		1.00		1.00	
3.Technicians	220	1783166	12.34	2.79	2.23-3.49	2.75	2.20-3.44	3.61	2.87-4.54
4.Clerks	149	3005564	4.96	1.13	0.89-1.44	1.11	0.87-1.42	1.57	1.23-2.01
5 Service workers	111	307066	36.15	8.12	6.26-10.53	7.92	6.11-10.27	13.88	10.66-18.07
6. Craft	1826	2294708	79.57	17.59	14.60-21.20	17.32	14.38-20.88	27.27	22.51-33.03
7. Machine Operators	1021	3886059	26.27	5.66	4.68-6.85	5.71	4.72-6.91	9.13	7.50-11.11
8. Elementary workers	1153	958013	120.35	23.39	19.29-28.38	23.73	19.56-28.78	57.10	46.70-69.82
Total	4598	14730002	31.22						
Log likelihood				101.86(8)	0.001	72.61 (3)	0.000		
Occupational groups									
1-3	338	4278592	7.90	1.00		1.00		1.00	
4-5	260	3312630	7.85	1.06	0.90-1.25	1.04	0.89-1.23	1.55	1.32-1.84
6-8	4000	7138780	56.03	6.79	6.07-7.58	6.88	6.16-7.69	12.35	10.98-13.88
Total	4598	14730002	31.22						
Occupational groups									
Non-manual	598	7591222	7.88	1.00		1.00		1.00	
Manual	4000	7138780	56.03	6.62	6.07-7.22	6.76	6.20-7.37	10.35	9.45-11.33
Total	4598	14730002	31.22						
Education									
College, University	510	5309881	9.60	1.00		1.00		1.00	
High school	1964	6895705	28.48	2.84	2.58-3.14	2.82	2.55-3.11	2.97	2.69-3.27
Middle school	1269	2478475	51.20	4.44	3.98-4.95	4.44	3.98-4.96	5.33	4.81-5.91
Total	3743	14684061	25.49						
Income (unit:1000won)									
>200	1432	3221714	44.45	1.00		1.00		1.00	
150-199	1015	3266186	31.08	0.80	0.74-0.87	0.79	0.73-0.86	0.43	0.40-0.47
100-149	1153	4725693	24.40	0.59	0.54-0.64	0.57	0.52-0.61	0.22	0.20-0.24
40-99	698	3401946	20.52	0.37	0.34-0.41	0.36	0.32-0.39	0.08	0.07-0.09
<40	51	61006	83.60	1.58	1.19-2.10	1.49	1.12-1.98	0.32	0.24-0.43
Total	4349	29.63							
Factory size									
>100	2206	7542908	29.25	1.00		1.00 [5]		1.00	
30-99	1090	3840570	28.38	0.89	0.82-0.95	0.87	0.80-0.94	0.99	0.92-1.07
10-29	1302	3346524	38.91	1.21	1.13-1.30	1.15	1.06-1.24	1.39	1.30-1.50
Total	4598	14730002	31.22						
Age group									
20-29	958	3812609	25.13	1.00		1.00 [3]		1.00 [2]	
30-39	1366	5802942	23.54	0.94	0.86-1.02	0.94	0.87-1.02	1.09	1.00-1.18
40-49	1145	3122636	36.67	1.46	1.34-1.59	1.46	1.34-1.60	1.44	1.32-1.57
>50	1129	1991815	56.68	2.26	2.07-2.46	2.24	2.05-2.44	1.38	1.26-1.53
Total	4598	14730002	31.22						

-Occupational groups : 1: Legislators, Senior officials & managers 2 : Professionals 3 : Technicians & Associate Professionals
4 : Clerks 5 : Service workers shop and Market Sales Workers 6 : Craft related Trades Workers
7 : Plant & Machine Operators & Assemblers 8 : Elementary Occupations

1.0 [1] : with adjusting occupation and age
1.0 [2] : with adjusting occupation
1.0 [3] : with adjusting factory sizes
1.0 [4] : without adjusting age
1.0 [5] : with adjusting education and age

6.5.1.2 Female workers

Female workers comprise 6.56 % of all occupational deaths in this study, a result which is consistent with the literature (Jenkins, 1994). The overall crude death rate is 6.01 per 100,000 persons and 7.03 for age adjusted overall death rates among female workers from 1995 to 1998 in Korea. For women, the information regarding occupation is only regrouped into manual and non-manual categories as well as our three groups, as the number of deaths in each occupational category according to 9 categories is too small to give a more detailed breakdown. The highest risk occupations - those with the greatest age-adjusted rates of work related injury deaths - are the 'elementary' sectors (23.89 per 100,000), service and market sales workers (23.39 per 100,000) and female crafts (4.87 per 100,000).

Table 6.6 shows the age adjusted relative rate ratios of deaths due to workplace injury (and 95% confidence intervals) according to occupation, educational level, income, and factory size for female workers. Manual workers suffer higher death rates than non-manual workers and this remains the case after adjusting for age, factory size and income. In addition, of the three groups of occupational categories, industrial workers (craft and related trade workers; plant and machine operators and assemblers; elementary occupations) suffer higher death rates than managers, professionals and technicians. These results correspond to those among male workers. On the other hand, compared to their male counterparts, female clerks and sales workers suffer relatively higher death rates than female managers, professionals and technicians.

The least well-educated group - those educated to less than middle or high school - have higher age-adjusted death rates compared to the better educated group - those educated beyond college level. However, a different pattern from male workers is noted in that the high school graduated group have relatively higher age adjusted death rates than the middle school educated group, even though this reverses after adjusting for income and age.

The higher income group seem to suffer higher death rates than the lower income group. After adjusting for age and factory size there is little change in the relationship of injury rates to income. After adjusting for occupation, there is no change in this relationship.

Large factories seem to have higher death rates due to workplace injury than smaller firms among female workers. This result is also different from that shown in the analysis of male workers. After adjusting for occupation, income and educational level one-by-one, there is also little change in the relationship between factory size and death rates. In particular, educational level does not change the relationship between factory size and death rates for female workers.

Older female workers have higher rate ratios than younger female workers. After adjusting for occupation, the rate ratios for older workers are reduced. After adjusting for factory size, income and educational level, there is little change in the relationship of deaths due to workplace injury to age group.

Table 6.6 Injury deaths in the workplace (and 95% confidence intervals) according to occupation, education, income, and factory sizes among women aged more than 20

Job	Injury Deaths	Person years	Crude Injury rates	Adjust for age		Adjust for age and factory sizes (or occupation)		Adjust for age and income (or occupation)	
Occupational groups									
Non-manual	132	3203662	4.12	1.00		1.00		1.00	
Manual	191	2172426	8.79	1.32	1.02-1.72	1.27	0.98-1.64	1.69	1.28-2.24
Total	323	5376088	6.01						
Occupational groups									
1-3	5	826569	0.60	1.00		1.00		1.00	
4-5	127	2377093	5.34	8.12	3.31-19.88	8.65	3.53-21.19	10.99	4.45-27.13
6-8	191	2172426	8.79	8.39	3.42-20.62	8.44	3.44-20.74	14.64	5.85-36.60
Total	323	5376088	6.01						
Education									
College, University	27	1238633	2.18	1.00		1.00		1.00	
High school	154	2762263	5.58	2.52	1.67-3.80	2.48	1.63-3.75	2.56	1.70-3.85
Middle school	117	1427414	8.20	1.47	0.93-2.41	1.43	0.89-2.32	3.76	2.47-5.71
Total	298	5428310	5.49						
Income									
>150	42	572114	7.34	1.00		1.00		1.00	
100-149	72	1188523	6.06	0.85	0.57-1.25	0.85	0.58-1.26	0.50	0.34-0.75
50-99	189	3102335	6.09	0.62	0.44-0.88	0.68	0.48-0.97	0.31	0.21-0.45
<50	15	500903	2.99	0.20	0.11-0.36	0.22	0.12-0.40	0.09	0.05-0.18
Total	318	5363875	5.93						
Factory size									
>100	185	2485625	7.44	1.00		1.00 [5]		1.00	
30-99	67	1539771	4.35	0.50	0.38-0.67	0.66	0.50-0.87	0.60	0.45-0.79
10-29	71	1350692	5.26	0.68	0.52-0.89	0.66	0.49-0.88	0.75	0.56-0.99
Total	323	5376088							
Age group									
20-29	119	2967027	4.01	1.00		1.0 [3]		1.0 [2]	
30-39	34	938161	3.62	0.90	0.62-1.32	0.97	0.66-1.43	0.93	0.63-1.37
40-49	65	884165	7.35	1.83	1.35-2.48	2.00	1.48-2.71	1.60	1.15-2.24
>50	105	586735	17.90	4.46	3.43-5.80	5.03	3.85-6.57	3.77	2.79-5.11
Total	323	5376088	6.01						

-Occupational groups : 1: Legislators, Senior officials & managers 2 : Professionals 3 : Technicians & Associate Professionals
4 : Clerks 5 : Service workers shop and Market Sales Workers 6 : Craft related Trades Workers
7 : Plant & Machine Operators & Assemblers 8 : Elementary Occupations

1.0 [1] : with adjusting occupation and age
1.0 [2] : with adjusting occupation
1.0 [3] : with adjusting factory sizes
1.0 [4] : without adjusting age
1.0 [5] : with adjusting education and age

6.5.2 The modifying role of income and factory size in the relationship between occupation and injury death rates

6.5.2.1 The role of income in modifying the relationship of deaths due to workplace injury with occupation

For both male and female workers, we find an interaction between income and occupation, in their association with deaths due to workplace injury (Log likelihood test, X2=519.17 (p<0.0001) for men, X2=30.85 (p<0.0001) for female). The differential in death rates between manual and non-manual workers is greater in the higher income group - those earning more than 1,500,000 won - than in the lower income group (Table 6.7).

Table 6.7 The "age adjusted relative rate ratios" of injury death rates (and 95% confidence intervals) according to occupation among men aged more than 20 (20-60, and 60~) with stratification of income

	Men		Women	
	Deaths	RR(CI)	Deaths	RR(CI)
More than 1500000 won				
Non-Manual	340	1.00	22	1.00
Manual	2088	13.42 (11.94-15.08)	20	6.19 (3.22-11.89)
Total	2428		42	
Less than 1500000 won				
Non-Manual	248	1.00	108	1.00
Manual	1631	3.66 (3.18-4.20)	155	1.07 (0.79-1.45)
Total	1879		263	

RR(CI) : age adjusted relative rate ratios

6.5.2.2 The role of factory size in modifying the relationship of deaths due to workplace injury with occupation

There is an interaction between the variable of occupation and factory size for both female (Log likelihood test, x2=37.04 p=0.0001) and male workers (Log likelihood test, x2=304.83 p=0.0000). The difference in death rates between manual and non-manual workers is greater in the smaller factories employing 10-29 workers than in the larger factories for both male and female workers (Table 6.8).

Table 6.8 The "age adjusted relative rate ratios" of injury death rates (and 95% confidence intervals) according to occupation among men and women aged more than 20 (20-60, and 60~) with stratification of factory sizes"

	More than 100 workers		30-99 workers		10-29 workers	
	Cases	RR(CI)	Cases	RR(CI)	Cases	RR(CI)
Men						
Non-manual	278	1.00	139	1.00	181	1.00
Manual	1928	5.98 (5.27-6.79)	951	7.28 (6.08-8.71)	1121	7.83 (6.69-9.17)
Total	2206		1090		1302	
Women						
Non-manual	91	1.00	23	1.00	18	1.00
Manual	94	0.83 (0.60-1.14)	44	2.02 (1.07-3.82)	53	3.79 (1.83-7.84)
Total	185		67		71	

RR(CI) : age adjusted relative rate ratios

6.5.3. Summary of results

Firstly, death rates due to workplace injuries among manual, industrial workers are higher than those for non-manual occupational groups among men and women. Elementary workers in particular have the highest rate ratios compared to the male managerial group. The difference in death rates between manual and non-manual workers is greater in the higher income group, in older workers aged over 40, and in smaller factories employing less than 10-29 workers for both men and women.

Secondly, in the relationship between injury death rates and educational level, among both men and women, the less well-educated group have higher rate ratios of deaths due to workplace injury than the better educated group.

Thirdly, in the relationship between injury death rates and income, the lowest income group (under 400,000 won) suffer higher death rates than the higher income group among male workers. The relationship between death rates and income level remains after adjusting for age and factory size among male workers. However, after adjusting for occupation, the differential disappears. On the other hand, for female workers, higher income group seem to have higher death rates than the lower income group. This might be due to the fact that deaths of female workers are relatively high among service and sales workers, especially, when compared to male workers.

Finally, in the relationship between injury death rates and factory size, smaller factories, especially those employing between 10 and 29 workers, have higher death rates among male workers than other factories. This relationship remains unaltered after adjusting for age, occupation and income; it disappears, however, after adjusting for education. Yet for women workers, larger firms seem to have higher death rates than smaller firms.

6.6 Discussion

6.6.1 Limitation of the data analysis

6.6.1.1 Limitation of the source of denominators

The reason why there has been so little research on workplace injury may be due to the fact that the denominators are not adequately determined. In addition, it may be difficult to collect complete information about injury data due to under-reporting of injury cases. These problems also afflict the present study as we employ the denominators as the estimated average number of workers from the *Korean Survey Report on Wage Structure.*

In fact, there seem to be no proper sources of information concerning total working population in most countries. Many researchers therefore attempt to determine their denominators indirectly. Thus, the following have all been used as denominators:

(i) working population estimates from the US Bureau of Labour Statistics' Geographic Profiles of Employment and Unemployment (Stout-Wiegand, 1988; Russell et al, 1991; Ore and Stout, 1996; Bailer et al, 1998; Stout et al, 1996; Bell et al, 1990);

(ii) census data for employment in the construction industry by age, race, and ethnic origin (Sorock et al, 1993);

(iii) annual average labour force estimates of Statistics Canada for Quebec (Rossignol et al, 1993);

(iv) data from the California Employment Development Department Employed Population (Cone et al, 1991);

(v) Pollack et al (1996) also calculate the Full-Time Equivalent (FTE) workers by dividing the total number of hours worked by 40 (assuming a 40-hour working week) from the population survey for the Bureau of Labour Statistics in the USA.

Several limitations on denominators used in our study are worth noting. Firstly, the survey used estimates mainly for full-time workers employed for more than one month and part-time workers employed for more than 45 days. Also, the denominators for 'person time' used in this study are approximated using the estimated average number of workers during each year, as there is no information available for individual workers concerning the number of hours worked per year. To estimate person time per year, it is assumed that the average number of workers work regular hours, for example 8 hours per day, during one year. Therefore, the total number of workers, taken as it is from the estimated number given in the cross-sectional survey, may not closely correspond to the actual workforce during that time. In particular, the numbers of part-time workers in construction industries may be under-estimated. Most cross-sectional surveys exhibit such a limitation when it comes to estimating the number of workers actively employed during a given year. In case the proportions of part-time workers according to different factory sizes are different, it may bias the relationship between factory size and deaths due to workplace injuries.

We note especially that surveys of the Korean workforce differ among themselves as to the proportion of construction workers. They all diverge from the figures given by WELCO, which include all temporarily employed, part-time workers, whose numbers swell the ranks of the construction industries (Tables 6.2 and 6.3). As a result, proportions of the workforce measured according to different factory size differ significantly between WELCO and the *Survey Report on Wage Structure*. We utilise the latter in our study (Tables 6.2 and 6.3). This may imply that irregularly employed, part-time workers are under-estimated in the national surveys and over-estimated in the WELCO data. Such irregularly employed workers in the construction industries may be relocated in other part-time categories, such as 'manual work' or placed temporarily in the industrial reserve army. Most of them, therefore, should be included in the 'elementary occupations' in the occupational categories. It may thus not cause so great a bias among different occupational groups, upon which we mainly focus in this study.

It is also worth noting that most other studies - from the United States as well as Canada - employ definitions of working population based on estimates taken from population surveys. Nevertheless, the discrepancy in the proportions of construction workers can be taken to highlight the limitation of estimating the total workforce in terms of person time for total working populations using any cross-sectional census. Thus, this study may underestimate the denominators among irregularly employed construction workers and, as a result, may overestimate the death rates among them. Also, this study could not calculate the differentials of death rates due to workplace injuries among different industries as reliable denominators could not be found (Section 6.3.3.2).

Secondly, as different sources for denominators and numerators are employed in this study, along with the problem of denominators described above, we may not have entirely avoided the problem of a numerator-denominator bias. This may also be caused by the different definitions and criteria of variables such as occupation, education and income in both numerators and denominators. Specifically, the possibility of numerator-denominator bias is to be expected for the income variable, as the definition of income was different between numerator and denominator terms. This may affect the results of the relationship between income and injury deaths in our study. However, we are not alone in this. Other studies are forced to use different sources of denominators to calculate injury death rates among variables (Bell et al, 1990; Stout et al, 1996). Most are explicit in noting bias due to linking denominators and numerators from different sources of data. Thus, Cubbin et al (2000) note the possibility of bias due to linking denominators and numerators based on a probabilistic matching methodology.

Thirdly, the study population for the present study is somewhat limited as the denominators used here include only those workers from factories employing more than 10 people. We cannot therefore analyse injury death rates among workers employed in smaller firms. As these workers constituted around 39.8% of the workforce in 1995[8], the present study cannot exhibit patterns of injury deaths for a significant proportion of the working population. This is doubly unfortunate, as it is precisely these workers who are likely to be in the worst socio-economic situation as well as labouring under the worst working conditions. Omitting such workers, then, is likely to lead to underestimation of the true situation as regards workplace injury deaths when it comes to generalising our results across the whole Korean working population.

Finally, the tabulated data from the *Survey Report on Wage Structure* (Appendix) used in this study lack complete cross-classified denominators. This leads to an admission that we are unable to control some confounding; for example, the confounding effect of education in the relationship between occupation and injury death rates.

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[8] This data is referenced from the 1995 report of the census on Basic Characteristics of Establishments.

6.6.1.2 The underreporting of injuries

In order to avoid problems of under-reporting, the numerators employed in this study cover only *fatalities* due to workplace injury. As the tables for injury cases in our study are taken from data compiled for the injury compensation records of *WELCO*, a government organisation, we might expect to see some under-reporting of injury cases by employers. Higher injury rates result in higher premiums paid as insurance cover for compensation claims. In Korea, establishments employing more than 5 workers have to belong to the WELCO insurance system for the compensation of occupational injuries and premium[9] levels are based on total wage bills and injury rates. In addition to this, factories which have higher injury rates are subject to closer inspection from government agencies. Employers therefore definitely have an incentive to hide the true rate of injuries.

As Nichols (1989) writes in this regard: "a case in point is the drastic under-reporting of all three day accidents in Britain that resulted when the HSE recently shifted the basis of its statistics from reliance on workers' actual claims for injury benefit to reports by employers" (p164). The risk of distortion due to this kind of deception is lessened in cases leading to employee deaths, as compensation costs in these cases are too high. It may therefore be difficult for employers to pay without properly reporting cases. In this light, we feel justified in limiting our study to those cases leading to death due to workplace injury.

Many studies report evidence for the under-reporting of all causes of workplace injuries in the USA and Canada (Murphy et al, 1996; Oleinick et al, 1995; Kisner and Fosbroke, 1994; Murphy et al, 1996; Oleinick et al 1995). In the UK, there is evidence from the 1990 Labour Force Survey that only 30% of workplace injuries are actually reported under RIDDOR, the Disease and Dangerous Occurrences Regulations (Reilly et al, 1995; Nichols, 1996). Under-reporting is more likely in cases of minor accidents (Nichols, 1989). According to Thomas (1991) "under-reporting is more prevalent for over-three day injuries than for the more serious fatal or major injuries" (Nichols, 1997). Also, the under-reporting of minor injuries is greater in smaller establishments. However, major injuries

[9] Premiums are calculated using total wages among the whole workforce multiplied by the insurance rate in each establishment. This insurance rate is weighted by injury rate according to industry group.

are not in the exception from under-reporting nowadays. Nichols (1996) argues that "recent evidence from the Labour Force Survey has now put it beyond doubt that the major rate is under-reported, and that the extent of under-reporting is very substantial indeed" (p117). In summary, then, even though this study is justified in limiting its scope to deaths due to workplace injuries, it cannot be completely insulated against the possibilities of under-reporting of fatal workplace injuries.

6.6.2 Original hypothesis, objectives and main findings

Our original hypothesis is that differentials in injury rates exist between occupational class, income, education and factory size. The general objective is to explore the relationship between occupational group and other socio-economic factors such as education, income and industrial factory size with death rates due to workplace injury.

Higher death rates due to workplace injuries are found among elementary workers (labourers), less well-educated workers, those earning an extremely low wage and workers in small-sized factories (especially those employing between 10 and 29 male workers). For female workers, there were higher death rates among elementary workers, service and sales workers and less well-educated workers. On the other hand, women in higher income groups and working in larger factories looks to have higher death rates. The difference of death rates between manual and non-manual workers is greater, especially in the higher income groups, in smaller factories and among older workers aged over 40 among both male and female workers.

6.6.3 Comparison of these results with those of other studies

6.6.3.1 The overall crude death rates

Overall crude death rates due to workplace injury among men in Korea is 31.22 per 100,000 persons. This is much higher than other studies, especially those carried-out in the USA. There, the overall death rates due to occupational injuries among men was 12.5 to 8.3 from 1980 to 1989 (Stout et al, 1996). The overall crude death rate was 6.01 per 100,000 person and 7.03 for age adjusted overall death rates among female workers from 1995 to 1998 in Korea. In the USA, the average annual fatality rate was 0.82 per 100,000 female workers from 1980 to 1989 (Jenkins, 1994); from 1.0 to 0.7 between 1980 and 1980 (Stout et al, 1996); and 1.3 per 100,000 female workers in Texas from 1975 to 1984 (Davis et al, 1987).

6.6.3.2 The relationship between occupational group and death rates due to workplace injury

In the present study, occupation, as a broad proxy of workplace hazard, is found to be the main determinant of fatal injuries in the workplace. Especially among elementary workers, labourers are shown to have higher deaths due to workplace injuries than any other occupational groups among both male and female in Korea (Tables 6.5 and 6.6). Our study has a limitation in that the differentials of death rates due to workplace injuries among different industries are not calculated, as reliable denominators could not be found (Section 6.3.3.2). This is because most possible denominators are collected from cross-sectional surveys, whereas injury deaths are collected for one year only. The largest deficit of denominators may be those for the construction industry. As we have seen, the relationship between occupation and injury deaths may also be affected by numerator-denominator bias due to differences between possible sources of information. Nevertheless, our findings strongly suggest that labourers find themselves most often in the most dangerous working conditions and are consequently apt to suffer higher death rates due to workplace injury than any other occupational group.

Only a few studies report that occupation is the strongest predictor of death due to workplace injury (Table 6.9). These studies consider particular occupation as well as industry sector in their analyses of the causes of workplace injury. Compared to other studies, death rates due to workplace injury seem higher in this study (Tables 6.5, 6.6 and 6.9). Consequently, labourers are also shown in the present study to have much higher rate ratios of deaths due to workplace injury compared to the managerial group than in other studies (Table 6.9).

Table 6.9 The comparing the relationship between occupation and fatal injury rates from other studies

Study base	Data source,year	Classifications	Crude Rate (per 100000)		RR (rate ratios)	
Russell et al (1991, USA)	Fatally injured during 1985-1986 in Oklahoma and BLS for working population		All		All	
		Managers	7.6		1.00	
		Professional	7.8		1.03	
		Technical	12.9		1.70	
		Sales	9.3		1.22	
		Administrative including clerical	10.6		1.39	
		Service	13.7		1.80	
		Farming	31.6		4.16	
		Craft	15.4		2.03	
		Machine operators	6.0		0.79	
		Transport, moving	46.4		6.11	
		Labourers	57.2		7.52	
Ore and Stout (1996, USA)	Deaths among construction industries for 1988-1991		USA	Australia	USA	Australia
			All	All	All	All
		Craft	7.4	4.2	3.08	1.20
		Labourers	32.3	26.6	13.36	7.60
		Transportation operatives	25.6	24.2	10.67	6.91
		Managers	2.4	3.5	1.00	1.00
		(others)	(1.2)	(0.8)		
Cubbin et al (2000, USA)	NHIS/Multiple Cause of Death Public Use Data file from 1987 through 1994		Men	Women	Men	Women
		Blue collar	71.4	22.8	1.61	1.50
		Unemployed	123.4	37.2	2.79	2.45
		Not in labour force	176.2	35.9	3.98	2.36
		White collar	44.3	15.2	1.00	1.00
Bailers et al (1998, USA)	Fatality data from NTOF and employment data from BLS		All		All	
		Managers	2.85		1.00	
		Professional	1.43		0.50	
		Technical	0.30		0.11	
		Sales	2.56		0.90	
		Administrative including clerical	0.56		0.20	
		Service	2.53		0.89	
		Farming	20.26		7.11	
		Craft	8.02		2.81	
		Machine operators	2.73		0.96	
		Transport, moving	21.84		7.66	
		Labourers	13.22		4.64	
This study	Death data from WELCO and workforce from WLS between 1995 to 1998		Men		Men	
		1. Legislators +2 Profe	4.73		1.00	
		3.Technicians	12.34		2.79	
		4.Clerks	4.96		1.13	
		5 Service workers	36.15		8.12	
		6. Craft	79.57		17.59	
		7. Machine Operators	26.27		5.66	
		8. Elementary workers	120.35		23.39	

*Age adjusted rates

NHIS: National Health Interview Survey

NIOSH: National Institute for Occupational Safety and Health

NTOF: National Traumatic Occupational Fatalities surveillance system

BLS: Bureau of Labour Statistics

All: men and women

6.6.3.3 The relationship between educational level and death rates due to workplace injury

The least well-educated group is shown to suffer higher death rates due to workplace injury (Table 6.5, 6.6). The confounding effect of occupation could not be explored because of the limitation of the denominators used in this study (Section 6.3.3.2).

The educational variable has rarely been included in research on fatality rates due to workplace injury. Cubbin et al (2000) find that men and women without a high-school degree are at significantly increased risk of death due to all causes except suicide. The age adjusted rate ratio for general injury mortalities among those who do not have a high school degree is 1.93 for men and 1.78 for women, compared to US high school graduates.

However, for non-fatal injuries, they find no difference for educational attainment and suggest that low educational level is a risk factor only for the most severe injuries. Kelly and Miles-Doan (1997) also note that educational level has no significant effect on the risk of non-fatal injury. Kirschenbaum (2000) finds no evidence of educational differentials in the rate of work injuries among those interviewed upon entering hospital emergency wards. Nevertheless, Zwerling et al (1996 and1998) find that low educational level was a predictor of increased non-fatal injury risk among 7089 older workers aged 51-61 years (odds ratio of non fatal injury: 1.78 (CI: 1.38-2.29) in their first interview and of occupational injury: 2.35 (CI: 1.86-2.97)). In summary, the less well-educated group have been shown to suffer higher rates of death due to workplace injury for both men and women in this and other studies.

6.6.3.4 The relationship between income and death rates due to workplace injury

In our study, men in the lowest income group, especially those earning less than 400,000 won, suffer higher death rates (rate ratio 1.58 (CI: 1.19-2.10)), compared to the highest income group, those earning more than 2,000,000 won (Tables 6.5 and 6.6). However, those men in the middle income strata seem to have lower injury death rates than the highest income group. On the other hand, among women workers, the higher income group seem to be afflicted by higher injury death rates than the lower income group. After adjusting for occupation, the relationship between income level and injury deaths is reversed. The lower income group seem, then, to exhibit lower injury deaths rates. As for limitations on this aspect of the study, the posited relationship between income and injury death rates might be affected by the numerator-denominator bias discussed above.

There are several studies concerning the relationship between income and injury rates. There would seem, however, to be different approaches concerning the exact role played by income. Of course, much depends on the type and character of the injury. Income differences may not have much effect on non-fatal injuries but for fatalities, lower income has a significant effect. Baker et al (1992) discuss low-income areas that have high rates of death for causes which are typically work related. The rates are 10 times as high in the lowest-income versus the highest-income areas for deaths from machinery and four-times as high for falling objects, electrocution and explosion in the USA (Baker et al, 1992). Cubbin et al (2000) find that men with low income-to-needs are at increased risk of death due to 'all injury' mortality outcomes (except motor vehicle-related fatalities). Yet, for women, it was less clear that those with the lowest incomes had higher injury rates compared with women who have high incomes (except for deaths due to suicide) (Cubbin et al (2000)).

However, for non-fatal injuries, they argue that there is no differential for non-fatal injuries among different income groups. Zwerling et al (1996) also note no difference for non-fatal occupational injury among different income levels. Kirschenbaum et al (2000) state that the odds of being injured for high-paid employees increase by a factor of 1.7 in contrast to low-paid employees. They also assert that accident proneness is affected by the interaction of longer working hours and wage levels. In summary, then, we show that lower income groups have higher death rates due to workplace injury compared to the higher income groups among men in Korea, but this result did not mirror the result for women workers.

6.6.3.5 The role of factory size in the relationship between occupation, education and income and deaths due to workplace injury

Workers in smaller factories (employing 10-29 people) have higher death rates due to workplace injuries; this remains the case after adjusting for age, occupation and income and disappears after adjusting for educational level among men. For the interaction between occupation and factory size, in their association with deaths due to workplace injuries, the difference in death rates among different occupational groups is greater in the small-sized factories among men. Labourers in smaller establishments have higher rate ratios of deaths due to workplace injury when compared to managers than their co-workers in medium-to-large factories. The fact of higher injury death rates in smaller factories suggests that such establishments pose a greater threat to their employees. Higher death rates due to workplace injuries among small factories suggest also that labourers in particular are operating in more dangerous working conditions and are therefore apt to suffer higher death rates due to workplace injury. As a limitation of this study, the relationship between factory size and injury deaths may be affected by numerator-denominator bias as well as the deficit number of temporary part-time workers in the denominators.

These results are compatible with many other studies. Reilly et al (1995) note an inverse relationship between injury rates and factory size. Thomas (1991) also reports an inverse relationship in the UK. Oleinick et al (1995) document an inverse relationship between Potentially Standards-Related (PSR) fatality rates and establishment size in manufacturing, construction and transportation industries. Several researchers have discussed the fact that industrial injuries are closely related to the formal organisation of work such as subcontracting (Mayhew, 1996) and relative size of establishment. Nichols strongly suggests that the smaller the size of the work unit, the higher the injury rate is likely to be (Nichols, 1997). He argues, in particular, that major injury rates are more pronounced in smaller establishments. Nichols gives several reasons for this: the multi-faceted lack of resources in smaller establishments; lack of trade unionism; unilateral determination of health and safety standards by management.

For non-fatal injuries, some studies report higher injury rates among larger factories. Markku et al (1996) note that, considering only company size, small companies have lower, and large companies higher, disabling injury rates. The age adjusted rate ratio for occupational injuries is 2.00 ($p=0.004$) compared to smaller factory size. However, as Nichols (1997) mentions, for non-fatal injuries, under-reporting might be more common in smaller than larger factories. Thomas (1991) finds "the pattern for minor injuries to be the reverse of that for major injuries, with the rate of injury generally increasing with size of establishment" (Nichols, 1997, p164). Thomas (1991) also suggests that "the most likely reason for this was under-reporting in the smaller establishments, under-reporting being held to be generally much more prevalent for over-three-day injuries than for the more serious fatal or major injuries" (Nichols, 1997, p164).

On the other hand, for women workers, our study shows that larger establishments have higher death rates than smaller factories. This may be because a higher proportion of women work in service and sales, a sector suffering higher than usual rates of injury deaths in the recent past. These sectors tend to employ younger women and are concentrated in large establishments. Some of the younger women who died due to workplace injuries were stewardesses or sales workers in department stores. This characteristic of female occupation may contribute to higher than expected death rates due to workplace injury in larger firms.

6.6.3.6 Injury rates according to industry type

Injury rates by industry type are not calculated in this study, as reliable denominators could not be found. Several national surveys for estimating working population in Korea underestimate the proportion of temporary part-time workers, especially in the construction sector (Section 6.3.3.2). On the other hand, WELCO tends to over-estimate the number of construction workers in the total population. This is because the organisation exists in order to collect premiums for social insurance intended to cover compensation for workplace injuries. Thus, temporary workers tend to be included and may in fact be over-represented as full-time workers (Section 6.3.3.2). Exploring the relationship between different industries and injury death rates due to workplace injuries is the next challenge to researchers in Korea.

In the USA, the highest risk industries for occupational fatal injuries are: mining; construction; communication and transportation/public utilities; agriculture, forestry and fishing (Baker et al, 1992; Stout et al, 1996; Bailer et al, 1998). Oleinick et al (1995) suggest that workers in construction and transportation industries have higher rates of compensable injuries. Kisner and Fosbroke (1994) show that the construction industry has the highest rate of workers' compensation claims in the SDS data. They also find that labourers have the highest fatality rate in the construction industry: 39.5 per 100,000 full-time workers. Pollack et al (1996) agree, they show that construction labourers (with death rates of 38.2 per 100,000 in 1992; 35.7 in 1993) and structural metal workers (with death rates of 153.5 per 100,000 in 1992; 89.5 in 1993) are the most likely to be fatally injured in the US construction industry. Bell at al (1990) find that the occupational categories with higher fatality rates due to workplace injury were crafts, transportation, agriculture and labouring.

6.6.3.7 Age differences and death rates due to occupational injury

Our study shows that older manual workers suffer higher death rates due to workplace injury both for men and women. Age does not confound the relationship between death rates and occupation, education, income and factory size for either gender.

Our results correspond to those arrived at in other studies. Several show that occupational fatality rates are higher among elderly workers (Baker et al, 1992; Stout et al, 1996; Rossignol and Pineault, 1993; Ore and Stout, 1996; Bailer et al, 1998). In particular, several studies report the highest injury fatalities among workers aged over 65 (Bell et al, 1990; Bailer et al, 1998). Several studies also note that age does not significantly confound rates for fatalities due to occupational injury. Rossignol and Pineault (1993) mention that crude rates of fatal injury are almost identical to the age adjusted fatal occupational injury rates.

6.6.3.8 Women workers and death rates due to workplace injuries

We find that those occupations which inflict higher injury death rates differ greatly between men and women. The highest risk occupations, with the greatest age-adjusted rates of work related injury deaths, are the elementary tasks employing female workers (23.89 per 100,000), service and market sales (23.39 per 100,000) and female crafts (4.87 per 100,000). This is a quite different pattern to that shown among male workers (Tables 6.7 and 6.8). In particular, for younger female workers (those under 40), the occupations which have higher age adjusted death rates due to workplace injury are service and market sales (31.67 per 100,000) and elementary sectors (20.89 per 100,000).

However, for older workers (those over 40), the most hazardous occupations are the elementary (31.86 per 100,000 female workers) and craft sectors (13.40 per 100,000 female workers). Due to the relatively higher injury rates of service and market female workers, this occupational group is included in the non-manual group, the differential between death rates for manual and non-manual workers looked less wide than for male workers. For females, the proportion of service and market sales sectors is relatively higher than that of male workers (National Statistics Office, 1997). Thus, between 1995 and 1998, a cluster of disasters affected this sector, including several aeroplane crashes in 1996 and the Sampoong department store collapse in 1995. On such occasions, a significant number of female service workers and stewardesses were killed and these were incorporated into the lists of deaths due to workplace injuries. In particular, during the re-coding and categorisation process for occupational death cases, younger female workers were noted to have died working as stewardesses or shop sales workers and older female workers, working as construction workers.

For the occupations which had higher injury deaths for women workers, Jenkins (1994) notes that the occupations with the highest rates of work-related injury deaths were pilots and navigators (93.33 per 100,000), heavy truck drivers (30.71 per 100,000), construction labourers (23.97 per 100,000) and policewomen (11.24). The injury rate for stock handlers and/or baggers was 5.72 per 100 000. Jenkins also shows that younger workers (aged 25 to 29 years) made up the largest percentage of deaths in the sales sector. This is quite similar to our study. Davis et al (1987) show that the occupations with the highest fatal injury rates in Texas were heavy truck drivers (54.9 per 100,000), stock handlers and baggers (22.1 per 100,000), food counter and fountain workers (15.4 per 100,000), supervisors, proprietors and sales (8,7 per 100,000) and labourers (7.9 per 100,000).

Our conclusions are as follows: firstly, the occupations which carry a higher risk of injury may be different for women than for men. For women, service and sales work, as well as elementary or labouring work are the highest risk jobs; whereas elementary or labouring work poses the highest risk for men. Secondly, the causal pathways of injury in the sales and service sectors need to be examined in more detail in the future. Thirdly, a re-classification of occupations in terms of social class should be considered.

6.6.3.9 The relationship of socio-economic factors and working conditions to death rates due to workplace injuries

This study has a real limitation in that it cannot claim a complete exploration of relations between occupation, education, income, factory size and death rates due to workplace injuries. However, several interesting points give us some expectation that it may be possible to expand the scope of our enquiry into a broader study of the relationship of socio-economic factors and working conditions to deaths due to workplace injury.

Firstly, in the relationship between occupation and income, the differential in death rates between manual and non-manual workers was greater in the higher income group than in the lower income group. This may be because working conditions may be similarly hazardous across the lower income group. Also, in the lower income group, lower income itself may indirectly act as one of the risk factors for injury deaths. Table 6.10 shows the relationship between occupation, income and working hours. In particular, in Korea, lower-waged employees tend to work longer hours than higher-waged workers. Our study shows that labourers suffer higher rates of deaths due to workplace injury than any other occupational group. Also, the lower income group have higher death rates due to workplace injury than the higher income group. From this, and from the evidence laid out in the table 6.10, labourers, who tend to have a lower income and work longer hours, have a much higher chance of dying due to workplace injuries than any other group.

Table 6.10 The monthly wages and monthly working hours according to occupation among whole working population

(unit : hours, 1000 won)

Year	95		96		97	
Occupation	Working hours	Wages	Working hours	Wages	Working hours	Wages
Manager	195.7	1746.1	187.1	2042.6	187.1	2170.4
Professionals	194.4	1232.7	185.7	1382.8	185.8	1470.8
Technicians	199.9	1046.6	192.3	1197.2	190.8	1285.5
Clerks	199.1	882.6	192.2	999.5	191.8	1045.7
Service, sales	209.4	734.1	202.3	838.1	201.4	877.2
Crafts	228.4	837.6	216.2	961.1	215.3	1054.6
Machine operators	230.1	854.5	224.5	945.7	224.6	1006.4
Labourers (Elementary workers)	243.0	658.0	239.7	700.9	240.9	748.0

Source : Survey Report on Wage Structure 1995-1998, The Ministry of Labour, Korea

Secondly, the difference in death rates for manual and non-manual workers is slightly higher in smaller than larger factories. Particularly among elementary workers, those in smaller factories suffer much higher death rates due to workplace injury compared to the managerial group. This may be because in smaller factories, relatively desperate conditions exist. For example, in such establishments, extremely hazardous working conditions as well as extremely poor people may co-exist. Linking income and factory size, Table 6.11 shows that income level is relatively lower in smaller than in larger factories. This result may suggest that lower income group members may be concentrated in smaller rather than larger factories, even though this is obviously a very rough and ready claim.

Table 6.11 The relative difference of income according different factory sizes

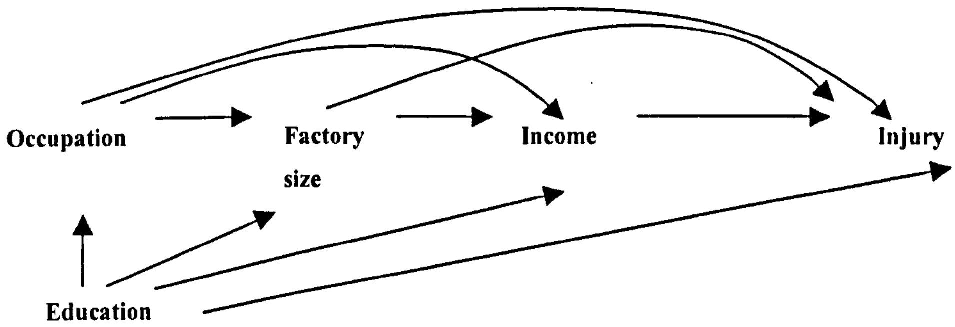
Year / Factory sizes	Total	10-29	30-99	100-299	300-499	>500
1995	106.0	100.0	99.8	106.2	113.6	116.1
1996	105.6	100.0	101.6	102.9	112.0	116.0
1997	104.5	100.0	99.5	102.6	109.0	116.0

Source : Survey Report on Wage Structure 1995-1998, The Ministry of Labour, Korea

Elementary workers suffer higher deaths due to workplace injuries in smaller firms, which may have more hazardous working conditions than larger factories, compared with the same kinds of industry organised in larger units. Also, income may contribute to death rates as itself an indirect socio-economic factor, as well as being a result of differentials determined by work status and position. Linking these findings, we suggest that lower socio-economic groups work longer hours, in more hazardous environments and have a tendency to higher death rates than higher socio-economic groups. Kirschenbaum et al (2000) confirm that the correlation between cheap labour and hazardous working conditions appears to be a potent one for increasing the chance of being involved in an accident. Reilly et al (1995) find that the more concentrated the work-force is in terms of manual workers, the greater is the scope for workplace injuries. As we have seen, Nichols (1997) also argues strongly that the intensification of labour is a major cause of industrial injury.

In sum, then, this study suggests that membership of the class of those with the lowest educational achievement tends to be linked to membership of the class of those employed in elementary occupations and in smaller factories; this may in turn lead to lower income, longer working hours and more hazardous working conditions. It is no surprise, then, that these factors tend to result in higher death rates due to workplace injury.

Figure 6.6 The causal pathway of socio-economic factors and factory sizes



6.6.4 Conclusions

This study examines the relationship of occupation, education, income and factory size with occupational deaths due to workplace injury, and draws the following conclusions:

1. Manual workers, especially elementary workers, suffer higher death rates due to workplace injury than non-manual workers among both men and women in Korea.

2. Lower educational groups, especially those who did not graduate from middle school, have higher death rates than better educated male and female workers in Korea.

3. Lowest-waged workers have significantly higher death rates than higher income male workers.

4. Very small factories employing 10-29 workers inflict higher death rates on their employees than larger firms (over 500 workers).

5. Within the lower income group, differences in death rates due to workplace injury between manual and non-manual workers are not as obvious as the differences within the higher income group

6. Differences in death rates between manual and non-manual workers in smaller factories are slightly greater than in larger firms (more than 500 workers).

The key conclusion, therefore, is that the main victims of deaths due to workplace injuries are manual elementary workers who are less well-educated, and who work in the smallest factories.

6.7 Policy implementation & further suggestions

6.7.1 The most vulnerable group for workplace injuries

This study suggests that elementary workers, who are the lowest educated and lowest waged, especially in the small firms, should be the primary targets of workplace injury prevention strategies. We therefore suggest that our findings should be incorporated into deliberations on prevention strategies for workplace injury deaths.

6.7.2 The need to develop a valid data set of denominators

During data manipulation, problems were met concerning several possible sources for estimating the total Korean working population. Firstly, there is no correct source of denominators to estimate 'person time'. Each of the candidates chosen to serve as denominators comes with its own specific limitation. Several national programmes estimate temporarily-employed, part-time workers according to cross-sectional surveys taken over a limited period. This may tend to under-estimate the number of workers who are employed part-time.

On the other hand, data supplied regarding registered factories by WELCO was found to mis-represent the person time of the total working population. This includes all part-time and full-time workers and therefore makes a significant difference in attempts to estimate total numbers of workers, especially for construction workers, as data from WELCO and other sources tend to conflict (Section 6.3.3.2). Even though WELCO officials state that the working population is estimated as the number of full-time equivalent workers, a significant difference remains between WELCO and other national surveys. This would lead to an over-calculation of the construction industry workforce a genuine problem as death rates among labourers might well be under-estimated. As a consequence, Korean official statistics which employ denominators drawn from WELCO data tend to show relatively lower death rates among construction workers compared to other studies in USA and Canada.

Secondly, it is difficult to find denominators which include potential risk factors for deaths due to workplace injury. For example, given that most surveys estimate the industrial working population based on the establishment as the survey unit, some potential risk factors may not be included in these data sets.

To solve these problems in the future, we make several recommendations: firstly, existing national surveys for estimating the total workforce need to be improved, especially in relation to collecting information on temporary part-time workers. One simple improvement would be if the existing surveys could include a question concerning 'total number of hours worked' for full-time as well as part-time workers during one year. As Pollack et al (1996) note, "the number of hours worked is important for purposes of computing rates because we are interested in the amount of time the individual was exposed to the risk of death on the job". This can be undertaken without difficulty in the existing Korean data collection system.

Secondly, the whole working population could be registered and followed-up as a longitudinal data set, were we to be a little more imaginative in our approach. As each worker has their own identification number (such as a social security number), once this registration system is up and running, Korea could maintain the records indefinitely. Each Civil Office currently manages population data and there is no reason why this system cannot be computerised and linked across the civil service. As a result, variables relating to information on working conditions as well as socio-economic conditions could be added. For example, firm size, economic activity, occupation, industry type, job tasks, number of hours worked per period could all be collected by the official registration system in Korea.

Thirdly, another alternative is the improvement of the national census. For example, census data could be used to estimate total working population in relation to occupational epidemiology, if it were to include factory sizes, work process, tenure and other working conditions. The census already includes several variables: occupation, industry type, employment status and employed state.

Fourthly, a validity test and stricter quality control of national surveillance systems should be carried-out. This would help to determine possible explanatory variables, including socio-economic factors, as well as working condition factors for workplace injury and disease.

6.7.3 The need to develop a valid data set of numerators

Another major problem is the under-reporting of workplace injuries. To avoid this problem, only deaths resulting from workplace injuries were included in our study. However, some researchers warn that major injury rate is also under-reported in the UK (Nichols, 1996) and occupational illness may be universally under-reported, though the extent of the under-reporting is unknown in the USA (Murphy et al, 1996). Korea may not be an exceptional case in that sense. There are also many missing values concerning explanatory variables for the injury data set. These were especially marked for socio-economic factors such as occupation, education and income in the injury data from WELCO.

As a strategy for reducing under-reporting of workplace injuries in Korea, the data needs to be collected from multi-information systems. In particular, employers ought not to be regarded as the sole legitimate reporter of workplace injuries. As Nichols (1989) points out, under-reporting of workplace injuries increases when employers have a responsibility to report. Therefore, several alternatives might be considered. Firstly, if several variables related to working conditions are included on the death certificates, this could be used for collecting data. To do this, information on whether deaths are linked to workplace accidents should be included. In addition, detailed information concerning the deceased's workplace, job tasks, firm size and industry would be useful. Secondly, labour unions could take charge of collecting such data. They can thus play a role in correcting any one-sidedness in an employer's reporting of workplace injuries as well as technically managing database systems.

6.8 Further study

6.8.1 The need to study the detailed causes of occupational injury

This study could not analyse the detailed causes of occupational injury. To investigate this, quantitative and qualitative analysis, along with case study methods need to be developed. Also, some longitudinal studies concerning socio-economic factors as well as working condition factors are needed. In Korea, each individual has a social security number, therefore, if the data set were to include social security numbers and the variables related to working conditions, it could be used for the longitudinal follow-up study in the occupational epidemiology area.

6.8.2 The need to study association between working conditions and socio-economic conditions

This study is the first attempt to investigate the relationship between socio-economic factors, working conditions and death rates due to workplace injury in Korea. To find the area of highest vulnerability for injury deaths, and to link in the general socio-economic factors and specific working conditions, more detailed study of the association between working conditions and socio-economic factors is needed.

6.8.3 The need to clarify the definition of social class

From the process of data analysis in this chapter, it has been noted that there is a limitation to using the existing the *Korean Standard Classification of Occupations*[10]. This classification system is mainly based on an understanding of particular individuals and

[10] The National Statistics Office states that occupation has been classified as jobs performed by economically active individuals

their specific job definitions. It cannot include criteria geared toward social class based on an understanding of the conflictual relationship between capital and labour, the ownership of property and social position. This problem appears, for example, when we re-group occupational data into two groups: manual and non-manual. The present occupational classification system cannot discriminate the lower class of non-manual jobs from the higher class of non-manual job. Therefore, female sales workers are usually classified as non-manual workers, falling into a 'higher' class than manual workers. The Korean system cannot clearly discriminate manual and non-manual jobs within a particular occupation, as its occupational classification was not designed for this kind of study. As an alternative, therefore, several questions such as job status or position in their workplace and details of job task ought to be included in future national surveillance material.

Chapter 7: Working conditions, socio-economic factors and injury rates in one car factory

7.1 Introduction

Taking the population of Korea as a whole, previous chapters investigated how socio-economic differentials in occupation, education and income affect workplace injury death rates, mortality, and morbidity. These results highlight, in particular, the fact that less well-educated, manual workers suffer higher mortality, morbidity and deaths due to workplace injuries than well-educated, non-manual workers. From the broad national picture of inequalities in health painted in previous chapters, we now turn to present the pattern of workplace injury incidence in one car factory. This will give us a more detailed picture of workers' ill health and will allow us to focus on the effect of working conditions on workplace injury rates. We explore how specific types of work in different departments affect workplace injury rates. We also attempt to understand how working conditions, focusing on work intensity, are related to workplace injuries. In particular, we examine how the relationship between employers and workers impacts on workplace injuries

Even though many studies concentrate on particular hazards in the workplace, only a few international studies focus on work intensity as a risk factor in workplace injury rates (Nichols, 1997; Noveck et al, 1990; Grunberg, 1983). In Korea, while workers' concerns about the intensification of work have been surfacing since 1990, only a few studies related to work intensity and workplace injuries have been undertaken (Kang et al, 1996; Park et al, 1996). Also, there has been little research into socio-economic factors and work conditions as risk factors for workplace injuries in Korea. As Moncada (1999) notes, "separating work from social class is difficult as the social division of labour is at the origin of social class". This study therefore attempts to understand how the relationship between employers and workers affects workplace injuries in one car factory.

7.2 Background to the study

7.2.1 Characteristics of work processes in each department: how has the work process changed?

7.2.1.1 Work departments

The targeted car factory is located in Incheon in Kyung Gi Do, Korea; it has about 10,000 workers on its production lines. It was built in the early 1980s, for mass car production following the Fordist model under contract from General Motors and OPEL (Cho et al, 1997). It functions using a large degree of mechanisation, e.g. conveyer belts and heavy machinery for mass production. The car factory consists of five main sections: (i) press; (ii) body welding; (iii) painting; (iv) assembly; and (v) engine processing/assembly (see Appendix). The process begins with raw materials being loaded into the press line in the form of steel sheets. The press line has two main parts: a shearing line for the cutting of steel sheets and a stamping line for the processing and shaping of the cut steel sheets on dies using several hundred tons of force. The body welding line includes four sub parts: welding, sealing, installing and grinding of panels. The processed panels from the press line are welded and sealed. At this point, some accessories - doors, hoods, trunks and fenders - are fitted to the body. Any damage or marks resulting from the welding are ground and sanded-out. The painting process is made up of pre-manipulation, electro-coating, primer and top coating. The engines are added at the engine processing/assembly stage. Finally, the assembly process involves adding the vehicles, electrical system, chassis and accessories.

7.2.1.2 The conveyer line

The 5 main production processes are carried out on conveyer lines which run continuously. Workers perform the same tasks, often up to 60-90 times per hour. This repetitive work is done at speed, while standing, bending and twisting. This repetitive and awkward activity represents one of the major health risk factors for car factory workers on conveyer lines.

7.2.1.3 Shift work

The majority of the workers in the 5 main production lines work in shifts. They work on the basis of two weeks of night work and two weeks of day work. A shift entails 12 hours of work, either throughout the night or during the day. Night work is seen as the greatest burden by the workers, as expressed in their opinions about their health and safety needs.

7.2.2 Changes in management policy from 1992 to 1999: what is the manager's interests?

The employers and managers in the car factory imported NAC I (New Autonomous Concept) management techniques in 1992 from the Japanese management system, so-called 'Lean Production[1]'. The basic objectives of NAC I are to extend Fordist mass production techniques through the introduction of 'just in time', 'model mixing' and 'quality control', as well as co-operative labour-employer relationships. The latter entails team meetings, suggestion schemes, team production and change of personnel administration, as preconditions of mass production (Cho et al, 1997). However, many researchers have already observed from field studies that 'Japanese production' techniques do not improve on traditional capitalist modes of production, in some senses they are even more onerous for the workers than Taylorism and Fordism (Fucini and Fucini, 1990; Garrahan and Stewart, 1992; Graham, 1995; Moody, 1997; Rinehart et al, 1997; Delbridge, 1998; Danford, 1999; Parker and Slaughtor, 1988).

NACI was introduced for a number of reasons. Firstly, managers sought to increase productivity in competition against other multinational car factories. Secondly, managers wanted to re-establish control of the workplace, which they felt was controlled by the labour unions since a worker-employer struggle in 1987 (Cho et al, 1997). Thus, the implementation of NAC I was focused on reducing costs and increasing productivity. The main approach to increasing productivity from 1992 to 1996, was the speeding up of work rates and the intensification of the labour process. In 1996, the factory announced the introduction of NAC II and started to establish a new labour-employer culture, urging more productivity and better quality. The drive to increase the pace of work and to reduce the number of workers continued until the Korean economic crisis of November, 1997. From January 1998, employers announced the introduction of NPS-G1 (NAC Paradigm Shift-Global No.1) and began to stress the need for increased productivity, higher quality and more cost reductions (see Appendix).

7.2.3 A brief history of the labour union in the car factory

The labour union in this car factory is democratically organised, with leaders elected by workers, rather than nominated by employers, since 1987. This is the result of general progress in the labour struggle since 1987. Since this time, the labour union has been a centre for workers' struggles, especially against the lowering of income and welfare and over several political issues. The workers in this car factory have struggled several times against increases in work intensity. These struggles have usually started from shopfloor workers or workers' representatives rather than labour union leaders. Since the economic crisis in 1998, the labour union has made an agreement with the employers to co-operate in the reduction of workers' welfare benefits, for example, bonuses, educational expenses for workers' children, medical treatment and other such benefits. However, despite this agreement, workers continue to struggle against increases in work intensity.

7.3 Hypotheses and objectives

The central hypotheses pursued in this section are: firstly, that working conditions (work departments, shift and conveyer line work and work intensity) affect workers' injury rates. Secondly, that broader socio-economic factors also have such an affect.

The objectives of this study are threefold: firstly, we examine the relationship between working conditions – work departments, shift work, conveyer line work, and work intensity – with workers' injury rates. In particular, we attempt to understand the mechanism of intensified work and its impact on health, focusing on the conflictual relationship between employers and workers. Secondly, we explore the relationship between socio-economic factors - income and job status - with worker's injury rates.

[1] Moody (1997) lists the constituents of 'lean production' as follows: substantial job elimination, with or without technology, faster and harder work force, etc.

Thirdly, the relationship between work conditions and socio-economic factors on injury rates is investigated.

7.4 Methods

7.4.1 Study framework

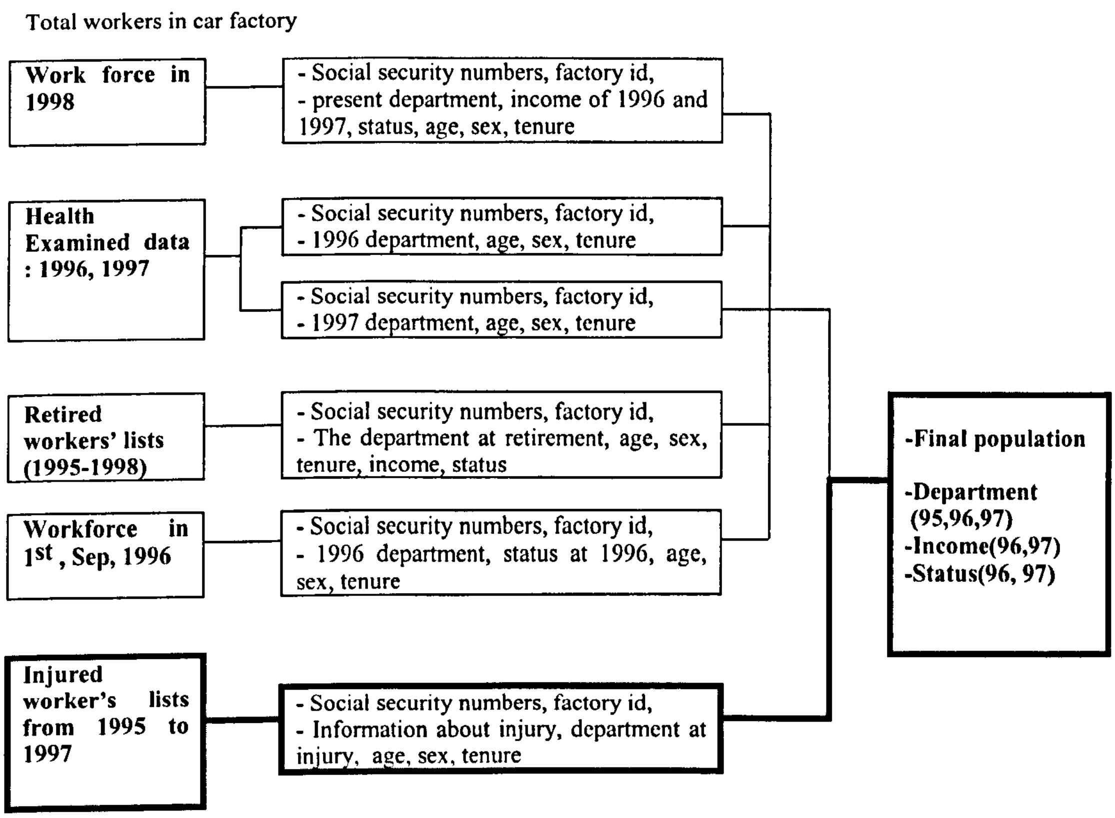
This study has both a qualitative approach and a quantitative element. The quantitative aspect investigates the relationship of work conditions and socio-economic factors with workplace injuries, using a retrospective cohort study. Work conditions are likely to have a direct effect on workplace injuries while socio-economic factors may have both a direct and indirect effect. The qualitative aspect was made up of in-depth interviews and a walk-through survey; this aspect attempts to understand how workers in the factory perceive their working conditions and how this affects workplace practices and injuries. In particular, we attempt to understand the relationship between employers and workers as it impacts on working conditions by focusing on work intensity. Therefore, the qualitative approach gives added depth to the findings of the quantitative element.

7.4.2 Data sources for the quantitative element: workplace injury analysis

7.4.2.1 Incheon car factory data: three year-follow up data set

Five data sets are linked to obtain the variables and time-varying explanatory variables, using 'unique identifiers': workers' names, social security numbers and factory identification numbers (Figure 7.1). The main explanatory variables were age, sex, tenure, income, job status and work department. We use data for the total work force in January 1998 and injuries between 1995 and 1997. To include retired workers from this period, the lists of those who had retired from 1995 to 1997 are added. To get the time-varying variables for work department and job status, the health examination data in 1996/1997 and lists covering the total number of workers in 1996 are linked together.

Figure 7.1 Data sources in a car factory



As a consequence of linking the five different sets of data, the study population of the Incheon factory comprises 12,121 workers and 2465 injuries of which there are 1962 injured workers. 84 injuries are not matched in the linking process. The workers from other sub-factories outside Incheon are excluded. However, the workers who moved to another workplace, but originally worked in the Incheon factory between 1995 and 1997 are included. Non-manual (non-productive, white-collar) workers are excluded, as the factory does not hold any records on income. Finally, the study population is confined to male workers, as female workers in Korean car factories are few and far between. The month of December 1996 has been deleted from the total person years because data for injury cases during this period are missing from the original records. Therefore, the final study population is 25,561.4 person-years, 8965 study population, 2259 injury cases and 1793 injured workers (Figure 7.2).

Figure 7.2 The study population in this study

Total workers (15038) from several different workplaces and total injury occurrences from Incheon factory (2465)

Incheon factory only
(12121 workers, 2465 injury occurrences, 1962 injured workers)
➔We deleted the workers from other workplace.

Manual workers
(9132 workers, 2303 injury occurrences, 1813 injured workers) ➔We deleted the non-manual (non-productive) workers.

➔ Total population : male only (8965 workers, 2259 injury occurrences, 1793 injured workers)

7.4.2.3 Completeness of the quantitative data

(1) Omission of information for the period 1-12-1996 to 31-12-1996

The workplace injury occurrences are lost for the period of December 1996 from the original data set. To overcome this problem, we end the follow-up on 1st December 1996 and re-start the follow-up from 1st January 1997. That is, a period of one month - December 1996 - has been dropped from the person-years calculations.

(2) Missing information

As there is no information regarding the department in which individual workers worked during 1995 obtainable from factory records, the information covering departments for 1996 is used as a proxy for 1995. This would cause some bias, if there had been a dramatic change of workers in departments between 1995 and 1996. However, a brief comparison of total workers' lists between 1996, 1997 and 1998 shows that the movement of workers between departments was not significant up to 1997. It was, in fact, more frequent after the economic crisis in November 1997.

(3) Missing values

The income variable has 560 missing values (6.25% among the 8965 study population). The job status variable has 311 missing values (3.47% among the 8965 study population). There are no missing values for age, sex, department, birth date, and employment date.

7.4.2.4 The variables – grouping and re-grouping

Explanatory variables utilised in this study are: income, department and job status. The grouping and re-grouping of variables is as follows (Table 7.2) :

(1) Age

Age at the starting point of the collection process for injury cases, 1st January, 1995, is calculated. Age is grouped into quintiles. A 5-year band for age groups is used for adjustment.

(2) Tenure

The tenure (duration of labour at the factory at the starting point for the collection of injury data: 1st January 1995) is calculated. For display purposes, workers are grouped into quintiles by tenure. 5-year band groups are used for adjustment for tenure.

(3) Department

The original information for departments includes more than 200. These departments are grouped into 6 categories: five main departments (paint, assembly, press, body welding, engine processing and assembly) and the supporting departments (framing, institute, quality control, moving vehicles and several other parts (total quality control, total management, repair, KD, product management)).

Workers in the painting department do not deal with heavy materials, but usually engage in repetitive movements using spray or brushes. The work on the assembly line involves bending and twisting and is generally quite demanding on the workers' bodies. The press line deals with heavy sheets of iron. In some workstations - those which utilise the old press machine - press workers move these sheets manually. Therefore, this department can be one of the most physically demanding in the factory. Body welding involves operating heavy machinery with a large amount of repetitive work. Engine department tasks include processing and assembly work. Individual workers in engine processing each deal with several large automatic machines. These five departments are the major productive sections, operating 24-hour conveyer lines and organised around 2 shifts per day.

Sub-groups of supporting departments function as follows: frame workers make car frames. This task is quite skilled and does not constitute part of the conveyor line. The institute also demands skilled work and is not part of the conveyor line. Those working in the quality control department usually check the quality of products at the end of the production process in the five main departments. Some workers in this section are involved on the conveyor line and some work in the office. The workers in the vehicle-moving department drive the moving vehicles and move materials into each workstation in the five main departments. Up to this point, processes take place inside the factory. The remaining departments constitute several other parts of the main car production process and they generally function elsewhere than on the production line.

In this study, the five main departments - press, paint, assembly, body welding, and engine – are dealt with separately, as the job tasks within each department are rather homogenous but quite different between themselves. All other supportive departments are combined together, as these have rather small numbers of workers and their job tasks are more varied within each particular section. Also, the conveyor/night-shift lines are specified for each department in which work is carried-out in over-night shifts for more than 50 hours per week on the conveyor lines. The conveyor/night-shift lines correspond with the five main departments (Table 7.1).

Table 7.1 The average hours per week for night-shift

	Grouped as Conveyor line	Grouped as Night-Shift line	Hours for night work per week
Paint	Conveyor line	Night-shift	54.8
Assembly	Conveyor line	Night-shift	54.5
Press	Conveyor line	Night-shift	51.3
Body-welding	Conveyor line	Night-shift	52.1
Engine	Conveyor line	Night-shift	55.3
Quality control	Non- Conveyor line	Night-shift	19.6
Vehicle moving	Non- Conveyor line	Night-shift	35.96
Frame	Non- Conveyor line	Non-shift	8.7
Institute	Non- Conveyor line	Non-shift	3.4
Supporting parts	Non- Conveyor line	Non-shift	Less than 10

Source : Annual report from labour union, 1996-7

(4) Job status

Workers are grouped according to three categories: shopfloor workers (including drivers and machine operators), supervisors and foremen.

(5) Income

The income variable is obtained through analysis of premiums for medical insurance. In this way, we calculate the standard monthly income.

-Insurance rate: 30/1000 (15/1000: employee contribution; 15/1000: employer contribution)
-Insurance premium = insurance rate * standard monthly income, therefore,
the standard monthly income for each person = ((premium in 1996/12)*1000) /15

Table 7.2 Categorisation of explanatory variables

Variables	Original form	Grouping
Age	Birth date	5 year-bands, Quintiles
Tenure	Employment date	5 year-bands, Quintiles
Department	200 categories	6 main parts: 1.paint, 2.assembly, 3.press, 4.body welding, 5.engine, 6. Supporting parts (Quality control, Vehicle moving, Frame, Institute, Other supporting parts such as total quality control, total management, repair, KD, product management)
Night shift and conveyer line	Conveyer line and night-shifts more than 50 hours per week	Night-shift and conveyer line : 1-5 Others : 6-10
Income	Continuous variable	Quintiles
Status	About 20 categories	3 categories : Supervisor, Foremen, Workers

(6) Workplace injuries

The workplace injuries obtained from the health centre inside the factory are categorised according to the ICD 10 classification system (Table 7.3). These include all occurrences of injury, from minor to very serious. However, some minor injuries may be underreported, a fact which might dilute the results. Therefore, items coded by ICD 10 as 'superficial injuries' are not included in the study. We focus on 'severe injuries' and 'lower-back pain' as these are the main workplace injuries and are suffered at work through different mechanisms. 'Severe injuries' are defined as injuries which exclude superficial injuries of each part of body (Table 7.3). 'Severe injuries' tend to be linked to machine operation. 'Lower-back pain' is defined as herniated intervertebral discs (HIVD) and sprain of the lumbar area. Lower-back pain tends to be a common cumulative trauma due to repetitive action and lifting (Table 7.3). Also, HIVD is considered separately as such injuries have a clear definition as a unique injury category.

Table 7.3 Categorisation of workplace injuries

Categories	Grouping	ICD10
All injury	- Including all workplace injuries	S00-T98
Severe injuries		
	- Open wound	S01, S11, S21, S31, S41, S51, S61, S71, S81, S91
	- Fracture	S02, S12, S22, S32, S42, S52, S62, S72, S82, S92, T02
	- Injury of nerves and spinal cord	G55, S04, S14, S74, S94
	- Injury of blood vessels	S26, S36, S85
	- Injury of muscle and tendons	S46, S56, S66, S76, S86, S96
	- Crushing injuries	S17, S28, S47, S57, S67, S77, S87, S97
	- Traumatic amputation	S18, S68,
	- Burns	T20, T21, T22, T23, T24, T29, T31
Lower back pain	-Lower back pain -Herniated intervertebral discs (HIVD)	S33, M51
Herniated intervertebral discs (HIVD)	- Herniated intervertebral discs (HIVD)	M51

7.4.2.5 Statistical methods

The Proportional Hazards Model (Cox regression) is used to estimate the hazard ratios for workplace injury by different possible risk factors: work department, shift and conveyer line work, income, job status, age, tenure and calendar time.

A data structure is made using STATA for multiple record data with multiple events. For multiple injuries sustained by the same person, the multiple injury occurrences are clustered around the same person to produce robust standard errors using the 'cluster ()' and 'robust' option (STATA 6). For workers having suffered injuries and having returned to the factory, it is assumed that their return was immediate. For the variables of department and income, the information was updated on 1st January, 1996 and 1st January, 1997. For job status, the information was updated on 1st September, 1996. There are few changes in age and tenure variables because of the relatively short study period, even though these are also updated each year.

Age is taken as the primary time variable (origin). Crude hazard ratios are calculated for each exposure variable using univariate Cox regression analysis to examine the association of outcome with each exposure of interest, ignoring all other variables. The rate ratios are also calculated by Poisson regression. The results from the two analyses are compared and the results are found to be similar. Firstly, age and tenure are adjusted in the model, focusing on the relationship of different work departments with workplace injuries. Then, how socio-economic factors (income and job status) affect the relationship between work departments and workplace injuries is examined. Interactions between exposure variables are also investigated. To test the proportionality of hazards, the cumulative incidence plots (estimated cumulative hazards) are graphed using the Nelson-Aalen and related methods.

7.4.3 The qualitative approach: in-depth interviews and factory walk-through surveys exploring work intensity

7.4.3.1 Objectives and research questions for the qualitative approach

The objectives of the qualitative approach are: to understand workers' opinions concerning their workplace health and safety needs; to explore the perceived causes of intensified work; and to understand the relationship between workers and employers in the work process in relation to working conditions, focusing on work intensity. Thus, we first attempt to understand how working conditions, particularly the work process, have changed and how workers feel about management policy on the work process. Workers' opinions about their health and safety needs, the intensity of their work and their concerns over work-related injuries are explored.

We also attempt to explore how workers' opinions differ from management policy in relation to the work process. In particular, we attempt to show how workers' opinions on work intensity are contrasted with the employers' policies. Finally, we try to understand the role of workers' organisations (labour union) and workers' representatives in the relationship between shopfloor and management.

7.4.3.2 Theoretical framework for the qualitative approach

The qualitative element utilises observational data, experiences and interviews to develop variables for analysis using an ethnographic approach. Through in-depth interviews, workers' opinions were collected. We also observed working processes, listened to what was being said and asked questions while undertaking a walk-through survey. Data analysis involves interpretation of meanings and functions of human actions, which mainly take the form of verbal descriptions and interpretations. In mapping out the field of work intensity and the relationship between workers and managers, a Marxist interpretation of industrial conflict is presented.

7.4.3.3 Research design for the qualitative approach

(1) Participants

Those who participated in our in-depth interviews were mainly selected from among worker representatives, shopfloor workers, labour union leaders and foremen in the main five departments. These participants were selected using purposive sampling and some random sampling.

The interviews were undertaken by the researcher who visited the labour union offices and explained the objective of the study and thereby gained permission to interview several past and present labour union leaders. Some of these are in charge of the department of health and safety in the labour union. 10 workers' representatives were selected from among 73 workers' representatives in the five main departments. Some of them had previously taken part in a labour union study on work intensity. To interview shopfloor workers, the researcher obtained permission from the supervisors and visited each team[2] and each workstation[3]. These visits were mainly to assembly lines I & II, as well as other departments, such as press, body welding and engine processing/assembly (Figure 7.5). As workers identified the intensification of the work process as their main concern, the sampling fraction is weighted towards assembly departments. The participants are randomly selected from the workers' lists stratified by age and tenure in each team. For example, the author selected the 10th worker among the older and higher tenured group, or pointed out the 10th worker among the younger and lower tenured group in the lists. A few foremen participated in the interview. The author could not interview the supervisors because of their unwillingness to be interviewed. The participants are as follows: 43 ordinary workers (about 0.9% of the total), 3 labour union leaders (about 10%), 3 foremen (about 0.6%), 10 workers' representatives (about 14%) and 11 injured workers (about 14%) (Table 7.4).

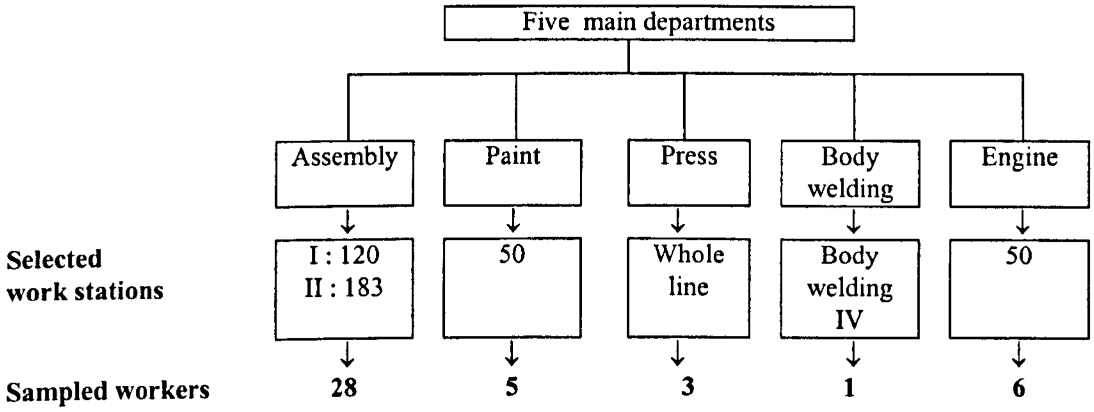
[2] Each team usually includes 20-30 workers and 3-5 foremen organised by 1-2 supervisors

[3] In each workstation, 1-2 workers do their job tasks. Therefore, each team has about 10-15 workstations

Table 7.4 Participants in the in-depth interviews

	Paint	Assembly I/II	Press	Body welding	Engine	Quality control, Vehicle moving	Total
Workforce (Numbers)							
Ordinary workers	670	2001	405	708	1080	740	5064
Supervisors and foremen	64	131	44	96	112	82	529
Participants							
Randomly selected							
Ordinary workers	5	28	3	1	6		43
Purposely selected							
Injured workers	1	6		2	1	1	11
Workers' representative	1	5	2	1		1	10
Labour Union leaders			1			2	3
Foreman		3					3
Total participants	7	42	6	4	7	4	70

Figure 7.3 Flow charts for the selection of participants (shopfloor workers for in-depth interviews)



(2) Qualitative research methods

The qualitative research methods used in this chapter are in-depth interviews and walk-through surveys to explore working conditions, especially focusing on changes in work intensity during the period between 1995 and 1997. Firstly, in-depth interviews were performed to understand workers' opinions regarding their health and safety needs in relation to workplace injuries. We then moved to more specific questions concerning the manner in which work intensity, as one of the risk factors for workplace injuries, has changed. To explore the changing pattern of work intensity, the walk-through survey was designed during the in-depth interview and was performed in parallel with the in-depth interviews.

Most interviews were carried out in quiet places: workers' restrooms inside the factory and outside the factory for shopfloor workers or in a separate room inside the labour union office for labour union leaders. Especially for injured workers and some shopfloor workers, the interviewer made an appointment and interviewed in a separate room after they had finished working. However, for some shopfloor workers, the in-depth interviews were undertaken inside the workplace, with the workers' representative taking over the interviewee's job during working time. In these cases, noise was sometimes an obstacle to the successful completion of an interview.

The interviewer started by explaining the objectives of the study to the interviewees, attempting to persuade them of the confidentiality of the survey and obtaining permission to use the tape recorder. Several workers refused to speak into the tape recorder, so the interviewer took written notes of what they said as they were speaking. Interviews took around one and a half hours for each participant, including main research questions and some subsidiary questions (see research questions in Appendix). The main research questions are given in Table 7.5.

Table 7.5 Main research questions on work intensity for in-depth interviews

Key Items	Key Questions
1.Work process	-How has the work process changed so far (since NAC, 1992)? : the method of production, technology, automation, raw materials
2 Labour using method	-How has the methods of using labour (power) changed? : working hours, work process, number of workers, work organisation, work pace, resting time
3 Technology	-How has the technology changed? : the method of production, technology, automation, raw materials
4 Work intensity	-How has work intensity changed? (How have you felt the changing physical load during the work according to time?)
5 Worker's opinion about their needs for health and safety	-What do you think is most needed for worker's health and safety in your workplace?
6 Opinion about employer	-Were there any struggles against increasing workpace?How was the relationship between workers and managers at that time?
7 Opinion about labour union	-What do you think about labour union's activity on workplace health and safety?
8 Opinion about workers' representatives	-How was the activity of workers' representatives on the issues of increasing workpace or work intensity?

No-one else was present during the interviews. A tape recorder was used and responses were also written down during the interviews. Information on workers' gestures and body language during the interview was also noted. As soon as the interviews were over, tapes were transcribed. After finishing the previous interview, new questions or some specific questions were added for later interviews.

Whilst performing in-depth interviews, the researcher also undertook in-depth observation of work processes at each station of the assembly line, in order to understand how work intensity has changed in the workplace. This was done via a walk-through survey. The author observed the work process at each workstation in assembly lines I and II, and posed several questions to those workers at each workstation. Each of these interviews took 15-20 minutes. In the walk-through survey, the researcher sought to draw out information concerning changes in work intensity since 1990. The author observed 201 workstations on assembly line I, 181 on assembly line II, and 18 on the body welding line, all workstations in the press line and 50 workstations on the painting line. The walk-through survey was done during the daytime and overnight, in order to include night-shift workers. The interviews and walk-through surveys were carried out from February to June 1999. In addition to this, some newspapers and documents from the employers and from the union were also collected. The main checklists used during the walk-through surveys are presented in Table 7.6.

Table 7.6 Main checklists for walk-through surveys

Key Items	Key Questions
1. Work pace	-Has work pace (Job per hour) been changing in your workstation? How and why?
2. Work intensity	-Has work intensity been changing since 1992 in your workstation, How and why?
3. Work amount	-Has the amount of work changed in your workstation, How and why?
4. Raw materials	-Have raw materials been changing? in your workstation, How and why? (weight of tools)
5. Work posture	-Has work posture been changing in your workstation, How and why? (Repetitiveness, posture, moving distance)

(3) Qualitative data analysis

After collecting all the interviews and observational data, the interviews were transcribed. Also, some information from official newspapers and documents were summarised to identify the key issues. All the collected data was reviewed in order to highlight key issues. After familiarisation, the data from the interviews and walk-through surveys, and facts from the written sources of data, were categorised according to research questions and issues raised by workers using a thematic framework. These categories are indexed and coded to identify similar and repeating phenomena. Our explanations for meanings and actions are developed focusing on why work intensity had increased.

7.5 Results

7.5.1 Quantitative data analysis: hazard rates of workplace injuries

This study explores how working conditions (work departments) relate to workplace injury and how workplace injury rates change over time. Secondly, it examines how socio-economic factors affect both the hazard ratio of workplace injury the relationship between work conditions and workplace injury.

7.5.1.1 Hazard rates of workplace injuries according to age and tenure

Hazard rates according to age are calculated using tenure as the primary time variable (origin), whereas age is used as the primary time variable for the other analyses. Crude injury rates show that younger workers suffer more severe injuries and lower-back pain than older workers. However, after adjusting for tenure, no difference of hazard rates among the different age groups is noted. Trend tests are also non-significant after adjusting for tenure. After adjusting for tenure, income, status and work department, there is little change in the relationship between different age groups and hazard rates for severe injuries and lower-back pain. For HIVD, the older age group seems to have a slightly higher injury rate than younger workers (Tables 7.7, 7.8 and 7.9).

The workers in the shortest tenure group have higher crude rates for severe injuries, lower-back pain and HIVD. After adjusting for age, the shortest tenure group continue to show higher hazard rates for these injuries. Trend tests are significant for lower-back pain and HIVD. After adjusting for tenure, income and status, this relationship reduces for severe injuries, disappears for lower-back pain and reverses for HIVD. However, it changes little after adjusting for work department (Tables 7.7, 7.8 and 7.9).

7.5.1.2 Hazard rates of workplace injuries according to working conditions

(1) Hazard rates of workplace injuries according to department

The age adjusted injury rates among different departments show that the press and engine departments have higher rates for severe injuries; press, engine and assembly for lower-back pain; assembly and others for HIVD. The paint department has relatively lower rates of severe injuries as well as of lower-back pain (Figures 7.4, 7.5 and 7.6). Press, body, and engine departments have higher hazard rates of severe injuries than other departments (Table 7.7). For lower-back pain, the press and other supportive departments have higher hazard rates than other departments (Table 7.8). In particular, the assembly line, engine and other supportive departments have higher hazard rates for HIVD, with wider 95% confidence interval, compared to other departments (Table 7.9). After adjusting for tenure, status, income, the relationship between department and hazard ratio of department do not significantly alter.

(2) Hazard rates of workplace injuries according to conveyer line and night-shift work

For severe injuries, the workers in departments using conveyer-line and night-shift have higher hazard rates on average than others (Table 7.7). However, it is noticeable that wide variations exist between conveyor and night-shift departments. After adjusting for income, status and tenure, the relationship between conveyer line and night-shift work and severe injuries changes little. The hazard rates on average for lower-back pain seem generally lower among conveyer line and night-shift workers than among others, even though several departments, such as press, engine and assembly, have higher hazard ratios of lower-back pain than other departments (Tables 7.8 and 7.9).

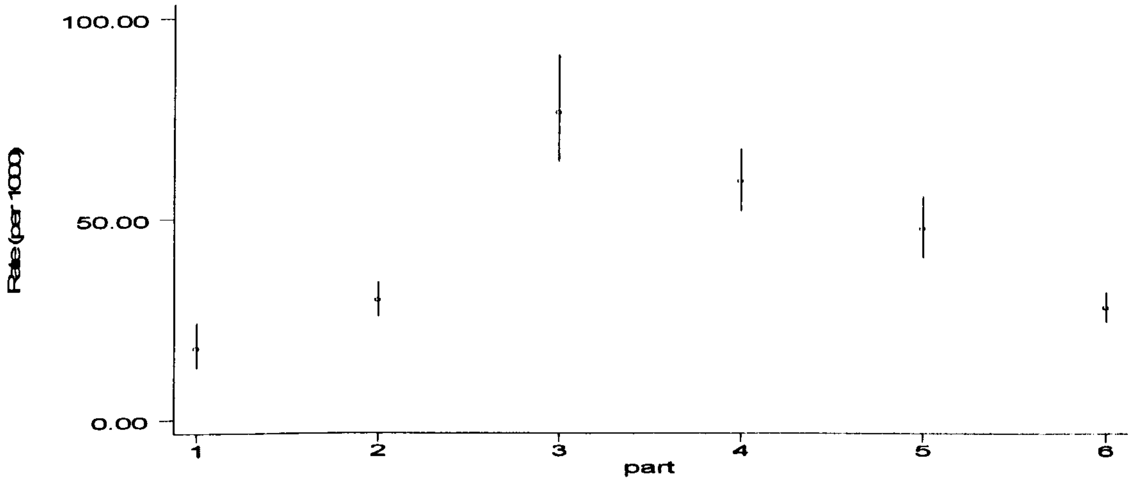


Figure 7.4 The age* adjusted rates of severe injuries according to 6 different departments

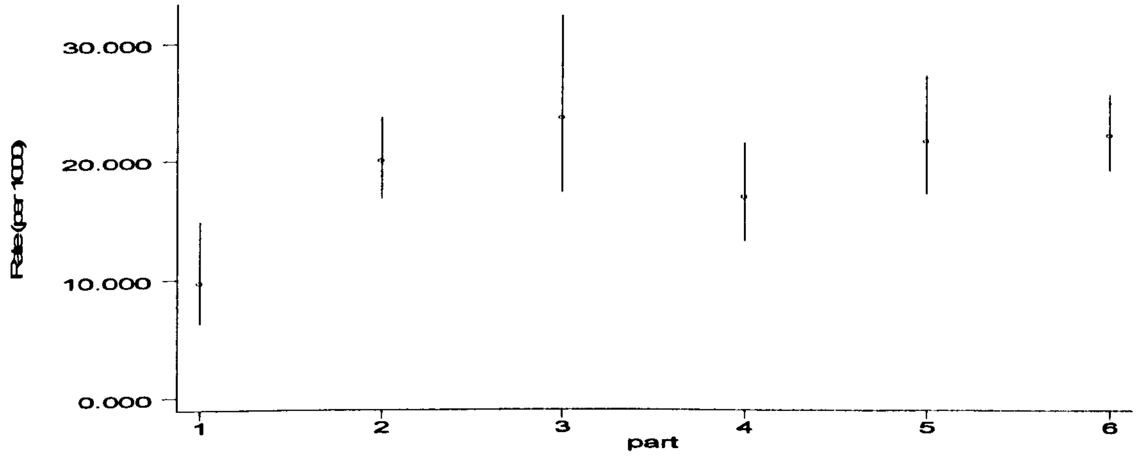


Figure 7.5 The age* adjusted rates of low back pain according to 6 different departments

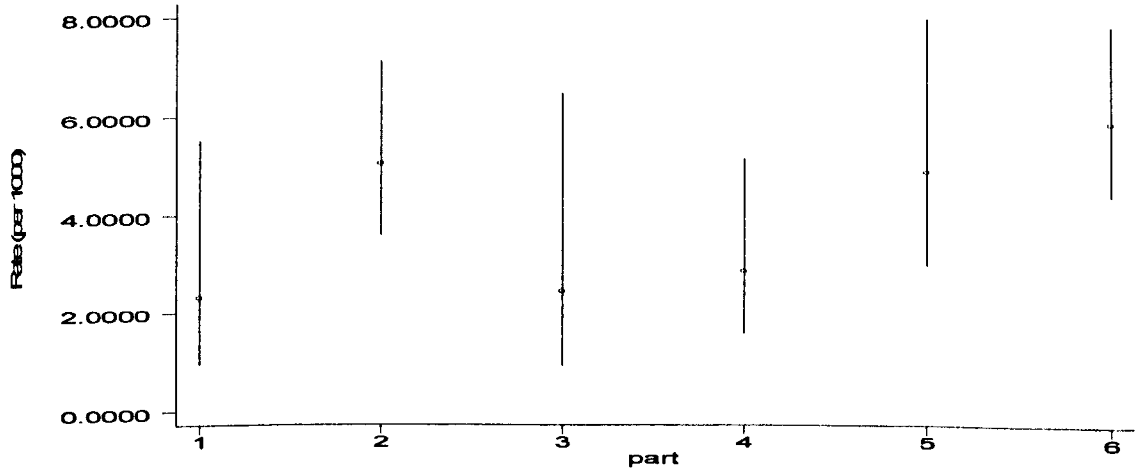


Figure 7.6 The age* adjusted rates of HIVD according to 6 different departments

*age adjusted Hazard Ratio and 95% CI : Age was set up as origin in the Cox regression.
** 6 Departments 1 : Paint, 2 : Assembly, 3 : Press, 4 : Body welding, 5 : Engine processing & assembly
6 : Others (Conveyor line and night-shift departments : 1-5)

7.5.1.3 Hazard rates of workplace injuries according to socio-economic factors: income and job status

(1) Hazard rates of workplace injuries according to income

There is an inverse relationship between income and hazard rates for severe injuries, lower-back pain and HIVD (Tables 7.7, 7.8 and 7.9). The inverse relationship of income for lower-back pain and HIVD is much higher than severe injuries. After adjusting for tenure and department, this relationship is little changed for severe injuries, lower-back pain and HIVD. On the other hand, this relationship is slightly reduced but still remains after adjusting for job status with respect to severe injuries, lower-back pain and HIVD. What is more, the lowest income group still have higher hazard rates after adjusting for tenure, job status and work departments with respect to severe injuries, lower-back pain and HIVD (Table 7.8 and 7.9).

(2) Hazard rates of workplace injuries according to job status

The hazard rate for severe injury among ordinary workers is higher than that for foremen or supervisors (Table 7.7). After adjusting for tenure and department, this relationship is more or less unaltered. However, after adjusting for income, hazard rates for severe injuries among ordinary workers lessen, although still remain. For lower-back pain and HIVD, the pattern is similar to that for severe injuries, but stronger (Table 7.8 and 7.9).

Table 7.7 Hazard rates of severe injuries according to department, income and job status

	Person years	Injuries	Crude rates	HRs adjusted age and tenure		HRs adjusted age and tenure and other factors*		HRs adjusted age, tenure, and other factors**		HRs adjusted age, tenure, and all variables ***	
Age				HR	CI	HR	CI	HR	CI	HR	CI
<37.05	5.1398	127	24.71	1.00		1.00		1.00		1.00	
33.65-37.05	5.2210	201	38.50	1.12	0.84-1.48	1.27	0.94-1.72	1.11	0.84-1.47	1.24	0.93-1.68
31.33-33.64	5.0679	183	36.11	0.98	0.73-1.32	1.10	0.80-1.51	1.01	0.75-1.36	1.10	0.81-1.51
28.12-31.32	5.3184	188	35.35	0.89	0.66-1.21	0.95	0.69-1.30	0.91	0.67-1.23	0.94	0.69-1.29
<28.11	4.8142	269	55.88	1.05	0.72-1.55	1.14	0.75-1.72	1.08	0.73-1.59	1.14	0.75-1.72
Total											
Trend1)				0.96	0.89-1.04	0.97	0.89-1.04	0.97	0.90-1.05	0.97	0.89-1.04
Tenure											
>9.59	5.8789	149	25.34	1.00		1.00		1.00		1.00	
7.86-9.58	6.1200	245	40.03	1.25	0.93-1.69	0.99	0.72-1.36	1.21	0.90-1.63	0.94	0.68-1.30
5.16-7.85	6.2040	207	33.37	1.03	0.76-1.40	0.76	0.54-1.06	1.01	0.74-1.37	0.73	0.52-1.02
1-5.16	4.7903	185	38.62	1.16	0.83-1.64	0.83	0.57-1.22	1.18	0.84-1.66	0.82	0.56-1.21
0-1	2.5681	182	70.87	1.78	1.18-2.67	1.17	0.75-1.84	1.62	1.08-2.42	1.05	0.67-1.64
Total											
Trend1)				1.07	0.98-1.17	0.98	0.88-1.08	1.06	0.97-1.16	0.96	0.87-1.07
Department											
Paint	2.1690	38	17.52	1.00		1.00		1.00		1.00	
Assembly	6.5350	194	29.69	1.51	1.06-2.14	1.45	1.02-2.06	1.54	1.08-2.18	1.49	1.05-2.12
Press	1.6539	126	76.18	3.85	2.66-5.59	3.72	2.56-5.41	3.78	2.60-5.49	3.68	2.53-5.36
Body welding	3.8664	228	58.97	3.09	2.19-4.36	2.97	2.10-4.18	3.14	2.23-4.42	3.00	2.13-4.24
Engine	3.2887	156	47.44	2.34	1.64-3.35	2.37	1.66-3.38	2.39	1.67-3.42	2.31	1.62-3.30
Others	8.0484	226	28.08	1.60	1.13-2.26	1.49	1.05-2.11	1.67	1.19-2.36	1.54	1.09-2.18
Total											
Test for hetero				135.8	P<0.00	135.3	P<0.00	129.3	P<0.00	127.9	P<0.00
Conveyer line & Shift											
No	8.0484	226	28.08	1.00		1.00		1.00		1.00	
Line & shift	17.513	742	42.37	1.37	1.17-1.60	1.44	1.23-1.69	1.32	1.13-1.55	1.40	1.20-1.64
Total											
Income											
1	6.4988	187	28.77	1.00		1.00		1.00		1.00	
2	6.2247	228	36.63	1.08	0.85-1.36	0.87	0.69-1.09	1.11	0.87-1.41	0.90	0.71-1.13
3	6.0498	228	37.69	1.06	0.82-1.36	0.83	0.64-1.07	1.13	0.87-1.46	0.89	0.69-1.15
4	3.2304	159	49.22	1.16	0.85-1.58	0.93	0.68-1.27	1.22	0.89-1.67	0.98	0.71-1.34
5	2.1000	136	64.76	1.56	1.15-2.10	1.33	0.98-1.80	1.70	1.25-2.32	1.45	1.07-1.98
Total											
Trend1)				1.11	1.03-1.19	1.08	1.00-1.17	1.13	1.05-1.22	1.10	1.02-1.19
Status											
Supervisor	2.9361	31	10.56	1.00		1.00		1.00		1.00	
Foremen	3.5035	87	24.83	2.20	1.41-3.44	2.01	1.26-3.19	2.29	1.47-3.57	2.19	1.36-3.53
Workers	18.8211	850	45.16	3.95	2.67-5.85	3.61	2.38-5.46	3.94	2.66-5.84	3.78	2.45-5.84
Total											
Trend1)				1.91	1.63-2.24	1.86	1.56-2.21	1.88	1.60-2.21	1.81	1.53-2.16

Origine: for age group, tenure was employed as origin in Cox model and age was origined for other variables

* : For age group, tenure, income, and job status were adjusted
For tenure group, age,income, and job status were adjusted
For department, age, tenure and income were adjusted.
For income, age, tenure and job status were adjusted
For job status, age, tenure and income were adjusted

** : For age group, tenure and work department were adjusted
For tenure group, age and work department were adjusted
For department, age, tenure and job status were adjusted
For income, age, tenure, and department were adjusted
For job status, age, tenure, and department were adjusted

*** Adjust all the variables : age, tenure, income, job status, and work department

Trend1): average hazard ratio associated with one group difference
Test for heterogeneity: log likelihood test for heterogeneity of department variable
Income group- 1: >1485833, 2: 1332500-1485832, 3: 1163333-1332499, 4: 1049167-1163332, 5: <1049166 won

Table 7.8 Hazard rates of low back pain according to different department, income and job status

	Person years	Inju ries	Crude rates	HRs adjusted age and tenure		HRs adjusted age and tenure and other variables*		HRs adjusted age, tenure, and other variables**		HRs adjusted age tenure, and all variables ***	
Age				HR	CI	HR	CI	HR	CI	HR	CI
<37.05	5.1398	66	12.84	1.00		1.00		1.00		1.00	
33.65-37.05	5.2210	101	19.34	1.08	0.72-1.64	1.04	0.66-1.64	1.09	0.73-1.64	1.03	0.65-1.62
31.33-33.64	5.0679	110	21.71	1.12	0.74-1.70	1.03	0.65-1.63	1.13	0.74-1.70	1.02	0.65-1.61
28.12-31.32	5.3184	114	21.43	1.04	0.68-1.58	0.91	0.57-1.44	1.05	0.69-1.60	0.89	0.56-1.42
<28.11	4.8142	113	23.47	1.00	0.54-1.85	0.68	0.35-1.31	1.02	0.55-1.88	0.66	0.34-1.29
Total											
Trend[1]				1.00	0.89-1.12	0.93	0.82-1.06	1.00	0.88-1.13	0.93	0.82-1.05
Tenure											
>9.59	5.8789	70	11.91	1.00		1.00		1.00		1.00	
7.86-9.58	6.1200	128	20.92	1.73	1.11-2.71	1.07	0.67-1.70	1.76	1.13-2.75	1.06	0.66-1.69
5.16-7.85	6.2040	127	20.47	1.69	1.06-2.68	0.99	0.61-1.61	1.74	1.10-2.75	0.98	0.61-1.59
1-5.16	4.7903	112	23.38	2.25	1.36-3.72	1.09	0.63-1.90	2.38	1.44-3.93	1.11	0.64-1.93
0-1	2.5681	67	26.09	2.73	1.49-4.97	1.09	0.58-2.04	2.69	1.47-4.90	1.01	0.54-1.90
Total											
Trend[1]				1.22	1.08-1.38	1.01	0.88-1.16	1.23	1.09-1.39	1.00	0.88-1.15
Department											
Paint	2.1690	21	9.68	1.00		1.00		1.00		1.00	
Assembly	6.5350	130	19.89	1.87	1.14-3.04	1.87	1.12-3.11	1.92	1.18-3.12	1.90	1.14-3.16
Press	1.6539	39	23.58	2.33	1.33-4.09	2.15	1.19-3.87	2.29	1.31-4.02	2.12	1.18-3.82
Body welding	3.8664	65	16.81	1.64	0.98-2.74	1.57	0.92-2.67	1.67	1.00-2.78	1.58	0.93-2.68
Engine	3.2887	71	21.59	2.15	1.27-3.62	2.52	1.47-4.32	2.20	1.30-3.70	2.54	1.48-4.34
Others	8.0484	178	22.12	2.35	1.46-3.76	1.96	1.19-3.22	2.47	1.54-3.95	2.02	1.23-3.32
Total											
Test for hetero				21.3	P=0.00	17.3	P=0.00	23.6	P=0.00	17.8	P=0.00
Conveyer line & Shift											
No	8.0484	178	22.12	1.00		1.00		1.00		1.00	
Line & Shift	17.513	326	18.61	0.77	0.63-0.94	0.93	0.76-1.15	0.74	0.61-0.91	0.91	0.74-1.12
Total											
Income											
1	6.4988	59	9.08	1.00		1.00		1.00		1.00	
2	6.2247	93	14.94	1.62	1.04-2.53	1.32	0.85-2.04	1.66	1.08-2.56	1.36	0.88-2.08
3	6.0498	116	19.17	2.32	1.47-3.66	1.86	1.18-2.95	2.35	1.50-3.68	1.90	1.21-2.98
4	3.2304	76	23.53	3.67	2.21-6.09	3.06	1.83-5.10	3.72	2.24-6.17	3.08	1.86-5.13
5	2.1000	130	61.90	8.48	5.46-13.16	7.69	4.92-12.04	8.70	5.64-13.42	7.77	5.00-12.05
Total											
Trend[1]				1.72	1.57-1.88	1.74	1.58-1.91	1.72	1.57-1.88	1.73	1.58-1.91
Status											
Supervisor	2.9361	13	4.43	1.00		1.00		1.00		1.00	
Foremen	3.5035	43	12.27	2.44	1.20-4.95	2.99	1.36-6.57	2.56	1.26-5.21	2.88	1.30-6.37
Workers	18.8211	448	23.80	4.65	2.43-8.92	4.38	2.09-9.14	4.80	2.51-9.19	4.12	1.96-8.65
Total											
Trend[1]				2.05	1.59-2.63	1.79	1.37-2.35	2.07	1.61-2.65	1.79	1.37-2.34

Origine: for age group, tenure was originated in Cox model and age was originated for other variables

* : For age group, tenure, income, and job status were adjusted
For tenure group, age,income, and job status were adjusted
For department, age, tenure and income were adjusted.
For income, age, tenure and job status were adjusted
For job status, age, tenure and income were adjusted

** : For age group, tenure and work department were adjusted
For tenure group, age and work department were adjusted
For department, age, tenure and job status were adjusted
For income, age, tenure, and department were adjusted
For job status, age, tenure, and department were adjusted

*** Adjust all the variables : age, tenure, income, job status, and work department

Trend[1]: average hazard ratio associated with one group difference
Test for heterogeneity: log likelihood test for heterogeneity of department variable
Income group- 1: >1485833, 2: 1332500-1485832, 3: 1163333-1332499, 4: 1049167-1163332, 5: <1049166 wo

Table 7.9 Hazard rates of HIVD injuries according to different department, income and job status

	Person years	Injuries	Crude rates	HRs adjusted age and tenure		HRs adjusted age and tenure and other variables*		HRs adjusted age, tenure, and other variables**		HRs adjusted age tenure, and all variables ***	
Age				HR	CI	HR	CI	HR	CI	HR	CI
<37.05	5.1398	17	3.30	1.00		1.00		1.00		1.00	
33.65-37.05	5.2210	27	5.17	1.05	0.52-2.13	0.92	0.41-2.04	1.06	0.53-2.14	0.92	0.42-2.03
31.33-33.64	5.0679	27	5.33	1.05	0.52-2.12	0.82	0.38-1.78	1.03	0.51-2.09	0.81	0.37-1.75
28.12-31.32	5.3184	23	4.33	0.82	0.39-1.73	0.62	0.27-1.44	0.82	0.39-1.73	0.62	0.26-1.45
<28.11	4.8142	22	4.57	0.72	0.23-2.22	0.39	0.11-1.36	0.72	0.24-2.17	0.38	0.11-1.34
Trend1)				0.92	0.75-1.13	0.82	0.65-1.03	0.92	0.75-1.13	0.82	0.65-1.03
Tenure											
>9.59	5.8789	15	2.55	1.00		1.00		1.00		1.00	
7.86-9.58	6.1200	33	5.39	2.93	1.30-6.57	1.50	0.68-3.32	3.05	1.37-6.81	1.49	0.67-3.30
5.16-7.85	6.2040	31	5.00	3.04	1.35-6.86	1.59	0.69-3.64	3.15	1.41-7.04	1.52	0.67-3.47
1-5.16	4.7903	26	5.43	4.15	1.75-9.84	1.79	0.72-4.43	4.38	1.85-10.41	1.74	0.70-4.31
0-1	2.5681	11	4.28	3.57	1.00-12.77	1.16	0.36-3.75	3.63	1.02-12.96	1.07	0.32-2.53
Trend1)				1.35	1.10-1.66	1.08	0.87-1.33	1.36	1.11-1.67	1.06	0.85-1.31
Depart											
Paint	2.1690	5	2.31	1.00		1.00		1.00		1.00	
Assembly	6.5350	33	5.05	2.12	0.82-5.49	1.77	0.68-4.62	2.18	0.84-5.66	1.78	0.68-4.65
Press	1.6539	4	2.42	1.03	0.27-3.83	0.81	0.22-3.04	1.01	0.27-3.77	0.83	0.22-3.08
B Welding	3.8664	11	2.85	1.20	0.40-3.57	0.89	0.28-2.79	1.23	0.41-3.65	0.88	0.28-2.77
Engine	3.2887	16	4.87	2.21	0.79-6.19	2.39	0.86-6.63	2.28	0.82-6.39	2.40	0.86-6.67
Others	8.0484	47	5.84	2.62	1.05-6.58	1.59	0.63-4.01	2.78	1.11-6.97	1.67	0.66-4.21
Test for heter				12.1	P<0.03	9.6	P<0.09	13.5	P<0.02	9.9	P<0.08
Conveyer & Shift											
No	8.0484	47	5.84	1.00		1.00		1.00		1.00	
Line & Shift	17.513	69	3.94	0.64	0.43-0.95	0.92	0.61-1.38	0.61	0.41-0.91	0.88	0.59-1.32
Income											
1	6.4988	4	0.62	1.00		1.00		1.00		1.00	
2	6.2247	16	2.57	5.89	1.76-19.79	4.91	1.46-16.43	6.07	1.82-20.19	4.98	1.50-16.49
3	6.0498	22	3.64	10.80	3.24-36.05	9.36	2.75-31.85	10.96	3.32-36.23	9.33	2.77-31.41
4	3.2304	17	5.26	24.20	7.36-79.65	22.29	6.61-75.23	24.23	7.42-79.15	21.89	6.54-73.30
5	2.1000	50	23.80	86.10	27.75-267.05	84.66	26.89-266.54	85.87	28.21-261.39	83.26	26.92-257.46
Trend1)				2.70	2.30-3.16	2.81	2.38-3.31	2.68	2.29-3.14	2.79	2.36-3.28
Status											
Supervisor	2.9361	2	0.68	1.00		1.00		1.00		1.00	
Foremen	3.5035	12	3.43	4.47	0.97-20.48	4.63	1.00-21.34	4.83	1.06-21.97	4.97	1.06-23.24
Workers	18.8211	102	5.42	7.46	1.74-31.95	3.99	0.92-17.38	8.05	1.90-34.14	4.35	0.99-19.11
Trend1)				2.14	1.36-3.36	1.39	0.89-2.17	2.19	1.40-3.41	1.42	0.91-2.22

Origine: for age group, tenure was originated in Cox model and age was originated for other variables

* : For age group, tenure, income, and job status were adjusted
For tenure group, age,income, and job status were adjusted
For department, age, tenure and income were adjusted.
For income, age, tenure and job status were adjusted
For job status, age, tenure and income were adjusted

** : For age group, tenure and work department were adjusted
For tenure group, age and work department were adjusted
For department, age, tenure and job status were adjusted
For income, age, tenure, and department were adjusted
For job status, age, tenure, and department were adjusted

*** Adjust all the variables : age, tenure, income, job status, and work department

Trend1): average hazard ratio associated with one group difference

Test for heterogeneity: log likelihood test for heterogeneity of department variable

Income group- 1: >1485833, 2: 1332500-1485832, 3: 1163333-1332499, 4: 1049167-1163332, 5: <1049166 won

Age group: 1:>37.5, 2:33.65-37.05,3:31.33-33.64, 4: 28.12-31.32, 5: <28.11

7.5.1.4 Hazard rates of workplace injuries according to calendar year

The effect of the calendar year appears to be different for different disease categories. For severe injuries, there is a decreasing tendency in hazard rate according to calendar year (Table 7.10). Also, while adjusting for tenure, income, status, department, and taking all of these variables together, there is no significant change and the relationship of different calendar years with severe injuries remains (Table 7.10). On the other hand, hazard rates for lower-back pain show a greater increase in 1996 and 1997 than in 1995. No significant change in hazard ratios after adjusting for tenure, income, status, and department is noted. In particular, the hazard ratios of HIVD show a strongly increasing tendency according to calendar year (Table 7.10).

Table 7.10 Hazard rates of total injury according to department, income and status group

	Person -years	Injuries	Crude rates	Hazard Ratios with adjustment of, age		Hazard Ratios with adjustment of age, tenure		Hazard Ratios with adjustment of age, tenure, and inc, and status		Hazard Ratios with adjustment of age, tenure and department	
				HR	CI	HR	CI	HR	CI	HR	CI
Sev.Inj											
95	8.4564	375	44.35	1.00		1.00		1.00		1.00	
96	7.9051	308	38.96	0.90	0.77-1.05	0.86	0.74-1.00	0.85	0.73-1.00	0.85	0.73-1.00
97	9.1999	285	30.98	0.74	0.63-0.87	0.69	0.59-0.81	0.70	0.59-0.83	0.69	0.59-0.82
Total Trend1)				0.86	0.80-0.93	0.83	0.77-0.90	0.84	0.77-0.91	0.84	0.77-0.90
LBP											
95	8.4564	144	17.03	1.00		1.00		1.00		1.00	
96	7.9051	177	22.39	1.33	1.05-1.69	1.28	1.01-1.63	1.32	1.03-1.70	1.28	1.01-1.63
97	9.1999	183	19.89	1.22	0.96-1.57	1.13	0.88-1.46	1.37	1.06-1.78	1.14	0.89-1.46
Total Trend1)				1.10	0.98-1.23	1.06	0.94-1.19	1.16	1.03-1.32	1.06	0.94-1.19
HIVD											
95	8.4564	13	1.54	1.00		1.00		1.00		1.00	
96	7.9051	46	5.82	3.76	2.02-7.00	3.71	2.02-6.83	4.27	2.15-8.48	3.74	2.03-6.87
97	9.1999	57	6.20	4.09	2.22-7.51	3.92	2.15-7.14	5.74	2.92-11.31	3.91	2.15-7.13
Total Trend1)				1.73	1.39-2.16	1.69	1.36-2.11	2.02	1.59-2.57	1.68	1.35-2.10

Origine : for age group, tenure was originated in Cox model and age was originated for other variables
Trend1) : average hazard ratio associated with one year difference

The interaction between department and calendar year is significant for severe injuries (X2: 26.30 (p=0.0034)), but other injuries exhibit no significant interaction with calendar year. Nevertheless, a stratification table is produced to explore which department has an increasing tendency compared to other departments. For severe injuries, engine and paint departments seem to have increasing tendencies according to calendar year, but this is not statistically significant (Table 7.11). For lower-back pain, the assembly line shows the strongest increase according to calendar year (Table 7.11). For HIVD, the assembly line and other departments show an increasing tendency according to the calendar year (Table 7.11)

Table 7.11 Hazard rates of workplace injuries according to age, tenure, department, income and status group

	Serious injury			LBP			HIVD		
Paint	Injuries	HRs*	CI	Injuries	HRs*	CI	Injuries	HRs*	CI
95	12	1.00	1.00	9	1.00	1.00	1	1.00	1.00
96	13	1.29	0.58-2.86	7	0.99	0.38-2.54	2	3.35	0.39-28.57
97	13	1.13	0.51-2.50	5	0.50	0.14-1.84	2	2.12	0.22-20.85
Total Trends1)		0.98	0.67-1.43		0.72	0.43-1.19		1.25	0.44-3.57
Assembly									
95	91	1.00	1.00	30	1.00	1.00	5	1.00	1.00
96	42	0.51	0.35-0.75	42	1.51	0.96-2.40	11	2.36	0.82-6.83
97	61	0.62	0.44-0.88	58	1.76	1.10-2.84	17	3.17	1.14-8.83
Total Trends1)		0.77	0.65-0.91		1.31	1.07-1.61		1.63	1.08-2.45
Press									
95	45	1.00	1.00	14	1.00	1.00	0		
96	50	1.14	0.75-1.74	10	0.68	0.30-1.56	1	1.00	1.00
97	31	0.58	0.36-0.96	15	0.88	0.40-1.94	3	2.42	0.26-22.36
Total Trends1)		0.79	0.64-0.98		0.97	0.66-1.42		2.42	0.26-22.36
Body welding									
95	106	1.00	1.00	23	1.00	1.00	3	1.00	1.00
96	72	0.71	0.53-0.96	21	1.05	0.53-2.06	4	1.47	0.30-7.27
97	50	0.50	0.35-0.70	21	1.06	0.51-2.20	4	1.45	0.30-7.02
Total Trends1)		0.71	0.60-0.83		0.97	0.72-1.30		1.16	0.57-2.38
Engine									
95	44	1.00	1.00	16	1.00	1.00	0		
96	54	1.23	0.81-1.86	35	2.27	1.21-4.30	8	1.00	1.00
97	58	1.09	0.71-1.65	20	1.07	0.56-2.06	8	0.65	0.27-1.59
Total Trends1)		1.06	0.87-1.28		1.01	0.76-1.33		0.65	0.27-1.59
Others									
95	77	1.00	1.00	52	1.00	1.00	4	1.00	1.00
96	77	1.06	0.77-1.46	62	1.33	0.88-2.01	20	5.95	2.06-17.24
97	72	0.82	0.58-1.16	64	1.18	0.78-1.80	23	5.99	2.04-17.64
Total Trends1)		0.93	0.79-1.08		1.05	0.88-1.26		1.71	1.21-2.41

Origin : Age was originated for variable of calendar year
Trend1) : Average hazard ratio associated with one year difference
1.0a : Reference category
HR* : Age adjusted HR

7.5.1.5 The relationship between effects of working conditions and socio-economic factors

Socio-economic factors have little effect on hazard ratios of severe injuries across different work departments. While adjusting for socio-economic factors (income and job status), the hazard rate for severe injuries in different work departments are slightly reduced, but remain. For lower-back pain and HIVD, similar patterns are found. On the other hand, adjusting for work department, the hazard ratios among different income groups decrease slightly, but remain. There are no interactions between work condition factors and socio-economic factors, in their association with severe injuries and lower-back pain. Thus, socio-economic factors and work department seem to contribute independently to workplace injuries.

7.5.1.6 Other interactions

All interactions between exposures, especially work department and other risk factors, are investigated. However, no significant interaction is noted, except for that between work department and calendar year, for severe injuries (Section 7.4.3)

7.5.1.7 Model checking

Hazard proportionality in each variable with residuals and Nelson-Aalen cumulative hazard estimates graph is investigated. The graph of cumulative hazards of severe injuries and lower-back pain shows that the hazards are reasonably proportional across work department, conveyer/night shift, income and job status.

7.5.2 Results of the qualitative research: working conditions and work intensity in one car factory

7.5.2.1 Working conditions by department and workers' opinions concerning their health and safety needs

Workers' assessments of the working conditions and their health and safety needs are explored (Table 7.12). The workers' subjective perceptions of what constitute the principle working hazards differ slightly different across departments. For example, for assembly line workers, the main problems are said to be: heavy lifting accessories for assembly (such as axles, engines, bumpers, seats and batteries), the repetitiveness of conveyor line work, night-shifts, speed-ups, work intensity and petrol/diesel fumes. In particular, assembly workers mainly complain that it is too physically demanding to lift heavy materials, to bend their backs through more than 90 degrees when entering cars to assemble accessories.

In the walk-through surveys, workers pointed out the most vulnerable work stations. Big engine or axles, etc., cannot be fixed without several workers' making an effort to pull, push, fix and move the engine into the car frame. Some workers have to lift heavy bumpers, seats and batteries by hand from the floor to the car frame. In particular, the increasing pace of work makes them vulnerable. This is particularly the case when, even though the production process is speeded-up, it is assumed that only two workers are needed to lift bumpers on each side of the car, the same number previously employed at a slower tempo. Workers have some clear suggestions about how the work process could be improved. For example, one worker notes that if the conveyor line were elevated, workers would not suffer from lower-back pain due to bending.

Press lines are the worst places to work, according to press line workers. In this department, concerns were voiced regarding fear of car frames falling from hoists, the risk of injury by press machine, sliding, physical loads, noise and work intensity. On the manual press line (a non-automated line), the workers stand by the side of each press machine and move each pressed steel sheet from one press machine to another. 300 steel sheets can be pressed per hour on this line. With the introduction of automatic machines, the number of steel sheets to be fed or collected by workers at the beginning and end of each line increases to 350 per hour. Several press workers also say that the floor of the press line is very slippery because of machine oil and workers tend to slip between the machines. Workers also use a narrow set of stairs between the press machines to carry over steel sheets from one machine to another. The workers' representative on the press line said that workers are apt to slip on the stairs. Also, the photo sensor in each press line, preventing the machine falling down, does not operate when the press line is overwhelmed by raw steel sheets to be pressed. In moving these sheets manually, workers often sustain severe injuries, along with severe musculo-skeletal disorders.

In the body welding department, the motor carrier (moving vehicle) and noise are cited as problems. Several workers suffer from extreme exhaustion after work and cite the repetitiveness of the work as the most physically demanding factor. In the paint department, the workers' main concern is about organic solvents, job posture and lack of ventilation. For the engine assembly workers, their expressed needs are to reduce the amount of all-night working.

In summary, the workers' health and safety needs differ depending on which departments they work in. The workers in the press and welding departments worry about the hazardous conditions created by sheer scale of the machines. In the assembly line, most workers worry about the effects of such physically demanding work, especially when the work is constantly being intensified. The most pressing concern expressed in the in-depth interviews in most of the departments is increasing work intensity and reductions in the number of workers. Work intensity was widely mentioned, particularly in the assembly line group, but the numbers of interviewees from other departments was rather small.

Table 7.12 Workers' opinions concerning their health and safety needs according to department

Department	Workers' needs for health and safety
Press	**Work intensity(2), Photo sensor(2), Falling down the car frame(2), Noise(2),** Safety machine, Sliding floor
Body welding	**Work intensity(2),** Repetitiveness, Tiredness due to conveyer line
Engine	**Night work(2),** Dust, Organic solvents
Paint	**Organic solvents(3),** Job posture (Bending)
Assembly I,II	**Work intensity(Intensified work due to speed up, Reducing of the number of workers, increased job tasks)(7), Highly physically demanding job when assembling engine and axle(7), Repetitive work(5), Night shift(5), Organic solvents(4), Job posture (Bending) (2), Hume or dust(2),** Heavy material and tools, Falling machines, Gas, Noise

-Bold one were the most prominent workers' opinions about their needs for their health and safety, which got from more than two workers. -( ): The number of workers.

7.5.2.2 Work intensity according to calendar year since 1992

(1) Workers' opinions concerning the detailed mechanisms of increasing work intensity[4]

In order to understand the ways in which work intensity increases, several mechanisms are categorised and summarised according to workers' opinions given in the in-depth interviews and walk-through survey.

(a) Use of labour power in the labour process

① Regular measuring of man-per-hour for speed up

Several workers' representatives note that regular measuring of standard working time by managers is the fundamental mechanism of speed-up and intensified work in the car factory. One workers' representative explains that the measurement of 'standard working time' in the factory is carried-out as follow: the working time is measured 10 times for 10 workers repetitively, 100 times per each workstation. The 'standard working time' is then calculated from the mean of these 100 time measured working times. These 'standard working times' for all workstations are summed up, and divided by the total number of workstations. This is the workload per worker. Therefore, if a new measure of working time is shorter than the previous one, managers speed-up the conveyer line or reduce the number of workers by removing the workstations with lower workloads, cutting workers at that work station and redistributing the work. After the economic crisis in 1998, two things changed. New measurements were introduced, the so-called 'Ready Work Factor'[5] method replaced the stopwatch method in 1999. With new methods, the 'standard working time' becomes tighter than before. Also, after the economic crisis, as white-collar technicians measure the standard working time directly on the shopfloor for each job, the measured time allocation has been reduced. Before, when supervisors had this responsibility, they allowed slightly longer rest break times.

[4] 'Increasing work intensity' is understood as increased density of work for unit time resulting in increased physical load on workers

[5] 'Ready work factor' methods mean that working time is measured according to the motion of each part of the body and weighted in terms of difficulty of motion

According to the workers themselves, the 'standard working time' has shortened as, firstly, when somebody is watching you doing your job, you are apt to work faster. Therefore, the more working time is measured, the faster the newly measured working time becomes. Secondly, the workers' working time at each station is lessened as the workers become accustomed to the work process. Therefore, workers feel that the employers have deliberately used the workers' skills[6] in order to achieve this increased work pace. In this way, employers are steadily reducing the number of workers at each station and increasing work pace. Several workers in the assembly line say as follows:

> When managers increase work pace or reduce the number of workers, their idea of what they are doing is completely different to that of the workers. We could have a rest break because we are more skilful. We like to sit down for a while; therefore we usually work faster on difficult or hard jobs. The factory sees that we rest a little bit, and says that working time is spent idling. But we cannot work by running all day. However, the factory seems to think this rest time is unnecessary. My neighbour helps my work when I have a rest, and I also help him when he takes a rest. But the factory says that working time is spent idling. This is different from what we think!
> (Ordinary worker in the assembly Line I, id27)

> The company attempt to take away our skill. If we finish work in 30 seconds, which used to be finished in 60 seconds, we should take the 30 seconds for ourselves, however as the company takes the 30 seconds, the work intensity doubles.
> (Assembly Line I worker)

The workers' representatives explain why real work time had increased when managers measure it as follows:

> As they measure repeatedly, workers feel uncomfortable if somebody observes their work; therefore they just do it quickly. Also, they want to have a rest after finishing it (the work) quickly, therefore they work quickly. Therefore, the real working time is reduced. Then, managers measure this reduced working time repetitively. Before, it took 50 seconds, now workers have the skill, but they ignore it, and measure the time with just a 'STOP WATCH', and they measure 40 seconds now. Then, managers say that 'before you worked for 50 seconds, now you work for 40 seconds, therefore aren't you idle for 10 seconds?' (32 years old, workers' representative in the assembly line, id60)

[6] In fact, 'skill' means physical dexterity and performing at line speed, as Rinehart et al (1997) mention.

② Increasing work pace without recruiting or by reducing the work force

On the conveyer lines, speed-up was the main strategy for this 'NEW' management in 1992. Since 1995, they have extended this to the reduction of the number of workers. In particular, speeding-up was the main mechanism of intensifying work on assembly lines. Most workers in the assembly lines note that the pace of work tends to speed-up without increasing the number of workers or even by reducing the number of workers.

Workers have felt twice the physical burden due to increased work pace with the same amount or even an increased amount of work than before (Table 7.14). In the walk-through survey, 82 (44.81%) among 183 workers on the shopfloor replied that the main factor in increasing work intensity was increased work pace, with job tasks either remaining the same as before or being increased (Table 7.13). 42 (22.95%) among 183 workers replied that work intensity increased because of the combination of heavy cars and light cars. 32 (17.49%) among 183 workers replied that the work intensity increased because of the introduction of the new car. 25 (13.66%) among 183 workers replied that there was no change (Table 7.13).

Table 7.13 Workers' opinions on how and why work intensity has increased since 1992 based on short interviews in the walk-through survey on the assembly II, April 1999

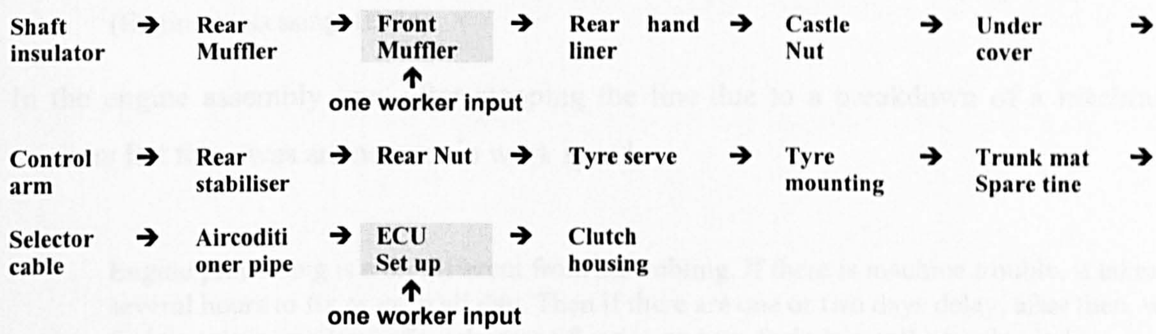
The items of increasing work intensity	Numbers	%
1 Work pace increased with the same amount of job tasks as before	52	**28**
2 Work pace increased with even increasing amount of job tasks than before	30	16
3 Due to new car, physical load increase	32	17
4 Combination heavy car and light car	42	**23**
5 Others (merged work process)	2	1
6 No change	25	14
Total	183	100.00

During the walk-through survey, each workstation showed how the speed-up loads workers with more work. Figure 7.7 shows how work pace increased from 35 to 42 Jobs per hour with the introduction of a new car, Leganja[8], and with only two workers added, although there are 17 workstations in assembly Line II. Therefore, workers in each of the

[7] id_{number} means the sequential numbers of workers who participated in-depth interviews.
[8] Leganja: the brand name of car which has been produced in this car factory.

15 other workstations experienced increased job load due to speed-ups. Most workers agree that there are too few workers to keep up with the increased pace of work.

Figure 7.7 Increasing work pace and input: two workers on the assembly line



Some workers in assembly line I and II say that managers change job tasks little-by-little for each worker during speed-ups as a means of concealing from workers the fact that the amount of work has increased with an increased work pace. However, most workers feel that job tasks remained the same even after the process had been speeded-up. In addition to this, some workers note that speeding-up itself increases the frequency of job tasks for each Job Per Hour.

> Managers change job tasks little-by-little when they increase work pace. In fact, the quantity has not changed. I did the labelling and radiator work before, now with 42 JPH, my job has been changed to setting-up the speakers.
> (Assembly line II ordinary worker)

> The job task has not changed even though the work pace has been increased. My main job has not changed and only small tasks have been reduced or increased.
> (Assembly line II ordinary worker)

> With increasing speed-ups, several trivial tasks are omitted, but there is no problem because the main task is the same. Just small tedious things are eliminated.
> (Assembly line II ordinary worker)

On the other hand, several workers note that, as workers themselves have been moved from one station to another, so new workers may not realise how work intensity has increased, compared to previous jobs on the shopfloor.

In other departments, speeding-up was the main cause of increased work intensity. A specific point is that the ways of increasing work pace are different depending on the department. For example, in the engine processing department, workers argue that work pace is usually increased during lunchtime by supervisors or foremen.

> From time to time, supervisors and foremen increase the work pace during lunchtime, after then they do not reduce it. They seems to forget about that fact on purpose.
> (Engine processing, ID 24)

In the engine assembly line, after stopping the line due to a breakdown of a machine, workers felt there was an increase in work speed.

> Engine processing is a bit different from assembling. If there is machine trouble, it takes several hours to fix or even all day. Then if there are one or two days delay, after then, we feel that there is a kind of work intensification and we feel physically overloaded.

In body-welding department II, workers noted that, when work pace increased from 45 to 55-58 jobs per hour in the 'moving installation line', the number of workers was increased at only two work stations: bonnet hinge and door setting. Other workers at other workstations therefore experienced an increase in their work load. In the paint department, most workers also experienced an increase in work pace.

> The facilities are the same as 10 years before. Only the work pace increased from 36 to 60 and the number of workers reduced from 33 to 16.
> (Paint worker)

③ Reducing the number of workers whilst keeping the same work pace as before

Most workers in all departments note the reduction of the number of workers as the main mechanism for increasing productivity and profitability, while the workpace remained the same since 1995. Most workers said that this tendency had been reinforced since the economic crisis in November 1997.

On assembly line I, the jobs per hour had already increased to 60 in 1995, but has not changed since then. For example, in the Ranos[9] line, on assembly line I, workers notes that each team had about 14-20 workers before 1997. However, it now had been reduced to 12-18. That is a 10-15% reduction in labour power between 1997 and 1999. During the walk-through survey, in the question on how the work had been changed on assembly line

[9] Lanos: the brand name of car which has been produced in this car factory

I, 24% of workers among 120 interviewees felt that the number of workers had been reduced and workstations had been merged, but the amount of job tasks had not changed (Table 7.14). Also, 46% of workers among 120 interviewees in assembly line I felt that increased work pace up to 60 JPH without any reduction in the quantity of job tasks (contrary to management's claim) was the main factor of intensified work (Table 7.14).

Table 7.14 Workers' opinions on whether work intensity had increased since 1992 in the short-interview 1st April 1999

The items of increasing work intensity	Numbers	%
1 Workers reduced, merging the department, no change of job tasks,	29	24
2 Work pace increased, without the amount of job tasks decreasing	55	46
3 Due to new car, physical load increase	19	16
4 Others (Combination, stress, machine-out of order)	4	3
5 No change	13	11
Total	120	100

Workers' opinions stand in quite a contrast to the employer's. One worker notes that employers gave the following reasons for reducing the number of workers: firstly, in 1997, when the new car, the Ranos, came onto the assembly line, they said that the work process had been simplified. Secondly, while introducing the new car, the employers re-measured working times for each workstation by stopwatch and came up with new standard times for each job, thereby reducing workers' rest time, increasing work pace and reducing the number of workers. The re-measurement of standard working time whenever introducing new car lines is the employers' prime strategy for reducing the number of workers and increasing work pace.

Workers pointed-out several ways of reducing the workforce in the labour process. A cut in the number of workers has been a regular occurrence every 6 months since 1997. One workers' representative puts it as follows:

> The managers have a plan to reduce the number of workers every 6 months. At the beginning of 1990, the main issue was increasing work pace, therefore workers struggled for an increase in the number of workers. Now the situation has changed. The managers attempt to reduce the number of workers without decreasing the work pace. Anyhow, they are trying to reduce the cost of the number of workers.
> (Assembly line II workers' representative, id32)

In cases of worker absence, there is no attempt to recruit replacement workers, particular after an economic crisis, November 1997.

> The real problem is reducing the number of workers. We have 16 or 17 workers. If one or two workers are missing due to a holiday, as the amount of work increases the number of workers should be supplemented. However, it is not usually supplemented. If workers are absent due to workplace injury, the deficit of the number of workers should be filled, but they don't. Therefore, sometimes the real number of workers in the workplace can be -1 or –2. That is the hardest time.
> (Assembly I worker, id 10)

Some workers are sent to another department; some are 'voluntarily' retired, at the manager's suggestion. Cuts in labour are supplemented by other departments who supply workers when they have no work to do. Some workers said that this kind of movement between departments ultimately makes workers voluntarily leave the factory.

> The present trend is not towards reductions in Jobs per hour, but towards reductions in costs by reducing the number of workers. Some workers retire voluntarily; some are moved to another departments. If they are dispatched to another department, they don't return... If the number of workers is abruptly reduced, then the workers in the workplace tend to be against it. Therefore, they (employers) start by reducing helpers, supporters, or fullmen[10], who are not visible in the line. Another way is to merge two teams into one.
> (Assembly II workers, id32)

Another way of reducing the number of workers is by abolishing some workstations so that workers 'disappear' automatically.

> Two teams are merged, some workers are moved to another part or retired, and there is no more recruitment in order to increase the number of workers.
> (Several assembly II ordinary workers)

Reductions in the number of workers were not recognised at first. However, workers have now recognised what is happening without any notification on the part of management.

> We refused work because they are cutting too many workers. The managers said that they would supplement the deficit in labour... However, workers disappeared! Workers disappeared without any notice.
> (Assembly II ordinary worker)

[10] Fullman is also a kind of helper. They are not on the line regularly, but become involved when there is a shortage of workers

(b) Using technology

①Automation

The walk-through survey shows that the main issue for workers in body welding departments I, II and IV is a big decrease in the number of welders since the introduction of welding robots in 1997. When the new car, the Ranos, was introduced in welding department I, robots replaced the workers on most of a whole line and work pace increased to keep up with the robots. Thus, for the remaining workers at other workstations, work intensity increased. There are some tasks which the robots cannot perform. But since these robots set an increased pace (45 to 60 jobs per hour), the workers supplying the lines and doing setting jobs have to work faster. For example, on the moving installation line, the number of workers was 18 for 45 jobs per hour, when the work pace speeded up to 55-58 only two workers were added for door setting, and one worker was added for the bonnet hinge job. Only two workstations therefore got extra hands to deal with the speed-up. In body welding IV, the number of workers was reduced from 500 to 120, with the introduction of robots in the welding line. In body welding IV, even though the jobs per hour had increased from 25 to 45 until 1996 and decreased to 35 since 1997, the decreased number of workers meant that those who remained became physically overloaded. Automation does not reduce the amount of work. The problem with automation is the reduction in the number of workers.

Also, press line workers explained how work had intensified since automation. Some of the press lines are completely automated when new cars, such as the Ranos or Leganja, are introduced, thus reducing the workforce. With automation, several work stations disappear. Before, the cutting and washing line were separated, now the machine washes automatically. Before, 6 press machines were needed. Now cars are finished with 4 machines. However, for the workers remaining on the automated line, 350 panels as opposed to 300 on the non-automatic line can be pressed per hour, so the amount of work has increased. This is because the workers who stand at the beginning and end of each line feeding and collecting the sheets and stacking them by hand, are the only ones needed, but they have more sheets to stack or feed. Paint line and engine plants have also introduced a huge amount of automatic machinery, which has also resulted in a reduced number of workers.

The effect of automation has also been a positive one for a few workers, especially in the engine processing part. They note that job tasks have become easier. However, with the massive reduction in the number of workers, work had intensified:

> Without automation, I myself had to act to make some product. At that time I felt leg pain, shoulder pain... Now, I just watch the automatic machine. I can see several automatic machines together. I just correct the things which automatic machines can't finish. I can not say it is bad... For health, it is not bad as well...
> (A worker in engine processing, id24)

> With automation, 3 people are cut. Before, 5-6 people did the job on 13 machines. Now three people do it. The problem is the cut in number of workers.
> (Engine assembly worker)

On the other hand, in assembly lines, there has been some innovation with regard to the machines or even the introduction of new machines for the heavy work, hoists, moving wheels or power machines have been added for lifting heavy loads. These new tools also contribute to the reduction in the number of workers. The work areas to which this applies are: seat assembly, rear bumper, front bumper, rear axle, under body re-bolt system, battery set-up on assembly line I, and doors off, IP pad mounting, windscreens and steering column. The workers are well aware that as a result their jobs have been cut (Table 7.15).

Table 7.15 Semi-automation and reducing the number of workers in assembly lines I and II, from the walk-through survey, April 1997

Work process	The period of automation	Type of semi-automation	Change of the number of workers
Assembly line I			
-Set up chairs	1998, since Ranos	Moving wheel	No change
-Rear bumper	1997, since Ranos	Moving wheel	One worker reduced
-Front bumper	1997, since Ranos	Moving wheel	No change
-Rear Axle	1996	Moving wheel	1996, Four workers→Now, Two workers
-Underbody rebolt system	1996	Complete automation	All workers were removed
-Battery set up	1996	Semi- automation	No change because only one worker has been working
Assembly line II			

Most workers on assembly lines I/II have three opinions on the question of semi-automation. Firstly, they have noticed that it has reduced the number of workers;

secondly, they feel that they have become machines themselves or have to act as part of a machine by being forced to follow its pace; thirdly, in the case of semi-automation, the workers have suffered a reduction in their numbers and the malfunctioning of semi-automised machines. Thus, for assembly line workers, semi-automation is not welcomed. Several workers complain about discomfort and physical load. Semi-automation is imperfect, resulting in the need for manual intervention, which is time consuming and puts additional pressure on the workers involved:

> We do not welcome it, if it is not a kind of 'complete automation'. Actually, it is better if it is complete automation, even with the reduction of one or two workers. Now, the machine cannot do the work completely, and despite this, the workers are reduced and the amount of work increased. It is not good for us.
> (Assembly worker, Shasi, id2)

> With the introduction of semi-automatic machines, the back posture required worsened. The working time decreased, but twisting postures increased. The machine is not flexible; therefore, we have to twist for the job. It is very stressful and lower-back pain occurs.
> (Assembly I worker)

For some assembly workers, semi-automation makes work easier, but despite this, a reduction in the number of workers has the result of intensifying work for the remaining workers.

② In the name of 'simplification[11] of the process' and reduction in amount of raw materials

On assembly lines I and II, with the introduction of the new cars *Ranos* and Leganja, employers asserted that the work process was now simplified as follows: 'the method of assembling was simplified'; 'the number of raw materials to be assembled and fitted was reduced'; 'the numbers of screws which the workers had to assemble are reduced'; 'the accessories to be fitted became simpler'. With this 'simplification', in assembly line I, the employers reduced the number of workers (Table 7.18).

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[11] Simplification is another way of saying 'deskilling'. According to O'Grady (1995) and Moody (1997), process simplification in Japanese production techniques, functions just like deskilling in classical Taylorism. Braverman (1974) asserts that with the extreme concentration of knowledge in the hands of management and its closely associated staff organisations, what is left to workers is a reinterpreted and woefully inadequate concept of skill: a specific dexterity, a limited and repetitious operation, 'speed as skill' etc. He therefore claims that, with the development of the capitalist mode of production, the very concept of skill becomes degraded along with the degradation of labour.

Against the management's assertion, workers in assembly line I replied in the walk-through survey that the work process had become simpler. With the introduction of the new car line, Ranos, 73.33% (132 out of 180) of workers felt that the amount of work had increased or was the same as before, and 80.65% (150 out of 186) of workers felt that the posture required for their work was more stressful than before. In assembly line II, workers felt the job posture required for producing the new car in the work process had become more taxing. As to stressful posture, out of 163, the percentages of workers who felt that job posture had become worse are: on the Leganja, 44%; on the Acardia, 34%; on the Prince, 8%; and 14% felt there was no difference in assembly line II. In addition, with the new cars, the torque[12] has been increased. 59% among 46 work stations which use torque replied that this had increased with the Leganja; 20% among 46 work stations replied that this was so for the Acardia; 15% among 46 work stations for the Prince. 7% among 46 workstations felt the torque had not changed.

Workers strongly disagree with claims made by the employers. Managers assert that the work process has been slightly simplified and working time slightly reduced, but most workers feel an increase in their physical load. For example, physical load increased even though the frequency of assembling or the number of parts to fit decreased. Workers mainly pointed out that employers did not take increased physical loads, nor the bad work posture imposed on them, into consideration. Workers, however, feel the increase in work intensity directly:

> There was no change of working time. Even though the work process was simplified, we felt that several parts of the body like the lower-back area were more physically loaded. The previous car was easy to assemble. Now they (managers) said that it is simplified and the working time reduced. However, it became harder to fit the accessories to the car. We feel the increased physical load in the lower-back area or leg, shoulder, and forearm. As the work becomes simpler, the workstations which are needed for more sophisticated work are increasing. At several points, we have to bend low to fit the accessories to the hood. Therefore, when we bend low, the physical load seems to be increased in the area of lower-back, shoulder, and leg.
> (Assembly line I, workers' vice-representative, 29 aged man, id59)

Several workers in assembly lines I and II note that the tasks involved in assembling the new car were much harder at some workstations: seat belt, bumpers, and chairs settings.

[12] Torque: twisting force caused by rotation

> In several workstations, the new car parts are harder to fit it. In the case of seat belt setting, previously there was no obstacle; therefore, we could do it from outside of the car. Now, there is an obstacle, and we must go inside the car and bend low down to fix it. The car was not designed for workers' bodies; therefore, workers are suffering from it.
> (Assembly line I worker, workers' representative, id 60)

> With the introduction of Ranos, one worker was omitted. The factory claim that, since Ranos is simpler than previous work, one person is no longer needed. However, real work intensity is higher. When it comes to lifting the bumpers, it doesn't matter what type of car it is, it is hard work to lift the bumper, regardless.
> (Assembly line I worker)

> The manager said that the work process became simpler, therefore, one worker was taken out from this workstation. However, regardless of the kinds of the cars, there is no difference when lifting the bumper... Therefore, the job became harder... (Assembly worker I: part I)

> The seats of the new car became more heavy and the numbers of seats increased...The physical load was higher for the new car line.
> (Assembly line II ordinary workers)

③ Model mix: combining heavy and light cars in the same line

Workers in assembly lines feel that the 'model mix' on the lines results in varying workloads and speeds. The heavy cars are introduced in between the light cars on the conveyor line, which had been set up for a lighter car. For example, even though the main assembly line had been planned for the light car, the Leganja, the production of heavy cars, the Acardia and Prince[13], increases the load without any increase in the number of workers since 1997. An the beginning of 1997, the ratio of heavy to light cars was 1:14; however, it has since increased to 1:6, doubling the load. Workers feel the harder physical load when assembling heavy cars, as these require a heavier engine and axle and the accessories need a longer time to fix to the body than lighter cars. Indeed, even though one or two workers are added in one or two work stations, the workers feel unable to finish their job if the line speed is maintained at 43 jobs per pour, a speed maintained for lighter cars. For example, workers complain of lower-back or leg pain and are physically more worn-out by the severe physical load. With regard to the workload in the walk-through survey, more workers said this was the case with the heavy car in assembly line II, for the Acardia (41%), for the Leganja (33%), and for the Prince (14%) among 160 workers. 13% said it was the same in assembly line II. Therefore, for workers, work intensity and physical workload has increased.

> It was difficult to assembly the big cars (Acardia and Prince) at 35 JPH. Before, it was an input ratio of 10:1. Now it is 42 JPH and big cars are coming 6:1 or 7:1. It is difficult to finish it at 42 JPH. Acardia is not good for job posture as well. The working time is long. Should bend lower-back 45-degree.
> (Assembly line II workers)

(c) Tightened control over workers in the workplace

Since 1992, the factory has attempted to control workers in the workplace in the name of a 'New labourer-employer culture'. For example, the regular meeting, the so-called 'meeting for production with one mind' organised by supervisors is held in the workplace. The main issue at these meetings is how to increase productivity, which in turn means how to increase work pace and intensity. In contrast to management's assertion, several workers note that another hidden goal of the meeting is to isolate the labour union from the shop floor workers. Since 1998, with the economic crisis in Korea, control over workers in the workplace has intensified through three mechanisms: putting 'worker's real names[14] on the products'; intensification of new disciplinary rules; institutionalisation of 'brothership' between supervisors and shop floor workers. Workers have felt that this control has resulted in an increase in work intensity.

① Quality control for productivity: 'suggestions' and 'worker's real names' on the products

At the beginning of 1992, during the period of NAC I, managers held regular meetings with workers, the so-called 'meeting for production with one mind' and workers were encouraged to make 'suggestions[15]' to increase productivity. This activity was probably adopted from the so-called 'team activity' of the Japanese model. However, workers felt that the effect of their suggestions was simply to increase work intensity. For example, in assembly line I, several workers reported that if they suggested a good idea during the meeting which would make a job easier or simpler, they found that this was used to

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[13] Acardia, Prince: the brand names of cars which have been produced in this car factory.
[14] The worker's name is listed for each product. Sometimes, supervisors or foremen write down the worker's name every 10 minutes, or sometimes workers have to put their name when they rotate the line.
[15] The managers hold 'regular meetings' every Monday morning with workers, mainly focusing on the 'quality of the products': a suggestion system, with bonuses (benefits) exists for workers who suggest a good idea related to quality.

reduce the numbers of workers, as well as to increase work pace. Several workers notes that after the economic crisis in November 1997, this 'suggestion system' seemed to be weakened and stronger methods such as quality control were introduced.

During the economic crisis, the factory started to ask the individual worker to check his product by himself in the name of 'worker's real name in the products'. In all departments, the worker's name was recorded on each product on the computer system. If there was an error among the products, this affected the worker's income and promotion. Workers note that this system seems to be used to blame and put pressure on individual workers, thereby increasing stress on each worker. Workers have felt the increasing work intensity with this kind of control over the workplace. They note that it may be because workers' power was reduced relative to employers' after the economic crisis[16]. In particular, the main pressure for 'quality control' was directed at the paint line. With the introduction of 'quality control', according to 'workers' real names', workers feel that work has intensified more than ever:

> It is like a system of responsibility. It is 'a system of quality assurance.' For the work that I sprayed, I have to take responsibility. The recorder shows who did the work at that time. We have a lot of stress about going over time. For me, I did my best during the work, but if there is an error, the higher managers warn supervisors that workers made a mistake. We have felt fear during the work. It is a lot of stress.
> (Paint line, ordinary worker, id12)

A worker explains how the system, which lists workers' names next to each job, actually works in practice:

> A foreman normally writes the name of the worker at each workstation every 15 minutes. In case there is an error in one workstation, it becomes obvious who did that job.
> (Paint, ordinary worker, id15)

In the engine processing area, work intensity has also increased under the pressure of quality control. The process has been automated and goes very fast, hence workers cannot check the quality one by one. Therefore, if there is some problem in the process, it is more difficult to correct immediately.

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16 Since the economic crisis, most workers are worried about being sacked from the factory. Since 1998, massive numbers of workers have already been expelled.

② Tightened disciplinary rules

Rules and regulations have also been tightened and the power of supervisors has increased, particularly after the economic crisis. Supervisors or foremen usually stand near the exit door just before lunchtime and finishing time, to prevent workers from leaving early. The starting and finishing times are also strictly checked by supervisors:

> Regulation of attendance and finishing time was tightened. They said that 'you have to be on the line 5 minutes before starting', 'do not go wondering', 'when you enter the factory, you have to go straight to your jobs.'...
> (Ordinary assembly I worker, id10)

One worker notes that it might be because management worries about being sacked:

> Since the economic crisis, 1998, the supervisors stress the ordinary workers very much. With the economic crisis, the supervisors seem to be worried about being sacked. Therefore, they press ordinary workers and bring them closer.
> (A worker in quality control department, id55)

③ Encouraging "fraternisation" between supervisors and shop floor workers in order to isolate the labour union

During interviews, workers notes that supervisors try to forge friendly relations with ordinary workers during work time. One worker warned that this kind of 'brothership' had been used to manage and organise the work, and to prevent workers from participating in struggles organised by the union:

> The most dangerous thing is splitting the workplace through supervisors and foremen. It is most fearful thing. They call the workers who participate in workers' struggles, and say: 'I am really worrying about you. You are on the black list already. The higher managers know about you already and they will sack you soon. Therefore, you have to trust me and follow me, in case I can help you.' Each foreman makes friendly relations with 5-6 workers. When the time comes, they split the workers' solidarity by saying 'let's go fishing.'
> (Assembly line II, workers' representative, id32)

> Usually, we are close to each other like real younger brothers and elder brothers, therefore, we usually forget that he is a manager (supervisor). Before, he was a very restrictive and authoritarian manager, but now, the image of the supervisor has softened. After finishing work, the supervisors go with ordinary workers for a drink, and they usually participate in funerals in ordinary workers' family.
> (Assembly line II workers' representative, id32)

Most workers note that this may be because workers' organised power has weakened due to their worrying about being sacked during the economic crisis, November 1997. The workers were strong before the introduction of NAC in 1992. Since then, with workers having being defeated in the struggles at the beginning of the 1990s, workers' power has decreased (Table 7.16).

Table 7.16 Summary of changing work intensity by department

	Changing the use of Labour power ➔ Work pace and the labour power	**Technology innovation ➔Automation ➔Simplification of work process ➔Combination of heave car and light car**	**Workplace control**
Assembly I	**Abrupt by increasing the work pace from 1992 to 1995, since then, the number of workers reduced**	Semi-automation, reducing the number of workers : Mainly, done in the assembly line since 1997	Quality control: 'workers' real name'
Assembly II	**Since 1997, the work pace is more increased(35->42) than the labour power**	Semi-automation, reducing the number of workers : Mainly, done in the assembly line since 1997	Quality control: 'workers' real name'
Paint	Similar to assembly line, the work pace has increased, and the number of workers reduced	With automation, the number of workers was reduced.	**Quality control was tightened : worker's real name is mainly stressed in the paint line**
Press	**The work pace increased due to automation**	**With automation, the sheets to press per hour have increased from 300 to 350. Massive workers were expelled**	Quality control: 'workers' real name'
Body welding I	With increasing work pace, the work intensity has increased	**With automation, massive workers were expelled**	Quality control: 'workers' real name'
Body welding II	Work pace has a little bit decreased, but the workers have reduced abruptly	**With automation, massive workers were expelled**	Quality control: 'workers' real name'
Engine	The pattern of work pace has been correspondent with the assembly line, and the number of workers has been decreased	With automation, the number of workers was reduced.	Quality control: 'workers' real name'

(2) The effects of intensification on the workforce

As a result of the speed-up, assembly line workers experience several difficulties during their work. The intensification of the work process means that they are subject to a higher physical load; they have to work without breaks which also means increased isolation and fatigue, if not disorientation[17].

(a) Lack of rest time

In the walk-through survey, many workers actually complained that they cannot go to the toilet. They suffer from lack of rest time in the work process:

> Now there is little rest time. There is no time to go to toilet. Before, there was some rest time. Previously, there was time for toilet, time for urination...Before, we asked our neighbours to take over the job and went to toilet. Now, as I am too busy, I cannot ask anybody...Also, I cannot help other people.
> (Assembly I line worker, id 63)

Some workers feel that the quality control system, 'workers' real name', deprives them of resting time:

> If we get accustomed to the line, we can do the work a little bit faster one second by one second. After one year, we can work faster by about 5 or 10 seconds. Even though we get accustomed to the work, we cannot go faster more than 5-10 seconds. Now, we have to confirm the quality car by car. When we check the quality one time per five cars, we still have some rest time. But now, we have to check it for every car. Therefore, we do not have the resting time at all.
> (Paint ordinary worker, id15)

Furthermore, many workers in the interviews and walk-through surveys complained about the difficulties to catch up with the conveyer lines:

> With the 5 jobs per hour increase, we have to work five job tasks more in that time. Therefore, at that time, the body cannot be maintained anymore...
> (Paint line worker, id26)

> We are pressed by the time. Sometimes, we cannot finish the work on the line. Then, next person has to do it.
> (Paint worker, id 27)

[17] Fucini and Fucini (1990) also show that workers in Mazda, an American autoplant, find it difficult to keep their minds focused on their jobs after nine hours of 57 second per minute motion.

(b) Physical load/exhaustion

Many workers feel extremely tired when they are at home after finishing work:

> I can now follow with 60 JPH, but after dinner, I just fall asleep. In the morning, it is very tiring. I feel this more. In the same working hours, we work more according to the increasing JPH, therefore, work is intensified.
> (Assembly line, Head lamp install)

On the other hand, for several workers who had been employed a long time, speed-up has not be affected their physical load. They said that they had become accustomed to their tasks and skilful in their jobs:

> Job tasks have not much reduced in 40 JPH, compared to 20 JPH... Only work pace became faster and job tasks larger... Could catch the line quickly because became skillful about the work...
> (Assembly line I worker, id 7, 38 aged, 12 year of tenure)

(c) Isolation/alienation

With an increased work pace, workers feel more isolated and alienated from the work process, as they no longer have the time to look out for one another:

> Before, there was a bit of spare time with 35 JPH. Now, there is no spare time with 42 JPH. I could talk with my colleague at 35 JPH, but now it is impossible.
> (Assembly line II worker)

> With the increase in the work pace from 58 to 60JPH, the most difficult thing is that I just have to work alone. It is very boring without talking with my colleagues. The job of tyre setting cannot be reduced or increased. Only one person can do it. But the work pace has increased in this situation.
> (Assembly line I worker)

Across most departments, another particular result of automation is alienation among the workers. Semi-automation also contributes to the workers' feeling isolated during the work process on the assembly line:

> Before, we helped each other. With automation, people's relationship is with the machine, therefore, people become machines and there is no room to help other workers. I should do all the work by myself and work intensity increases. Before, people helped me when I want to go to the toilet, however, now it is impossible.
> (Body welding worker, id25)

> Due to automation, people become separated from each other. When I do the job manually, I do it quickly and talk to my neighbour just one word. Automation does not allow doing that. Work pace is increasing continuously. Even though we just talk to each other quickly during the work, but... I just feel that I work alone...
> (A worker in Engine assembly line, id 24)

(d) Anger

Many workers feel angry because of the reduction in staff levels. One worker notes how workers spontaneously disappear in the workplace:

> I shouted: 'I will only do my own work or I won't work', then they discussed with the workers' representative, and said that 'we will support the work for the reduced number of workers or maybe the supervisor can do the work.' However, workers disappeared again. Workers are omitted by stealth, and disappear without anyone noticing.
> (Body welding workers, id11)

In the end, some workers show the depth of their anger against increasing speeding-up, coming into conflict with employers over the increasing pace of work:

> The factory usually talks about 'increasing productivity!', however, as a result, we are suffering worries about unemployment and increases in our workload. In the workplace, we might think: 'it is not friendship between employer and workers (workplace), we are just enemies of each other.'
> (35 years of age, 12 years service as an ordinary worker in the assembly line, id1)

(3) The conflict between workforce and employers over intensification

From the in-depth interviews and the walk-through survey, we see that workers are in conflict with employers. In terms of the relationship between workers and employers, this car factory witnessed major struggles from 1987 to 1990, when many workers in large factories in Korea went on the offensive. Since that period, a so-called 'Democratic Labour Union[18]', has been established to organise ordinary workers in many factories. This car factory was no exception. However, employers had already started to recover their control in the workplace by 1992, when they introduced NAC I. Prior to this, the union had dominated shop-floor life. With intensification of the work process, many struggles occurred and many workers were actually jailed as a result of fights against speed-ups until 1994. However, as one worker notes, after the defeat in 1994, these struggles seemed to have been resolved through negotiation via regular meetings between workers' representatives and managers in each department. These workers' representatives are elected by workers directly, one representative being elected by 30-50 workers. Workers' power has been weakened since economic crisis, November 1997. However, on the shopfloor conflicts have continued, even though it has lessened since 1998. Most workers have expressed great anger against the intensification of work. In the following sections, each work area is reviewed in turn and selected quotes drawn from interviews describe the experience of workers with regard to workplace conditions and work intensity.

Against the employer's increasing work intensity, workers engaged in a major struggle at the beginning of the 1990s. This started from the shopfloor. Before introducing NAC in 1992, ordinary workers and workers' representatives were aggressively against the increasing work pace. Until 1994, shopfloor workers struggled together. However, as one worker's representative who led the struggle at that time notes, after being defeated several times, workers' power decreased. Another big change was that struggles moved from factories to offices, from the relationship between managers and ordinary workers with workers' representatives to the relationship between managers and workers' representatives only:

> In 1986, several workers went to prison because of the struggle against speed up (id 50). Now the assembly line speed is 60 JPH.
> (Press workers' representative, id 50, id 50)
>
> In 1994, several workers' representatives stopped the line and refused to work, saying: 'we cannot increase production because we did not agree the speed up.' The factory called the police and they were sent to prison.
> (Workers' representative in assembly line I, id 33)
>
> Before 1992, we had more power; therefore, the factory accepted our claim. Since 1992, we were against speed-ups fundamentally in 1994, and told the factory 'no more increases in work pace'! From then, the agreement went on that the number of workers should be increased while work pace was increasing. After being defeated in 1994, the speed up was implemented, and workers have felt defeatist and say that 'it is impossible, even though we stopped line.'
> (Assembly line I worker, workers' representative sacked in the 1994 struggle, id 62)

[18] Democratic Labour Union: the union established by ordinary workers' direct votes. Before, the labour union was established by employers'nomination without election.

> Now, it seems to have changed from action-oriented to negotiation-oriented. Thus maybe the union itself has lost power...For example, before if we asked for 100, factory gives 90, but now only 20 or 30.
> (Engine plant ordinary worker, id21)

During negotiations, workers representatives feel that they are 'stuck' between workers and managers:

> We could not find adequate confrontational methods. We made an agreement with managers during the meeting between managers and workers that managers 'should not take away workers' skills', and 'should not measure the working time again unless for automation or changing the design of the work process'. Now we are trying to make an agreement that the workers' skills should not be taken by the managers...
> (32 years, workers' representative in the assembly line I, id60)

> Before, workers fought against working conditions. Recently, there seems to be no struggle by ordinary workers. Most struggles have changed to negotiation with factory bosses led by the union rather than ordinary workers...
> (Workers' representative, id 55)

Several workers' representatives explain their difficulties with the relationship meeting between managers and workers' representatives:

> The issue of the work force is not solved very well. Last year, managers attempted to move 40 press workers to KD department compulsorily. We were against it. We said that 'it should not be done like that. Only volunteers among workers should go there' In the end, we won. On the other hand, at the end of 1997, abolishing three lines, we did not want workers to move to other departments. We wanted them to work here as full-time workers. However, we were defeated. For the workforce, there is a serious conflict.
> (Press workers' representative, id 44)

> If we see the agreement between managers and workers, it was notes that the factory agreed and that there would be no more cuts in the number of workers and that work intensity would not be increased. Therefore, they (the bosses) might think it is difficult with this agreement. Then they attempt to introduce new methods. However, it is obvious that it is not for innovation, but just to cut the number of workers.
> (Workers' representative)

> We think that we will not participate in the meeting for cutting the number of workers unless there is a change of model.
> (Workers' representative, id62)

Most shopfloor workers know that negotiations between managers and workers' representatives have not worked properly:

> Workers' representatives should collect workers' opinions before they have a meeting with managers. They do not like that. They just participate in the meeting with managers without collecting workers' opinion. If we ask them 'let's do the meeting with us', then they say: 'we are busy'. Of course they have a lot of work, but it is a kind of excuse.
> (Assembly line II ordinary worker)

As a reason why workers' representatives do not organise the workers' struggle and only seem to talk with managers, and find themselves 'stuck' between employers and workers, several workers suggest that they do not seem to collect and ascertain workers' opinions. When they face the meeting with managers, they just seem to give their own, rather than the workers', opinions. In addition to this, workers feel that they are being pushed out by employer's power. Also, many workers are worried that the labour union has become powerless since economic crisis, November 1997:

> The role of Labour union has lessened. It was shown in the workers' struggle for wages in 1998. The union agreed to a reduction of the monthly bonus from 150% to 100% and to the cutting of welfare bonuses. Now, the support of 50 % of educational costs for children who are university students has been abolished.
> (Engine department worker, id 53)

> What are they (the union) doing now? It is not clear. There will be in trouble this year. After the IMF (economic crisis), they are stuck now. Even though a new leadership has been elected, they never held a 'public hearing'. For me they do nothing. We do not know their names. We do not know who they are.
> (Assembly ordinary worker)

> It has become inactive. Dissatisfaction is increasing, but union leaders as well as ordinary workers are depressed
> (Body welding ordinary worker)

> Leaders in the union should be strong. It should lead with confidence. It is not something else... It is struggling with confidence when they need to struggle for real. If they recover this image...
> (Workers' representative, assembly line II, id 32)

Workers themselves have felt their weakening power against employers, particularly since the economic crisis in November, 1997, most workers are now under a lot pressure to keep their jobs:

> We are pushed out now. If the economic situation is good, we can be stronger. Now that is not like that, we are being pushing out.
> (Ordinary workers)

> The Labour union should give us a reply about the crisis of unemployment. Documents say that there will be no cutting of workers. However, we do not believe it. We think that it is just a paper. We believe that the factory will sack us if they are in difficulty. Therefore, most workers may think: 'I will just perform very well by myself. Then they may not sack me.'
> (Assembly ordinary worker, id 67)

> Since 1994, workers started to believe in themselves. However, generally, there is a depression about the fact that they could not break the increasing work intensity fundamentally.
> (Workers' representative, id 62)

Nevertheless, some workers still feel struggle is inevitable in the relationship between employers and workers:

> We felt that if we lose without win the struggle, we cannot survive...
> (Engine Assembly worker, id 21)
>
> In fact ordinary workers have no power. Even though we have no power, if Union leaders and workers' representatives start to fight, about 70-80% of workers in assembly line I will join together with them...
> (Assembly line I, id 70)

7.5.2.3 Summary and interpretation of qualitative research

(1) Hazardous working conditions

According to the in-depth interviews and the walk-through surveys, press and body-welding department are seen to have higher physical loads and a greater risk of injury, as workers in these departments deal with heavy machines. On the other hand, the assembly line and engine assembly line seem to be exposed to risks caused by repetitive work and bad job posture. In terms of working conditions, work intensity is the main concern of most workers.

(2) Several mechanisms for increases in work intensity

During the labour process, work intensifiesd through changes in the 'use of labour power' and through 'technological innovations' (Figure 7.8). In the process of using labour power, work intensifies by regularly increasing work speed, workpace and by reducing the relative number of workers. The fundamental mechanism for increasing work intensity is speeding-up based on the regular measuring of working time[19]. Managers measure working time regularly with stopwatches and consequently reduce the number of workers. For managers, this is another way of increasing productivity. However, for the workers, it increases their work intensity. In particular, workers realise that managers deliberately use the workers' skills to speed-up and remove workers' rest time. One

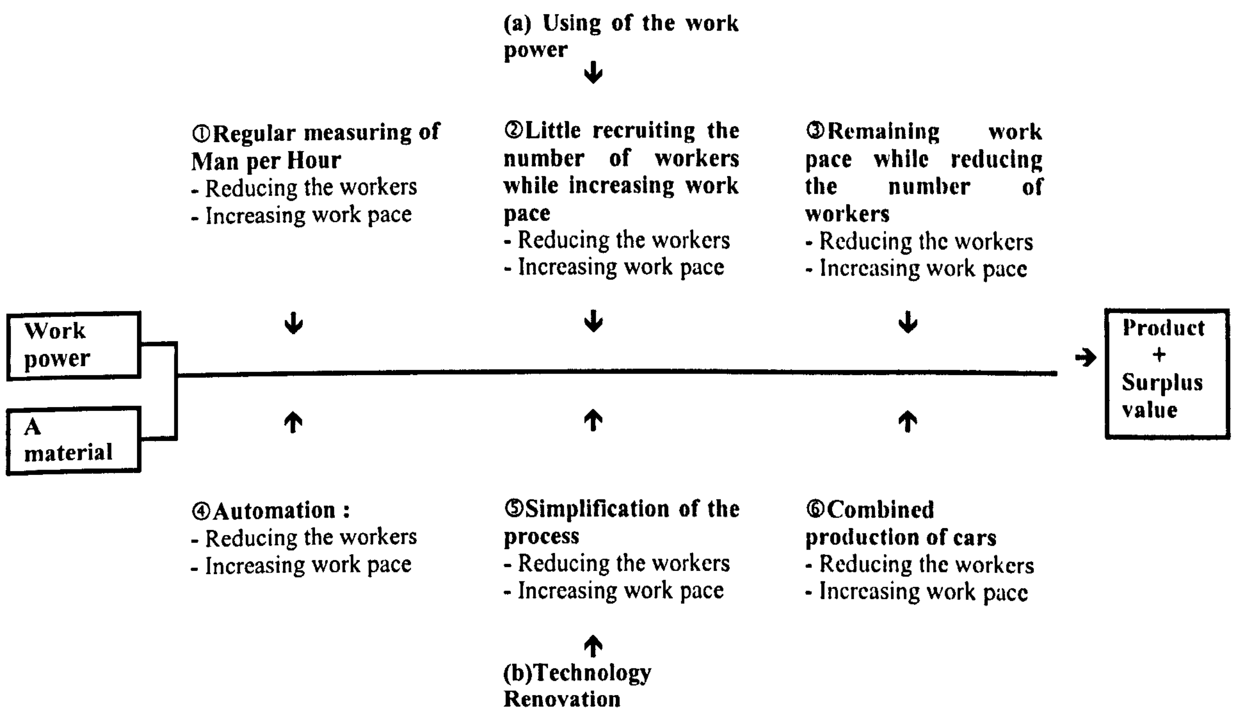
[19] This is also the main factor of 'lean production' a Japanese technique. Rinehart et al (1997) show that 'lean production' requires a rigid standardisation of human time and motion that has three aspects: cycle time, standardised work sequence and standardised work.

worker's representative notes that workers have just started to realise that this is an attack on their time and skill. He thought they would not allow this time to be taken away.

Technological innovations - automation, simplification of labour processes, combined production of cars - also result in increasing work pace and a massive reduction of workers. Technological innovations without considering workers' health has brought about increasing work intensity because of bad posture and physical demanding labour (Figure 7.8). That is, technological innovation also results in intensification of the labour process.

Another strategy developed by management to increase work intensity is tightened control over workers in the workplace. In particular, through introducing new technology, quality is controlled in the name of 'workers' real name' on the product. In addition to this, since the economic crisis, while tightening disciplinary rules[20], managers have been trying to make 'brothership' connections to workers in order to try to alienate them from the union.

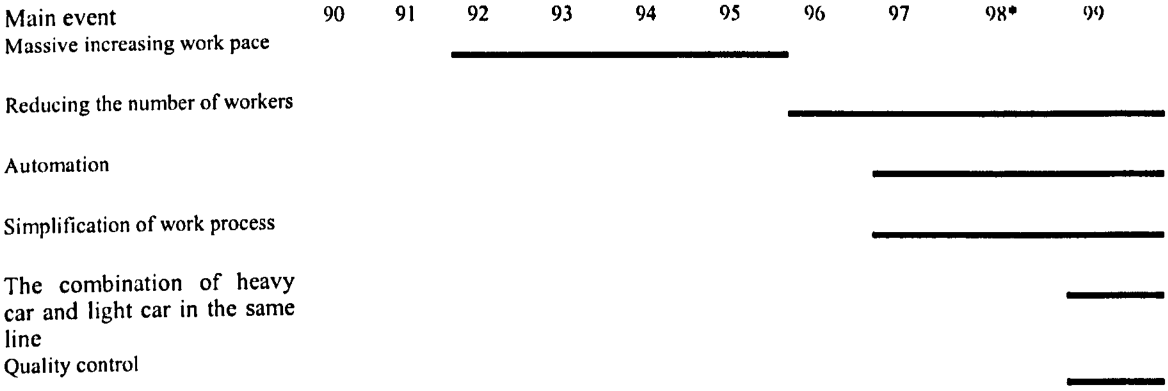
Figure 7.8 The changing of work intensity in the work process



[20] Danford (1999) also points out how 'the company's 'Bell to Bell working system' removes these longer discretionary breaks and consequently all supervisors were instructed to confine their operators to the line whether or not they were working' in several Japanese factories which operate in Britain. As Danford (1999) mentions this is intended 'squeeze these little portions of time'.

These mechanisms have changed over time. At the beginning of the attempt to introduce the Japanese model, between 1992 and 1995, speed-up was the main driving force of increased work intensity in all departments. After speeding-up to 60 JPH, which seems to be some sort of physical limit, employer's have sought to improve productivity through employing fewer workers. There has been a massive reduction in the number of workers since 1996 due to technical advances (Figure 7.9).

Figure 7.9 Changes in work intensity by time



98* : 1998 has been started economic crisis.

Recently, many studies have observed this kind of speed-up as well as the closing-up of all the porosity in the working day by reducing break-times and any 'idle time' in the production periods. This occurs, in particular, in the Japanese mode of production (Nichols, 1991; Danford, 1999; Moody, 1997). The latter notes that the basic methods for reducing time are those of classical Taylorism, whether in Japan, North America or Europe. O'Grady (1995) also notes that "cycle time analysis and process simplification are both associated with traditional or Taylorist approached to work organisation" (Moody, 1997). As Danford (1999) asserts, the attack on idle time is an attack on workers' own time and "an attempt to undermine the ways in which workers' tacit skills are used to create a breathing space".

This is a latter-day version of Taylorism and Fordism as introduced in the 'old' capitalist mode of production at the end of 19th century and in the early years of the 20th century. Therefore, in Korea, the introduction of the NAC I/II, Japanese model, has been little more than the introduction of intensified old traditional methods of capitalist management in the workplace, modified according to the situation in Korea.

(3) Effects of intensified work on workers

Intensified work increases the physical demands placed on workers. As evidence of this, many workers feel that they cannot catch-up with the workpace set on the assembly line. Due to increased work density during unit time, workers find themselves becoming exhausted. Another effect of closing-up rest time is the growth of a feeling of alienation between workers.

(4) Conflict: power relationships between employers and workers on intensified work

Work has been thoroughly intensified, based on the employers' intention to increase productivity or, in other words, profits. We find that there is a strong tendency towards conflict between employers and workers over the question of intensification of work. An outstanding point is that the degree of work intensity depends on the power relationship between employers and workers. This power relationship has changed over time, especially depending on the economic situation. At the beginning of the 1990s, workers were able to bring the assembly line to a standstill, such was their organised power. However, the struggle seemed to move into the boardroom and turn into meetings between workers' representatives and managers. There may be two reasons for this: one is that workers' power was weakened. Their representatives led the struggle at that time, and some of them went to jail until 1994. In this car factory, when employers introduced the Japanese NAC I/II system and increased work intensity in 1992, workers' power had already weakened after being defeated in the struggles of earlier in the 1990s. Another is that a 'culture of negotiation' has been introduced in the relationship between labour unions (on behalf of shopfloor workers) and employers, since democratic labour unions were established.

When conflict becomes systematised and regulated, there may be a softening effect. On the shopfloor, some workers feel that negotiation does not work and that conflict cannot be solved by negotiation. However, ordinary workers feel that this kind of negotiation without struggle does not seem to represent their opinion, nor does it help to establish solidarity. On the other hand, the economic crisis seems to weaken the workers' power and that of the union. In another sense, it seems to deepen the conflict between workers and employers: even though ordinary workers feel that their power has lessened with the onset of economic crisis, they are still impelled to fight against attacks on working conditions[21].

7.6 Discussion

7.6.1 Limitations of the study

7.6.1.1 Limitations of the quantitative data analysis

(1) Data source

There may be some under-reporting of workplace injuries. The data source used in this study was reported injury data, which was recorded in the health centre inside the car factory. Under factory regulations, injured workers go to the local clinic first, after that they are transferred to hospital. For official injury reports to the Government, under-reporting is substantial, as some of the injury occurrences are not reported by employers if the workers do not apply for compensation benefit from WELCO. In these cases, employers voluntarily pay the treatment cost for the injured workers and do not report the occurrence of the injury. As Kronebusch (1984) notes: "employers may under-report occurrences of injuries and illnesses because claims affect their experience rating, which determines workers' compensation insurance premiums" (Kisner and Fosbroke, 1994).

To avoid this kind of under-reporting, the total number of injury occurrences recorded in the factory health centre are used rather than official injury reports reported to the Government. However, there may still be some under-reporting if the injured workers did not visit the factory health centre or got private treatment by themselves without reporting to the factory. Also, there may still be under-reporting if managers do not agree with the fact that the injury occurrences are related to work. In such cases, they may not allow

[21] Danford (1999) also argues that "although the new forms of shop-floor regulation in capitalist production exact from labour a more complete subordination to management and through this, an intensification of its exploitation, this new despotism still cannot press the worker resistance and conflict which remain inherent to the capitalist labour process".

workers to visit or report to the factory health centre. These cases would have been missed in our data set. This is especially true for injuries that occur gradually and over time. To reduce the bias of the under-reporting of minor injuries, the health outcomes used are restricted to severe injuries and lower-back pain.

Under-reporting of workplace injures has been noted in the USA and in the UK (Murphy et al, 1996; Oleinick et al, 1995; Kisner and Fosbroke, 1994; Reilly et al, 1995; Hunting and Weeks, 1993; Nichols, 1996). In the USA, several researchers argue that the US Bureau of Labour Statistics (BLS)'s Supplementary Data System has a limitation of under-reporting (Kisner and Fosbroke, 1994). Murphy et al (1996) also point out that both the compensation system and the BLS survey are likely to underestimate the true incidence of emerging injuries and illnesses in the USA. In the UK, there is evidence (Reilly et al, 1995) from the 1990 labour force survey that only 30 percent of workplace injuries are actually reported under RIDDOR (Disease and Dangerous Occurrences Regulations). Nichols (1996) argues that major injuries are under-reported and the extent of under-reporting is very substantial in the UK. In particular, several researchers suggest that under-reporting is more substantial for smaller workplaces[22] (Oleinick et al, 1995; Hunting and Weeks, 1993). This under-reporting of workplace injuries might act as a non-differential bias, and therefore dilute the relationship of working conditions and socio-economic factors with workplace injuries.

(2) Short period of data analysis

The follow up duration of this data is only three years (1995-1997). This short period of data might cause some limitation in interpreting the results, in particular for the trends of workplace injuries according to calendar year. Small numbers of HIVD due to the short period of analysis might contribute the wider confidence intervals in the hazard rates of HIVD (Table 7.10).

[22] Oleinick et al (1995) note that under-reporting by smaller workplaces may result in "the lower injury rates reported for small establishments by the Bureau of Labour Statistics (BLS) in the USA". Hunting and Weeks (1993) also argue that small mines might under-report injuries relative to larger mines.

(3) Limitation of the information about work department as a indicator of hazardous working conditions

In the quantitative analysis of workplace injuries, work department, which is used as a proxy for different working conditions, is not measured based on each individual's physical load and hazards. Instead, this study attempts to understand some aspects of working conditions in different work departments, using in-depth interviews and a walk-through survey. This qualitative approach is also used to add depth to the quantitative workplace injury analysis. However, this has limitations as it is based on a general impression rather than directly measured working conditions. Therefore, ignoring the differences in working conditions between individuals may attenuate the relationship between working conditions and workplace injuries.

(4) Limitation of variations in socio-economic conditions for workplace injury data

Income and job status are employed as indicators of socio-economic status in the workplace injury analysis. However, these variables may not contribute much towards differentiating socio-economic conditions, as the study population itself is rather homogenous and it belongs to a broadly similar set of socio-economic categories. For example, the study population may be included in the same categories of the Korean Occupational System: craft and related trades workers, and plant and machine operators and assemblers. Therefore, among this study population, the variation in socio-economic status may not be so large.

(5) Omission of other explanatory variables on workplace injuries

In this study, there may have been omission of several explanatory variables for the causes of workplace injuries: socio-economic conditions (e.g., education, household income), social structural factors (e.g., labour union power) as well as some work condition factors (e.g., ergonomic factors). This study did not properly explore other organisational or social structural factors, for example, the effects of labour unions. Some researchers note the power of labour unions as a factor in workplace injury rates. Other researchers stress work organisation factors in injury rates. Reilly et al (1995) find a relatively positive role for labour unions and union safety representatives in reducing workplace injuries. Nichols (1997) also points out that in small employment units, lack of trade unionism and the unilateral determination of health and safety by management are seen to be partly interrelated constituents of a potentially injurious structure of vulnerability. In this study, these factors are not investigated.

7.6.1.2 Limitations of the qualitative data analysis

(1) Limitation of proxy measurement of work intensity

Work intensity was approximated in several ways: firstly, through in-depth interviews, some workers' opinions are described concerning how work intensity had changed since 1992, when the managers introduced NAC. Secondly, by using the walk-through survey, observation and workers' opinions are taken at each workstation to explore how the work process had changed. Thirdly, several indicators are used using documents and newspapers from the management side as well as the labour union in order to assess work intensity. Other indicators are the change in the number of cars produced per person, the change in the Job Per Hour rate, and the change in the number of hours worked per week. It was quite useful to take the workers' opinions about their working conditions as they are 'experts' for their work, but it does have limitations, as it is a subjective judgement. Thus, objective measurement of work intensity needs to be developed and used in any future study. This study may also miss some other aspects by focusing on work intensity.

(2) Limitation of sampling methods in qualitative study

A total of 70 workers participated in the in-depth interviews. Thus, even though the walk-through survey was added in an attempt to understand and verify workers' opinions concerning their conditions, the sampling size remains small, an obvious limitation.

In addition to this, sampling bias in the choice of interviewees is possible. In particular, given that most interviewees were assembly line workers, the walk-through survey was undertaken mainly in the proximity of the assembly lines. This choice was motivated by our focus on work intensity. It made sense, therefore, to interview assembly line workers given that they generally began the interviews by nominating work intensity as their most pressing concern. Evidently, then, a sampling bias is possible given the relative absence of workers from other departments.

7.6.2 Main findings

This study aims at understanding the relationship between working conditions (work department, shift work and conveyer line work and work intensity) and workplace injury rates. In particular, this study makes a qualitative interpretation of working conditions, focusing on the relationship between employers and workers.

The main findings of this study are as follows. The press, body and engine departments have higher hazard rates for severe injuries; the press, engine, and supporting departments for lower-back pain; and the assembly line (with wider confidence interval) and supporting departments for HIVD. Also the relationship between departments and injuries remains the same after adjusting for age, tenure, income, job status, and for all of these variables. The hazard rates of lower-back pain and HIVD have also increased from 1995 to 1997, even though serious injuries decreased over this time. The apparent increase in hazard rates for lower-back pain, a relatively broad category which includes HIVD, is largely explained by increases in hazard rates for HIVD, from 1995 to 1997. In particular, hazard rates of lower-back pain and HIVD among assembly line workers increased over this time compared to other work departments. The workers also experienced intensified work during this period in this factory. This suggests that work intensity can be a possible explanatory variable of workplace injuries in the car factory. There is an inverse relationship between income and workplace injuries. This relationship remains after adjusting for age, tenure, department, and status. Ordinary manual workers have higher hazard ratios than foremen or supervisors, a pattern which remains when adjusted for other variables. Working conditions and socio-economic factors contribute independently to workplace injuries.

7.6.3 Possible explanations of main findings

7.6.3.1 Age, tenure and workplace injuries

The younger group have a higher crude workplace injury rate, but the difference in workplace injury rates among different age groups is not significant after adjusting for the duration of employment. These results are in substantial agreement with those of Kraus et al (1997). They find that unadjusted, lower-back injury rates are highest for those less than 25 years of age and those with less than 2 years of current job experience.

Two reasons could explain why workers who have a short period of employment have higher injury rates: firstly, these workers may be in the most physically hazardous working conditions, i.e. because they are new and existing workers in these areas move on to less hazardous work in the factory. In interview, one worker notes that "the average age is very high in this factory... therefore, we give the easier jobs to the older workers...". Secondly, we cannot exclude the healthy worker effect. In each department, healthy workers may remain among the old and long-employed workers (McMichael, 1976). Fox and Colier (1976) note that "three factors are involved in the healthy worker effect: the selection of healthy members from the source population, the survival in the industry of healthier men, and the length of time the population has been followed" (Checkoway et al, 1989). Kraus et al (1997) also explain that the healthy worker effect could occur in a study of musculo-skeletal disease, especially lower-back pain. Firstly, there is a healthy hire effect: persons with severe, acute, or chronic/recurrent lower-back pain might not be hired into specific high-exposure jobs; secondly, the secondary selection effect: persons who develop back pain on a job may change to a lower exposure job or leave the workplace entirely. They also explain that when ill workers leave a cohort, the remaining cohort members are likely to be healthier. Kraus et al (1997) note that one way to estimate the impact of the healthy worker effect in a study of lower-back injuries is to determine the occurrence of lower-back injuries in persons who change or leave jobs. In this study, there may have been a healthy worker effect for the older and longer employed workers.

7.6.3.2 The relationship between department and workplace injury rates

This study shows that the departments of press, body welding and engine processing have higher hazard rates for severe injuries; press, engine, and supportive departments for lower-back pain; and assembly, engine, and supportive departments for HIVD. This pattern tends to be reflected in the relationship between job tasks and the type of workplace injuries.

From the in-depth interviews and walk-through survey, the workers in departments having 'severe injuries' - from open wounds to traumatic amputation - seem to deal with heavy machine and heavy tools (See 7.5.2.1). For example, some press line workers have to move the steel sheets by hand. Even if the process is fully-automated, steel sheets have to be moved at the beginning and end of each series of machines (See 7.5.2.1). For body welding, workers have to deal with big welding machines. Workers are wounded by welding machines as well as steel sheets (See 7.5.2.1). The workers in the engine assembly and processing also note that the floor of the engine plant is often very slippery (See 7.5.2.1).

In contrast, the incidence of lower-back pain and HIVD seems to be most frequent in the assembly line and supportive departments, even though 95% confidence interval of HIVD was wider for the assembly line (See section 7.5.2.1 and table 7.10). Assembly line work includes highly repetitive and badly-postured tasks. Most assembly line workers need to bend and twist the lower-back area more than 90 degrees. Workers know very well the exact work station where the incidence of lower-back pain and HIVD are most frequent.

On the other hand, there are several reasons why supporting departments have higher lower-back pain and HIVD. Firstly, some of these departments carry heavy materials from outside the conveyer line. Secondly, some workers who already have injuries, especially lower-back pain, may be moved into these departments as they avoid highly repetitive work. An interesting point is that the press line has relatively lower workplace injury rates. Even though the workers in the paint department have repetitive, as well as badly-postured work, the grade and severity of injury does not follow other departments. Nevertheless, the paint line has other hazards such as solvents, which are not investigated here. Therefore, the hazard rates of workplace injuries for departments and understanding working conditions through in-depth interviews as well as walk-through survey suggest that workplace injuries are primarily related to workers' job tasks. However, there may be some limitation because these categories of work department may be too broad to measure working conditions for individual workers. Yet our interpretation of why other supportive departments have higher injury rates for lower-back pain and HIVD might be *post hoc* as these departments are not focused on in the interviews and walk-through survey.

There has been little research into the relationship between work department and workplace injuries in car factories in Korea. Several projects on the relationship of physical loads and work departments with workplace injuries in car factories have been undertaken by researchers and labour union members (Kang et al, 1996; Park et al, 1996; Son, 1996a, 1996b and 1997). These reports show that body welding and assembly line departments have higher increasing crude rates of workplace injuries for all causes and lower-back pain compared to other departments in Kia car factories from 1991 to 1995 (Son, 1996a). Also, the assembly line has a higher repetitive motion of lower-back area and a higher prevalence of lower-back pain in the Kia car factory (Son, 1996a).

In another car factory (Asia), the body welding and assembly line of a buses has higher age adjusted incidence rates of workplace injuries for all causes and lower-back pain than the small car or truck departments in 1996 (Son, 1997). This factory (Daewoo) also shows that crude injury rates increased from 1993 to 1996. Our study corresponds to several previous studies, which are carried-out in the same car factory (Son, 1996b). That is, the assembly line, body welding, and engine plant departments have increased workplace injuries. Also, the assembly line had higher repetitiveness in the lower-back area and prevalence of lower-back pain. In addition, this study extends a little further by undertaking a follow-up analysis as well as understanding the risk factors of workplace injuries in working conditions through in-depth interviews and a walk-through survey.

7.6.3.3 The relationship between work intensity and workplace injury rates

This study finds evidence of increasing work intensity over a number of years, 1995-1997 and finds that the hazard ratio trends for lower-back pain also increased over this time. However, for severe injuries, the hazard rates decrease. This may be because lower-back pain and repetitive strain injuries could be caused by the increase in work intensity, whereas the serious injuries tend to be caused by machine operation or other safety issues which may not have increased between 1995 and 1997. This study has the limitation of a short study period in order to explain the relationship between workplace injuries and work intensity over time. Another limitation of this study is that there may have been some intervention by labour unions, which is beyond the scope of our study.

Furthermore, the reporting of some workplace injuries in this factory may have been dependent on the relationship between employers and labourers. While employers introduced a Japanese management system into the workplace, worker's power began growing after various struggles at the beginning of the 1990s. Thus, during 1996 and 1998, the leaders of the labour union became quite strong. This study could not prove how the labour union's activity affected working conditions and the incidence of workplace injuries. While there has been increasing evidence of a growth in lower-back pain with the introduction of the Japanese system in 1992, a strong labour union may have encouraged workers to visit the factory clinic more often to receive treatment. This may have contributed to the increase in the number of reported injuries. However, there is no clear evidence of this from the study. Nevertheless, these results lead us to believe that heavy work departments and work intensity are two factors in the increase in workplace injuries.

There has been little research relating work intensity and workplace injuries in Korea. A few studies describe workers' self-reporting of changes in work intensity through questionnaires and changes in workplace crude injury rates over time (Son, 1996a, 1996b and 1997). In the Kia car factory, increasing crude workplace injury rates corresponded with increasing work pace and a decrease in the number of workers from 1991 to 1995. The Daewoo car factory studied here also showed increasing workplace injury rates for all causes from 1993 to 1994 in a previous study (Son, 1996b). During that time, there was an increase in work pace as well. Only a few studies show the relationship between work intensity and workplace injuries around the world. Grunberg (1983) asserts: 'the greater the intensity of labour, the higher will be the incidence of accidents' (Nichols, 1997). Novek et al (1990) also describe the intensified labour process, highlighting line speed-ups and a growing risk of repetitive strain injuries as one of the leading causes of rising injury rates in the meat industry during the 1980s. Recently, several researchers have also noticed that repetition and speed-ups of the assembly line are 'inherently' harmful (Graham, 1995) and cause a high incidence of work related injuries (Berggren et al, 1991). Kenney and Florida (1993) also note that physical injuries are the obvious consequences of a faster work pace. According to Nichols (1997), the increased speed of throughput, made technically possible by the more specialised and mechanised packing houses, results in an intensification of labour which both contributes to increased productivity and leads to increased injury rates. Nichols (1997) suggests that the intensification of the labour process is probably part of a wider deterioration, which also entails increased corner cutting, the neglect of maintenance and other injurious practices, such as the neglect of worker training.

The increasing tendency to more intense working practices around the world may be for worse in Korea than in industrialised countries. Korea has been notorious for high levels of labour-driven work intensity for a long time. Williams et al (1994) show how industrialising enterprises among Asian countries have low wage competition: i.e. the lowest income level and the longest working hours compared to other industrialised countries e.g. Sweden and Germany. For example, if working hours are an indicator of work intensity, Korean workers annually work 2700 hours or more per worker up to 1989, whereas the workers in other advanced countries e.g. Germany, Italy, and Sweden worked at or below 1550 hours per year, while the Japanese work around 2,200 hours per year. Therefore, the main driving force behind productivity increases in Korean car factories might in the end be labour-driven work intensity. Despite the introduction of high technology, intensification of labour still increases. This corresponds with the study of injuries in the mining industry in Turkey, Nichols (1997) concludes that productivity had an adverse effect on the injury rate at Zonguldak because miners are subjected to a system in which productivity itself was labour-driven.

7.6.3.4 The mechanism of increasing work intensity

The Daewoo car factory introduced the NAC I and II management systems, which were imported from the 'Japanese model' and combined with existing Fordist modes of production in the workplace, in 1992. The technical aspects of the application of the Japanese model to the internal operations at Daewoo are that of: (a) reducing excess labour and time through tight control; (b) close monitoring of quality and making the workers responsible for the self-monitoring of quality. Since 1992, the management strategy has been more focused on the reduction in the 'excessive' labour force by increasing the work pace and reducing the number of workers, resulting in increased work intensity. An interesting finding in this study is that work intensity has increased in several different ways according to different situations such as external economic conditions and the power relationship between the workers and employers. For example, when workers lose their power during economic crises, for example, work intensity increases in more obvious and direct ways, i.e. through a massive reduction in the number of workers as well as an increase in work pace.

Managers regularly measure working times with stopwatches, which has been the main evidence for the speed-up and the reduction in 'idle time in the work process'. Braverman (1974) points out that 'stop watch' and 'speed-up' are the principles of Taylorism, which is a capitalist mode of production, exploiting workers through work intensification in the workplace. Thus, this study provides evidence that 'new' management systems, so-called NACI and II, adapted from 'Japanese model', are not different from or even beyond the principles of Taylorist or Fordist management. Recently, many researchers have agreed from their field studies that Japanese (or 'lean') production is not beyond the traditional capitalist mode of production and can be even worse than Taylorism or Fordism (Fucini and Fucini, 1990; Garrahan and Stewart, 1992; Graham, 1995; Moody, 1997; Rinehart et al, 1997; Delbridge, 1998; Danford, 1999; Parker and Slaughtor, 1988). Delbridge (1998) also points out that "the situation does not represent a discontinuous departure from traditional manufacturing, but rather an extension of the principles of Taylor through the systematic standardization of tasks within a context of heightened managerial dominance and control."

New technology is used to reduce the number of workers in this car factory. For example, automation has been introduced in the press, body welding, paint line with massive reductions in workers. Braverman (1974) also notes that the result of technology is not the elimination of labour, but the reduction of the workers to the level of an 'instrument' in the production process. Similarly, introducing a new model of car or 'simplification'[23] of the work process results in increased work intensity according to workers' opinions. It also implies two things: firstly, the amount of work has not changed for each worker as jobs are re-distributed after reducing the number of workers and for several workers the job posture becomes worse with a new car. Secondly, simplification means that workers are de-skilled (O'Grady, 1995; Moody, 1995) and degraded (Braverman, 1974). According to Braverman, with the development of the capitalist mode of production, the very concept of skill becomes degraded along with the degradation of labour and the yardstick by which it is measured shrinks to such a point that today the worker is considered to possess a skill if his or her job requires a few days or weeks of training, several months of training is regarded as unusually demanding

Since 1997, while the frequency and time of regular group or team meetings (so-called 'meeting for one mind for production') has been reduced, another strategy for 'squeezing the little portions' in the working time has been strict regulation and discipline during work time. Workers have usually been escorted by supervisors and foremen just before and after finishing work. Therefore, workers have felt it to be a problem even to visit the toilet. The quality control system, so-called 'workers' real name' system is another mechanism to close-up porosity and reduce any 'idle time' in the work process. Danford (1999) also sees tight control of working time ('bell-to-bell working') in the Japanese transplant factories in Britain and notes that the company's bell-to-bell system is designed to eliminate idle time, maximise labour utilisation, and to reduce individual worker control over the pace and rhythm of work by the introduction of a more disciplined control system. While workers' time is being squeezed out in the work process, one interesting finding is that outside of the workplace, or in rest time, supervisors and foremen make friendships with workers and therefore attempt to separate workers from the union.

In summary, in this car factory, with the introduction of the Japanese model, work intensity has increased through increasing work pace, reducing the number of workers, and tightening the control of work during the work process. It suggests that this work

[23] Managers assert that 'the work process became simplified' with introduction of new technologies and reduced numbers of workers.

process is no different to Taylorist management in principle and in application. In addition to this, it implies that increasing work intensity depends on the power relationship between employers and workers.

7.6.3.5 Socio-economic differences and workplace injuries

(1) Income and workplace injuries

This study shows that the lower income group has higher hazard rates for severe injuries, lower-back pain and HIVD. It remains after adjusting for age, department and job status. In particular, there are very strong relationships between income group for lower-back pain and intervertebral disc herniation.

There has been little research about the relationship between workplace injury and income level in either Korea or elsewhere. Kirschenbaum et al (2000) use the data source of 200 injured workers entering hospital emergency wards, and find that high-paid employees have higher injuries (OR: 1.7). Cubbin et al (2000) notes no difference in all non-fatal injuries for income. However, these two studies consider all injuries rather than dividing them into specific sub-categories. Therefore, the difference in injuries among different income group may not be obvious. Furthermore, dangerous or hazardous jobs may have higher than usual wages; however, this special case does not seem to effect the inverse relationship between income and injury. In general, the lower income group relates to elementary or labouring work, which tends to be mostly hazardous and dangerous manual work (Tables 4.38 and 6.21).

(2) Job status (grade of employment) and workplace injuries

Shop floor workers with low job status have higher hazard ratios for severe injuries and lower-back pain than foremen or supervisors. After adjusting for age, tenure, income and department, the association between job status and injury rates remains.

In this study, job status may effect injury hazard ratios directly in terms of different working conditions or indirectly as socio-economic status. For example, higher job status is related to higher income (Table not shown). Thus, in the workplace, supervisors with higher income are away from the repetitive and more physically demanding tasks. Foremen are directly involved in production, but only from time to time, under the direction of the supervisor. However, ordinary workers cannot leave their workstation. This may be one of the reasons why foreman and supervisors have lower hazards ratios than ordinary workers.

7.6.3.6 The relationship between work conditions and socio-economic factors

The lower income group or shopfloor workers have higher hazard rates for severe injuries, lower-back pain and HIVD, compared to the higher income group or supervisors and foremen. The differential relationship between socio-economic conditions (income and job status) and workplace hazard rates remains after adjusting for work department. Also, the relationship between work department and workplace hazard rates are slightly lessened but remain after adjusting for socio-economic factors. These two factors, socio-economic status and work department, thus contribute independently to the workplace hazard rates.

Three reasons for this may be: firstly, different income levels and job status exist independently from work departments. For example, in each department, there exist differential income and status groups. That is, income and job hierarchies exist in each department regardless of the degree of hazard. For example, higher waged supervisors can be based away from physical loads even though they are in a hazardous departments. Secondly, the measuring unit for working conditions is not at the individual level but at the department level. Work departments may not represent individual workers' working conditions. For example, it cannot discriminate between the workers doing the least hazardous work and those who are in the most hazardous situation within a department. This limit on information may leave residual confounding of status by work conditions. Thirdly, socio-economic factors may effect workplace injury rates indirectly; whereas work conditions more directly effect the hazard ratios for workplace injury in the workplace. However, the association between socio-economic factors and working conditions can be observed in the workplace itself. Thus, supervisors are away from the hazardous work conditions and consequently suffer fewer workplace injuries. That is, the lower socio-economic group have higher hazardous working conditions and higher injury hazard ratios.

Little research has done on the relationship between socio-economic factors and working conditions and workplace injuries. This study also could not fully investigate the relationship between socio-economic factors and working conditions, as the working condition factors could not be measured as individual-level indicators but only as department-level indicators.

7.6.3.7 Conclusions

Our conclusions are as follows:

Firstly, the rates of serious workplace injury are higher among workers in the press and body-welding department than among other workers. These departments are found to be highly hazardous working conditions dealing with heavy steel sheets and heavy welding machines through in-depth interviews and walk-through surveys.

Secondly, there is a tendency towards growth in rates for lower-back pain, in particular for HIVD, from 1995 to 1997. In-depth interviews and the walk-through survey tell us that work intensity increased over this time and in line with changes in power relationships between workers and employers.

Thirdly, lower waged workers have higher rates of workplace injuries, especially for lower-back pain. Workers with low job status have higher rates than foremen or supervisors. Thus, socio-economic factors and work department contribute independently to workplace injury rates. Nevertheless, the walk-through survey and interviews support the view that lower income groups and ordinary workers work in more hazardous working conditions than higher waged supervisors.

Fourthly, this study tells us that hazardous working conditions depend on power relationships between workers and employers. Workers already know the solution to hazardous working conditions and increased work intensity. They say: "the solution to the problem of increasing work intensity is to reduce the work pace and working time".

7.6.4 Needs for further research

7.6.4.1 Further understanding and investigation of associations between socio-economic status and working conditions in health

This study has limitations in its ability to identify a relationship between socio-economic factors and work conditions with workplace injuries. Firstly, the study population needs to include all social classes. Secondly, a better measure of working conditions needs to be developed. It ideally should be measured at individual-level of physical workload or hazards. Thirdly, socio-economic factors need to be measured in a way that includes several other variables such as education and housing income. Thus, further study on the detailed mechanisms of how socio-economic factors are related to working conditions, with work-related injuries and diseases in the workplace, is needed.

7.6.4.2 Further investigation of work intensity

Further study is needed to develop the methodology to investigate the effect of work intensity on injuries. This study shows that workers' subjective opinions can play an important role in exploring the workers' health and safety needs. For example, some methods, such as the use of focus groups or participatory action research, need to be supported. Also, objective methods for exposure factors of workers' ill health should be added to this kind of qualitative research.

Chapter 8: A comparison of variable values between NSO death data and WELCO death data due to workplace injury

8.1 Subjective

The objective of the validity study in this chapter is to compare explanatory variables for occupation, education, cause of death, age and sex between two data sources: the death data provided by the National Statistics Office, used in the mortality study presented in Chapter 4, and data from WELCO concerning national deaths due to workplace injury, used in Chapter 6.

Neither data set is problem-free. We propose, however, that the WELCO statistics are more accurate as they are drawn from information given directly by workplaces rather than, with the NSO material, relatives of the deceased. This assumption may be more appropriate in relation to occupational rather than educational variables, however. The information on education taken from WELCO is likely to be no more accurate than NSO data.

8.2 Data source

To explore the validity of our variables, we merge WELCO data on deaths due to workplace injury between 1995-1997, with data from National Statistics Office on deaths occurring during the same period, using social security numbers. The study population is confined to persons aged 20-64. The main variables for the test are occupation, education, cause of death, age and sex.

8.3 Methods

8.3.1 Data linking method and study population

To check the accuracy of our linkage using social security numbers, the outcome of variables not included in the linkage identifier, but which are in both data sets, are compared. For example, we compare 'area of residence' and 'death date'. This method is taken from several Canadian studies concerning data linkage methodologies (Howe, 1998; Newcombe, 1988). Several problems arise here. One concerns the phenomenon of the 'false negative' in matched data for death and injury. For example, in the WELCO data, those (830 people) whose deaths are attributed to workplace injuries sustained between 1995-1997, but who died some time later or whose records were not immediately forwarded to the National Statistics Office, are not matched to the NSO death data. A second problem concerns missing records. In at least one case, where social security numbers as identifiers are missing, the record is simply omitted. A further problem arises in that, in at least one case, three records share the same social security number, more than likely due to recording errors. To avoid this problem, we again omit the data from the record linkage.

Out of a total of 7666 deaths reported to the National Statistics Office between 1995-1997, 799 people injured before 1995 but who died after 1995 are omitted. These deaths are not included in death incidence due to workplace injury figures reported to WELCO during this period. A further case having incorrect information concerning death year is omitted. From the 7698 deaths due to workplace injury reported to WELCO between 1995-1997, two wrongly recorded deaths are omitted. Also, 830 injury deaths, false negatives, reported to WELCO between 1995-1997 when the fatal injury occurred, but not reported to the NSO, are omitted. Consequently, 6866 deaths occurring between 1995-1997 to persons over 20 years of age and reported to WELCO are linked in the present study with those from the National Statistics Office. The final study population is limited to 6513 deaths cases among persons between the ages of 20 and 64 between 1995-1997. Among these cases, we omit 855 variables for occupation, 1071 for education, 1548 for cause of death. This is due to the fact that the original data sets, in a raw, uncorrected state, are used for the validity analysis. In general, cases from the National Statistics Office data match those from WELCO, except for a few cases in which an error occurs in relation to social security numbers.

8.3.2 Statistical analysis

On linking the data sets, two different sources of data are cross-tabulated to determine the percentage of agreement. Correlation coefficient and Kappa index are also calculated.

8.4 Results: value of variables for occupation education, age and sex

8.4.1 The value of occupational variable

Table 8.1 shows the agreement between national death data and national injury death data in classifying manual, industrial workers (craft and related trades, plant and machine operators and assemblers and elementary workers) and non-manual groups (managers, professionals, technicians, clerks and service workers). Some manual workers are promoted into the non-manual group in the national death data from the National Statistics Office (Table 8.1). In particular, as Table 8.2 shows, some industrial workers (craft and related trades, plant and machine operators and assemblers and elementary workers) are promoted to non-manual groups such as 'clerks', 'technicians', or even 'managers' in the national death data from the National Statistics Office (Table 8.2). As a result, the proportion of manual workers among industrial worker deaths could well be underestimated (Tables 8.1 and 8.2). There is also little clarity surrounding the criteria used to discriminate between industrial workers in either survey (Tables 8.1 and 8.2). On the other hand, managers, professionals and technicians are also demoted to clerks in the NSO data (Tables 8.1 and 8.2).

Table 8.5 presents the present study's Kappa statistics. The Kappa index for occupational group is 0.49 when the occupational groups are categorised as manual and non-manual workers; and 0.36 when the occupational groups are categorised in 8 broad classifications excepting agricultural workers (Table 8.5).

Table 8.1 Cross-tabulation of manual/non-manual groups between deaths from the NSO and WELCO data

Standard	Deaths from national death data (From National Statistics Office)		
Deaths from national injury data (WELCO)	Non-Manual	Manual	Total
Non-Manual	950 (88.62)	122 (11.38)	1072 (100%)
Manual	1100 (23.99)	3486 (76.01)	4586 (100%)
Total	2050	3608	5658 (100%)

Non-manual: Legislators, senior officials & managers , Professionals, Technicians & Associate Professionals, Clerks, Service workers & shop and Market Sales Workers
Manual: Craft & related Trades Workers, Plant & Machine Operators & Assemblers, Elementary Occupations

Table 8.2 Cross-tabulation of 8 occupational groups between deaths from NSO and WELCO data

Standard	Deaths from National Statistics Office								
WELCO data	Managers	Professionals	Technicians	Clerks	Service	Craft	Operators	Labourers	Total
Managers	5 (5.32)	7 (7.45)	8 (8.51)	51 (54.26)	8 (8.51)	11 (11.70)	3 (3.19)	1 (1.06)	94 (100%)
Professionals	2 (1.56)	30 (23.44)	31 (24.22)	52 (40.63)	1 (0.78)	11 (8.59)	0 (0.00)	1 (0.78)	128 (100%)
Technicians	9 (2.38)	13 (3.44)	49 (12.96)	233 (61.64)	19 (5.03)	46 (12.17)	6 (1.59)	3 (0.79)	378 (100%)
Clerks	0 (0.00)	7 (3.13)	10 (4.46)	171 (76.34)	6 (2.68)	25 (11.16)	1 (0.45)	4 (1.79)	224 (100%)
Service	1 (0.40)	1 (0.40)	13 (5.24)	112 (45.16)	111 (44.76)	6 (2.42)	3 (1.21)	1 (0.40)	248 (100%)
Craft	1 (0.06)	28 (1.56)	91 (5.08)	240 (13.39)	37 (2.06)	1107 (61.74)	42 (2.34)	247 (13.78)	1793 (100%)
Operators	1 (0.08)	5 (0.39)	30 (2.36)	138 (10.85)	41 (3.22)	209 (16.43)	807 (63.44)	41 (3.22)	1272 (100%)
Labourers	0 (0.00)	3 (0.20)	32 (2.10)	372 (24.46)	81 (5.33)	493 (32.41)	61 (4.01)	479 (31.49)	1521 (100%)
Total	19	94	264	1369	304	1908	923	777	5658

Occupation 8 groups
1: Legislators, Senior officials & managers
2 : Professionals
3 : Technicians & Associate Professionals
4 : Clerks
5: Service workers & shop and Market Sales Workers
6 : Craft & related Trades Workers
7 : Plant & Machine Operators & Assemblers
8 : Elementary Occupations

8.4.2 Value of educational variable

Table 8.3 shows the extent to which educational groups are promoted or demoted between NSO and WELCO death data. An interesting point is that some groups of middle- or high-school graduates from the national workplace death data are re-coded downwards to elementary education level in the NSO death data. This may be due to information bias on the part of reporters (relatives of the deceived) in the national death data or, perhaps, due to promotion in the WELCO injury death data. Thus, for the educational variable, we cannot pinpoint the source of the potential mis-classification.

The Kappa index is 0.50 in the two-category classification for education: *beyond* and *below* university levels; 0.32 in the three-category classification: *university*, *high-school* and *less than middle-school*; and 0.25 in the four-category classification: *university*, *high-school, middle-school* and *less than elementary school* (Table 8.5).

Table 8.3 Cross-tabulation of educational groups between NSO and WELCO data

Standard	Deaths from national death data (From National Statistics Office)				
Deaths from national injury data (WELCO)	University	High	Middle	Elementary	Total
University	457 (36.77)	226 (28.07)	78 (9.69)	44 (5.47)	805 (100%)
High	291 (10.63)	1380 (50.42)	565 (20.64)	501 (18.30)	2737 (100%)
Middle	49 (3.75)	413 (31.57)	386 (29.51)	460 (35.17)	1308 (24.04)
Elementary	23 (3.89)	107 (18.07)	133 (22.47)	329 (55.57)	592 (10.88)
Total	820	2126	1162	1334	5442

8.4.3 Validity of causes of death

We test the validity of cause of death data by comparing national death data from National Statistics Office and death due to workplace injury data from WELCO. As WELCO's data is limited to workplace injuries, some deaths due to cardiovascular and other diseases, we use a tripartite categorisation for the comparison: *workplace injuries, deaths due to cardiovascular diseases* and *other causes*.

Table 8.4 shows the degree of agreement among the three categories for cause of death. The Kappa index is 0.69 for the three-category disease classification: *injury, poisoning and certain other consequences of external causes* (S00-T98, ICD10), *diseases of the circulatory system* (I00-I99, ICD10) and *other disease categories* except the two-category classification (Table 8.5).

Table 8.4 Cross tabulation for cause of death between NSO and WELCO data

Standard	Deaths from national death data (From National Statistics Office)			
Deaths from national injury data (WELCO)	Injury	Cardiovascular	Others	Total
Injury	3177 (91.87)	175 (5.06)	106 (3.07)	3458 (100%)
Cardiovascular	219 (17.42)	905 (72.00)	133 (10.58)	1257 (100%)
Others	71 (28.40)	17 (6.80)	162 (64.80)	250 (100%)
Total	3467	1097	401	4965

8.4.4 Age and sex

The Kappa index for the 5-year age band is 0.99. It is well-matched. There is no disagreement for the sex.

Table 8.5 Kappa statistics for occupation, education, cause of death, age and sex between NSO and WELCO data

Categories of variables	Total deaths	Agreement(%)	Expected agreement(%)	Kappa Index
Occupation				
Manual/non-manual	5658	78.40	58.55	0.49
Occupation (3 groups*)	5658	71.40	54.86	0.37
Occupation (7 groups*)	5658	50.85	20.87	0.38
Occupation (8 groups*)	5658	48.76	19.59	0.36
Education				
University/below University	5442	86.93	74.60	0.50
High school/below High	5442	67.29	51.25	0.33
3 groups*	5442	57.79	37.89	0.32
4 groups*	5442	46.89	29.68	0.25
Causes of death				
3 groups*	4965	85.48	54.63	0.68
Age				
5-year bands	6513	99.25	11.76	0.9915
10-year bands	6513	99.65	22.87	0.9954
Sex	6513	100.00	87.91	1.0000

- Occupation 8 groups : 1: Legislators, Senior officials & managers
  2 : Professionals
  3 : Technicians & Associate Professionals
  4 : Clerks
  5: Service workers & shop and Market Sales Workers
  6 : Craft & related Trades Workers
  7 : Plant & Machine Operators & Assemblers
  8 : Elementary Occupations

- Occupation 7 groups : combined 5 into 4 from occupation 8 groups
- Occupation 3 groups : (1+2+3)/(4+5)/(6+7+8) from Occupation 8 groups
- Education 3 groups : University, high school, middle school
- Education 4 groups : University, high school, middle school, elementary school
- Cause of diseases 3 groups : Death due to pure injury, death due to cardiovascular disease, others

8.5 Discussion

8.5.1 The strategy of linking data sets

In linking using our chosen unique identifiers, we note that several records cannot be linked completely by social security number. For these cases, the raw data sets are checked manually. Also, the information for common variables from both data sets, but not unique identifiers, are compared and checked for matching. Howe (1998) notes that, although one may generally take the social security number as a unique enough identifier, in reality this will not always be the case. It is conceivable, firstly, that two individuals could have been issued with the same social security number in error and, secondly, and more importantly, when such numbers are being recorded, errors will almost certainly be made. Thus, even with what is thought of as a unique identifier, errors in linkage can occur even though, in truth, such errors are likely to be small in number. That is, using 'unique identifiers' such as social security numbers may be flawed, as recording errors are inevitable. To reduce this problem, Howe (1998) reconfigures the stages for linking data as follows: (i) making groups with the same injury year; (ii) initial linkage within the same groups; (iii) computing initial error rates; (iv) repeating the linkage; (v) re-computing error rates; (vi) setting lower and upper thresholds; (vii) manual resolution; (viii) creating a set for groups of links.

To link records using unique identifiers, a theory of probabilistic record linkage has been developed by a number of authors (Newcombe et al, 1969; Howe and Lindsay, 1981; Newcombe, 1988; Fellegi and Sunter, 1969). Howe and Lindsay (1981 and 1983) show the measure of relative probability and the method of weights in the linking of record data. Methods for the computerised linkage of records on the basis of identifying characteristics such as 'surname' and 'date of birth' were originally developed in Canada by Newcombe and his associates (Newcombe, 1969). Identifiers used with computerised record linkage in the Canadian studies are: social security number (as unique identifier); first name; surname; month and year of birth; province of residence; place of birth; father's name and place of birth; mother's name and place of birth; occupation and industry (Howe and Lindsay, 1983; Howe et al, 1987; Howe et al, 1986; Howe et al, 1983).

8.5.2 Interpretations of findings

No 'golden standard' is used in this study. However, this comparison may be a starting point for exploring the validation of different sources of Korean death data sets. Information on occupation drawn from injury death data is likely to be more accurate as it originates directly from documents supplied by individual workplaces. However, this is not appropriate for determining educational variables, as we do not know how information on educational achievement is obtained at the workplace level. The educational variable therefore marks a weak-spot in our analysis.

Table 8.5 presents a comparison between national workplace injury data and national death data and tells us that occupational and educational variables are not in the range of 'excellent agreement' suggested by Koch (1977a). According to Landis and Koch (1977a):

> For most purposes, values greater than 0.75 or so may be taken into represent excellent agreement beyond chance, value below 0.40 or so may be taken into represent poor agreement beyond chance, and values between 0.40 and 0.75 may be taken to represent fair to good agreement beyond chance (Fleiss, 1981).

The Kappa indices among occupational and educational groups depend upon the number of categories. A rule of thumb here is: the broader the categories of occupation and education, the higher the Kappa indices. The broader categories for manual/non-manual workers and beyond/below university level seem to exhibit reasonable agreement (0.49 for manual/non-manual group; 0.50 for beyond/below university level). However, the more detailed categorisation leads to poor agreement for occupation as well as education (Table 8.5). Our comparison study suggests strong prediction of random errors, mis-classification as well as systemic errors. We acknowledge major mis-classifications for occupation, education, in either NSO and WELCO data or both. For example, some occupational values are promoted from the manual to the non-manual group (Chapter 4). This might attenuate the relationship between occupational class and mortality, especially in regard to expected values of relative rate ratios for all-cause mortality among manual workers, these may turn out to be less than their true value. In addition to this, we notice a possibility for mis-classification of occupational and educational groups between two data sets, which might bias the effect measure toward the null value (Armstrong, 1998). As for the cause of death, injury and cardiovascular disease from the NSO data are well-matched with those from the WELCO workplace injury death data. However, this comparison may have a limitation as the present study is confined to comparing only the categories of injury and cardiovascular disease.

Few reports exist on the validity of death information in Korea. Kong et al (1983) match each item from the 1980 death registration information to special survey data in three rural counties. In interviews with 994 households (82.8%) among 1201 cases, they show that concordance amounts to about 77.6% for the occupational variable and 79.1 % for the educational variable. This data looks well-matched. Nevertheless, we note a possible limitation, as the study was carried-out in three confined rural areas only. Therefore, occupations other than those based on agriculture are likely to have been omitted. Along with this, the educational data might not include all ranges of education.

In Britain, the OPCS (1978) describes several sources of inaccuracy for occupational variables in census-based as well as death certificate-based surveys. Firstly, some people recorded as 'permanently sick' do not record their occupation in 1971 Census. The authors suggest that this helps to explain the low mortality rate findings in industrial cohort studies. Secondly, varying detail of description recorded by the census and at death registration also influences the use of the occupational classification. Thirdly, while the OPCS (1978) notes that longitudinal studies provide only a limited basis for identifying examples of deliberate promotion by informants reporting a death. Nevertheless, according to Heasman et al (1958), there is evidence of widespread promotion of occupations among coal miners. Fourthly, some mis-classification of occupation in census and on deaths certificates may occur among retired workers. For example, Heasman et al (1958) give strong evidence concerning the tendency for ex-coal miners to be recorded as coal miners when they died even if they had pursued other work subsequent to leaving the mines. Fifthly, there is evidence of differences of social class between death certificates and the census. For example, according to the OPCS (1978), there is a strong tendency for males to be allocated to occupations assignable to social classes I and II more often at death registration than in the census, with a compensating under-reporting of occupations classifiable to social classes IV and V. Finally, some people, such as the members of the armed forces, students and disabled people, are not assigned to their appropriate social classes.

As for the validity study for causes of death, the National Statistical Office in Korea (1991) carried-out a survey comparing causes of death in reported death data to those from interviews by direct visiting and interviewing of 15,710 households (85.8%) among the 19,249 death cases occurring in May, 1991. This report shows that among the households of the deceased, 71.5 % replied that causes of death were confirmed by medical doctors (or doctors of oriental medicine). Particularly in cases of neoplasms, the confirmation rate by medical doctors was about 97%, 94.7% for Ischemic Heart Disease, 91.3% for urogenital diseases and 90.7% for chronic liver diseases (National Statistics Office, 1991). If we assume that the causes of death diagnosed by doctors are more accurate than those reported by families or neighbours, this high confirmation rate by medical doctors may show that causes of death from death reports are believable. In conclusion, even though this study is not based on complete information, comparison between different data sources may help us to understand possible sources of random and systemic errors in national death data in Korea.

8.5.3 Implications of this validity study

The reason why the validity of socio-economic variables (occupation and education) has not been tested may be because the variables in the two data sets (national death data and national death data due to workplace injuries) are not employed for health related research in Korea. This study firstly attempts to use these socio-economic variables in studying inequalities in health and suggests that further validity tests for both data sets are needed. Also, we suggest that national death data as well as workplace injury data need to be carefully collected and organised for use as health indicators in studies relating socio-economic factors and working conditions to mortality in Korea.

Chapter 9: Overall findings, interpretations and implications

9.1 Original hypothesis and main findings

9.1.1 The relationship of occupation, education, income and deprivation with mortality, morbidity and deaths due to workplace injury

The central hypotheses of this thesis are:

(i) Differentials of mortality, morbidity and death rates due to workplace injury exist across different occupational classes, educational, income and deprivation levels in Korea.

(ii) Workplace injury rates are caused by hazardous working conditions such as work department, work intensity, and shift/conveyer work.

The general objective has been to explore the relationship between occupation, education, income, level of deprivation and work conditions and mortality, morbidity, and workplace injury rates in Korea, focusing on the association of occupational class with health. This study is the first attempt to investigate national patterns of occupational and other socio-economic indicators of class and health in Korea.

Manual workers exhibit higher rates of general mortality and death due to workplace injury and higher odds ratios for morbidity among the Korean population (Table 9.1). Death rates for all causes among manual workers compared to non-manual workers in this study were slightly higher than those of European countries (Chapter 4). In addition to this, the difference in death rates due to workplace injury between manual and non-manual workers is much bigger than that of general mortality in Korea. In particular, labourers (elementary workers) have a higher ratio of death rates due to workplace injuries compared to managerial group than do other studies. However, comparing Korean rates with other countries needs caution because the differences in economic structures of other countries may affect the denominator for the rates. For example, the percentage of total employed population in manufacturing sector from Census data in England is smaller than Korea (18% for England[1], 24% for Korea[2]). Table 9.1 shows the strong inverse relationships between different educational levels, with mortality, morbidity, and workplace injury deaths in Korea (Chapters 4,5 and 6). The differences of death rates between lower and higher educational groups were similar between general mortality and deaths due to workplace injury, but greater than the differences of odds of morbidity in Korea. Also, deaths rates for all causes among lower educational groups, compared to higher educational groups in this study were higher than those of European countries (Chapter 4). Lower income groups had higher odds ratios of morbidity than higher income groups among both male and female workers in Korea. For the deaths due to workplace injury, the lowest income group had higher rates than highest income group among male workers (Chapter 6). However, female workers did not show any difference in rates of death due to workplace injury among different income groups (Chapter 6). For non-fatal workplace injury, there was a strong inverse relationship between income and workplace injury (severe injury and lower-back injury) in male workers in one car factory (Chapter 7). Income variables were not available for the general mortality analysis. There was an inverse relationship between deprivation and all causes of mortality in Korea. Also, deprivation and socio-economic factors (occupation and education) contributed independently to mortality risks among both males and females in Korea.

9.1.1.1 Joint relationship of occupation, education and income to mortality, morbidity and deaths due to workplace injury

For mortality, after adjusting for education, the difference of all causes of mortality among manual workers and non-manual workers disappeared for male, however, for women, it still remained. On the other hand, after adjusting for education, the occupational effect on mortality remained for deaths due to infection, mental illness, respiratory, digestive and musculo-skeletal diseases among male workers and for most specific diseases among female workers. For morbidity, the pattern was similar to that for mortality (Table 5.8). This result leads us to believe that education is closely related to occupation. Therefore, there does not seem to be any difference in deaths between manual workers and non-manual workers with the same education level. Actually educational

[1] Data source: 1991 Census (10% sample): from tabulated table, England
[2] Data source: 1995 Census (10% sample): from raw data, Korea

`level is closely related to occupational class among the whole population according to Korean census data (Table 4.34). The least educated group are the manual workers, both male and female (Table 4.34: 86.86% for male; 76.64% for female). We conclude that education is therefore strongly related to occupation with respect to mortality and morbidity.

After adjusting for income, still higher odds ratios of morbidity among manual workers, compared to non-manual workers remained, for both male and female (Table 5.8). The difference in death rates due to workplace injury between elementary workers and managers in fact grew larger. Another interesting point is that the difference in injury death rates between manual workers and non-manual workers was greater in the higher than in the lower income group. This suggests that in the latter group, the risk of death due to manual work and non-manual work are not so different as both kinds of work may be hazardous.

Table 9.1. Summary results of the mortality, morbidity, and deaths due to workplace injury

	Mortality	Deaths due to workplace injury	Morbidity*
Men	RR*(CI)	RR*(CI)	OR*(CI)
Occupation			
Non-manual	1.00	1.00	1.00
Manual	1.65 (1.63-1.66)	7.11 (6.53-7.75)	1.34 (1.05-1.71)
Education			
1 Highest	1.00	1.00	1.00
2	1.68 (1.66-1.71)	2.97 (2.69-3.27)	1.40 (1.00-1.96)
3	3.29 (3.24-3.34)	5.33 (4.81-5.91)	2.13 (1.45-3.13)
4 Lowest	5.11 (5.03-5.18)		2.02 (1.37-2.98)
Income			
1 Highest		1.00	1.00
2		0.70 (0.65-0.76)	0.91 (0.66-1.25)
3		0.55 (0.51-0.59)	1.15 (0.86-1.55)
4		0.46 (0.42-0.51)	1.66 (1.16-2.36)
5 Lowest		1.88 (1.42-2.49)	
Women			
Occupation			
Non-manual	1.00	1.00	1.00
Manual	1.48 (1.45-1.52)	1.32 (1.02-1.72)	1.24 (0.94-1.63)
Education			
1 Highest	1.00	1.00	1.00
2	1.25 (1.19-1.32)	2.52 (1.67-3.80)	1.12 (0.66-1.90)
3	1.98 (1.87-2.09)	1.47 (0.93-2.41)	1.57 (0.90-2.74)
4 Lowest	3.42 (3.24-3.60)		1.82 (1.05-3.15)
Income			
1 Highest		1.00	1.00
2		0.85 (0.57-1.25)	0.94 (0.63-1.39)
3		0.62 (0.44-0.88)	1.25 (0.88-1.76)
4 Lowest		0.20 (0.11-0.36)	1.71 (1.17-2.50)

RR* : Age adjusted relative rate ratio OR* : Age adjusted odds ratio
Morbidity* : For (medically confirmed) chronic disease
Education : For mortality and morbidity – 1: Above university, 2:High, 3:Middle, 4: Elementary
For injury deaths – 1: Above college/university, 2: High 3: Middle,elementary
Income : For morbidity (unit :1000 won) – 1: >150, 2 :100-150, 3:50-99, 4:<50
For injury deaths (unit :1000 won) –1:>200, 2: 150-199, 3:100-149, 4:40-99, 5:<40 for male
1: >150, 2: 100-149, 3:50-99, 4:<50 for female

9.1.1.2 The role of health behaviours in the relationship between socio-economic status – occupation, education, and income - and morbidity

The lower the socio-economic group – manual workers, those with less education and those earning least – the more likely it is for people to exhibit negative health behaviour in Korea. However, health behaviour did not confound the relationship between socio-economic status and morbidity. This result corresponds with the findings of many other studies (Black Report, 1982; Davey Smith G, 1990, 1991, 1994b, 1997; Marmot MG 1984; Chandola T, 1998). Thus, differences in health behaviour may themselves be the result of differentials of socio-economic status.

9.1.1.3 The role of factory size in the relationship between occupation and deaths due to workplace injury

The present study suggests that factory size does not confound the relationship between occupation and deaths due to workplace injury among both male and female workers. However, factory size itself affects death rates due to workplace injury. For example, smaller factories (employing between 10-29 workers) had higher injury deaths rates among men than larger factories. In addition to this, in smaller factories the difference in injury death rates between labourers and managers was greater than in larger factories, especially among male workers. This result suggests that the risk of injury deaths is greater in smaller factories and also those differences in injury death rates between labourers and managers are increased in smaller factories.

9.1.2 The relationship of working conditions and socio-economic factors with non-fatal workplace injury in one car factory

This study exposes a national pattern in which Korean manual workers, especially labourers, suffer significantly higher death rates due to workplace injury (Chapter 6). It also shows that male Korean workers employed in smaller factories have increased injury death rates than those working in larger factories. To further our understanding of both the factors which underlie the statistical correlation between workplace injury and working conditions and the reasons why labourers have higher workplace injury rates than other occupational groups, we undertook a study of the connections between working conditions, socio-economic factors and workplace injuries in one factory (Chapter 7). Although this aspect of the study may not necessarily be generalised to factories as a whole, it can provide some insight into the causal pathways of workplace injury.

In one car factory, the sections that exhibited higher hazard rates for severe injury and lower-back pain were the press, body and engine departments. In particular, the departments using shift working and conveyer lines had higher hazard rates for severe injury. These results were supported by in-depth interviews and walk-through surveys. Moreover, the departments that worked night shifts and conveyer lines proved to be more hazardous than other departments. In particular, rates of lower-back pain, especially for herniated intervertebral discs, increased according to the calendar year, mainly on the assembly lines. These results were supported by workers' opinions, as expressed via in-depth interviews and walk-through surveys, that work intensity had increased since 1992 .

We also saw that ordinary workers who had lower-status jobs had increased hazard rates for severe injuries and lower-back pain than foremen or supervisors, those with higher-status jobs. Also, the lower income group had higher hazard ratios for severe injury and lower-back pain, compared to the higher income group. Statistically, socio-economic factors and working conditions seem to impact independently on hazard rates for workplace injury.

9.2 Interpretation: causal pathway of risk factors on health differentials

This study provides evidence for the existence of national patterns of higher mortality, morbidity and death rates due to workplace injury for both male and female manual workers compared to non-manual workers in Korea. These findings lead us to believe that occupation may have an indirect but significant effect, on a par with socio-economic factors, for general mortality and general morbidity as well as a direct impact on the workers' physical working conditions. In particular, occupation directly affects workplace injury rates. To link these pathways, workers in lower socio-economic class usually work in the most hazardous conditions in workplace. Therefore, hazardous working conditions directly effect the health of these workers but they also have a health impact as an aspect of the whole of the workers' material conditions.

Education is shown to be a strong factor in the unequal distribution of mortality, morbidity, and death rates due to workplace injury. It also affected the relationship of occupational class with mortality and morbidity rates for both men and women. After adjusting for education, the differences in mortality and morbidity rates between manual and non-manual workers seemed to be lessened or even to have disappeared. However, our interpretation of this phenomenon is that educational level did not loosen the connection between occupational class and mortality and morbidity. This idea is borrowed from Navarro (1998), who argues that the relationship among different explanatory variables with health is not linear, but dialectical:

> Under Capitalism, class relations are relations that structurally define the matrix in which other relations relate. Needless to say, other variables such as race and gender could be conjuncturally more important than class in specific contexts and conjunctions; but class is always there and on many occasions organises the frame in which other variables relate. This explains why under capitalism, class differentials in mortality are in general larger than race differentials in mortality. (p398).

The role played by educational level in affecting mortality and morbidity rates may be stronger in Korea than in more advanced developed countries for several reasons. Firstly, there are financial barriers preventing poor people from entering universities, as these are mostly private organisations charging high tuition fees. Secondly, lower education level may act as a strong barrier to achieving better occupation and better material conditions, which may lead inequalities in health in Korea. These barriers tend to be transmitted from generation to generation. That is, the father's occupational class usually tends to determine their children's educational level. Also as skills obtained from education or training enable the specialisation of labour-power[3], gaining a better education can be the main reason for obtaining better employment. Therefore, the difference between a university and high-school level of education can be correspondent with the difference between manual and non-manual in Korea (Tables 4.34 and 4.35)

The lower income group had higher morbidity and workplace injury death rates than the higher income group among male workers. National statistics from the Korean Government also show that labourers earn less than the managerial group. Lower waged labourers also usually work longer hours in Korea (Table 6.21). This may suggest how we can relate lower income to lower occupational status and more hazardous working conditions. Nevertheless, in the chapter on injury deaths in the workplace, the reason why income seemed to have little impact on the relationship between occupation and injury deaths may be due to the indirect role of income levels on injury death rates compared to the direct nature of the effect of occupation. In addition, lower income indicates the level of material deprivation in a person's general life conditions.

Even though some studies focus more closely on the psycho-social factors that are associated with relative poverty or income (see Wilkinson, 1996 for example), as Muntaner and Lynch (1999) argue, investigations into the role of income in health inequality should concentrate on class relations. This approach might help explain how income inequalities are generated and account for both relative and absolute deprivation. The *Black Report* (1980) indicates that relative as well as absolute poverty exists. It states that "people may still have too little for their basic physiological as well as social needs.

[3] According to Marx (1981): "In order to modify the human organisation, so that it may acquire skill and handiness in a given branch of industry, and become labour-power of a special kind, a special education or training is requisite, and this, on its part, costs an equivalent in commodities of a greater or less amount. This amount varies according to the more or less complicated character of the labour-power. The expenses of this education (excessively small in the case of ordinary labour-power), enter *pro tanto* into the total value spent in its production."

Poverty is also a relative concept, and those who are unable to share the amenities or facilities provided within a rich society, or who are unable to fulfil the social and occupational obligations placed upon them by virtue of their limited resources, can properly be regarded as poor". The *Black Report* also noted a "tendency for those with the lowest relative income standards to increase in number and proportion in the UK".

We therefore conclude that, with regard to income inequality, the lower income group can be closely related to the lower occupational group and hazardous working conditions and this income inequality can still be seen to be a major source of material deprivation. In summary, the results from this and other studies suggest that occupation, income, educational achievement and material deprivation are closely related as leading factors of inequality in health in general.

We find that health behaviours - diet, exercise, smoking and alcohol intake - do not significantly confound the relationship between occupation and morbidity. Also, this study shows that the lower socio-economic group (in terms of occupation, education and income) exhibited much worse health behaviours, especially as regards smoking and exercise. This study provides evidence which backs up the contention that the role of health behaviours, which have been a major focus of health promotion strategies in Korea, should be re-considered. In particular, this study implies that socio-economic factors should be seen as central risk factors in such strategies. Many studies have found that health behaviours do not confound the relationship between socio-economic status and ill-health (*Black Report*, 1982; Davey George Smith, 1997). The *Black Report* explains this well: "behaviours do not explain away class differences, but contribute to them, and push the explanatory task further back to ask why such behaviours are persistently more common in poorer groups". In addition, different health behavioural factors originate out of the difference in social classes (Javis and Wardle, 1999; Bennet et al, 1996). As the *Black Report* suggests, culture/behaviour cannot be explained independently of class. This study suggests, therefore, that health behaviours can be seen to be derivative factors on the causal pathway, not independent (or confounding) factors.

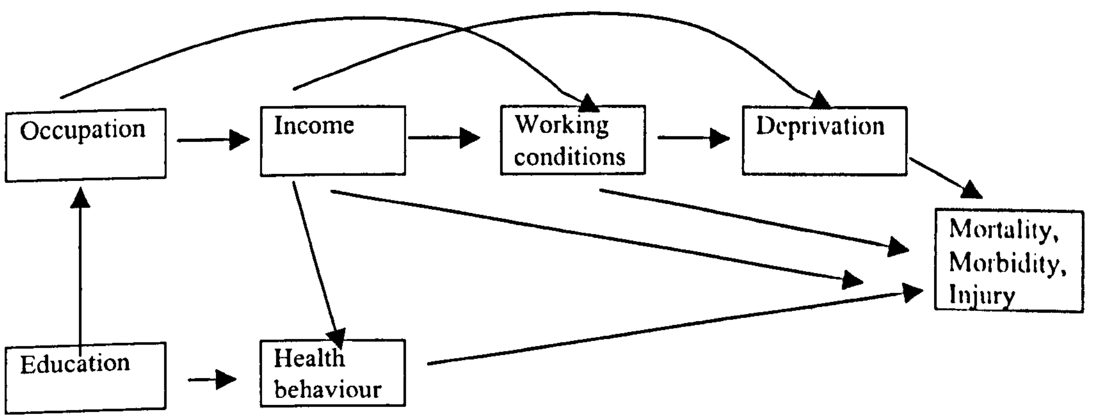
To understand the relationship of working conditions and socioeconomic factors with workplace injuries, we focus on a particular car factory and attempt to understand the causes of hazardous working conditions, particularly work intensity. As stated above, this may not be generalised to all the industries in Korea, it can provide a clue for research into general mechanisms of health inequality. We found that departments with more hazardous working conditions (press and body welding departments) had higher hazard ratios for severe injury and lower-back pain, compared to other departments. For HIVD, assembly and supportive departments had higher rates. Also, conveyer line and night-shift work entailed higher hazard ratios for severe injury and lower-back pain. In particular, there was an increase in the incidence of low back pain and HIVD from 1995 to 1997. Also, the in-depth interviews and walk-through survey show that work intensity increased over this time.

This relationship between working conditions and hazard ratios for injury remained after adjusting for socio-economic factors (income and job status). There was a strong inverse relationship between income and hazard ratios for lower-back pain and HIVD. Shop floor workers in the workplace had higher workplace injury than supervisors or foremen. This relationship between socio-economic factors and hazard ratios for injury remained after adjusting for working conditions. Working conditions and socio-economic factors look as if they independently affect workplace injury as a statistical finding. However, our interpretation is that working conditions and socio-economic factors are inter-related with each other in the incidence of workplace injury. For example, supervisors have higher wages than shop floor workers (Table 7.21); they are also physically away from hazardous working conditions as their task is supervising and organising the shopfloor workers in each unit. There was big difference in hazard ratios for severe injury as well as lower-back pain between supervisors and shopfloor workers. This may suggest that low socio-economic status is related to hazardous working conditions. In addition to this, according to Korean Government, lower socio-economic group generally works long hours (Table 6.21) and has a lower income (Tables 6.21 and 7.21). This study suggests that those earning less and of lower socio-economic status who work in more hazardous conditions have higher severe injury as well as lower-back pain, in this car factory at least. This is one of the causal pathways in the relationship between social class and health.

Few studies have been carried-out on possible associations between socio-economic factors and physical work conditions with regard to workplace injury. The *Black Report* recommends that "health hazards in relation to occupational conditions and work" should be studied in the future. Our research would contribute in this research area. The findings in this study may be correspondent with a 'materialist approach' based on the analysis of class relations, which explains inequality in health in the Black Report (pp106-107, pp114-115). The *Black Report* states that "amongst explanations which focus on the direct influence of poverty or economic deprivation in the production of variation in rates of mortality is the radical Marxian critique" (p106). It argues further that "it is in some form or forms of the 'materialist' approach that the best answer lies" (p114). The approach recommended in this study can also be linked to the conclusion drawn by David Smith G et al (1994) that overall social class gradients in health can be explained in materialist terms by the accumulation of multiple factors over the course of life. The present study can also be connected to the argument put forward by Navarro (1997) that class relations are the most important factor in understanding inequalities in health.

In conclusion, this study suggests that material deprivation based on class differentials is the main factor in inequality in health in general. In particular, it suggests that the difference of occupational class is one of the main risk factors determining inequality in health. Many other determining factors can be derived from social class: education, income, deprivation, working conditions and social behavioural factors can be explained as intermediate factors in the relationship between different social class and health differentials. In particular, hazardous work tasks and increased work intensity can be a main factor in workplace injury. Therefore, the causal pathways are as follows:

Figure 9.1 Causal pathways between socio-economic factors and work conditions with mortality, morbidity, and workplace injury



This study shows a strong correlation between occupation and education, both of which are associated with mortality and morbidity in Korea (Chapter4, 5). The role of income on differentials in health seems much weaker (Chapter 6). Health behaviour seems to have only a very week impact on morbidity and does not significantly confound the relationship between occupational class and morbidity (Chapter 5). On the other hand, working conditions (firm size, hazardous work tasks and increased work intensity) are the main risk factors of workplace injuries (Chapter 6, 7). Finally, area based deprivation also seems to have an impact on mortality in Korea (Chapter 4).

9.3 Implications

9.3.1 Equity: which strategies ought to be adopted in combating health inequality?

Researchers carrying-out epidemiological studies on health inequalities have discussed the political implications of such inequities from several different point of views. Most obtain similar results: inequality in health exists between different social class. However, significant differences have emerged, with political implications, when it comes to recommendations for action. Firstly, according to Heymann (2000), "Investments in human capital have also been raised as one way to decrease social inequalities". Initiatives for increasing 'human capital' may take the forms of job training or education. In addition to this, Heymann suggests civil rights legislation as a way of decreasing social discrimination. Such suggestions can be seen as libertarian in inspiration. Libertarians emphasise respect for individual liberty, including the right to life and to personal property (Williams 1993).

The question is: can this solve the problem of inequality in health? We suggest that health inequality cannot be solved simply by asserting an "equal right of equal access in health care." Marx pointed out that the idea of an abstract 'equal right' makes no sense in an unequal society. Marx's point is that the origin of inequality should be found in the class relations. As Le Grand (1982) points out, this idea may be based on the fact that the present structure of inequalities is basically fair, that people deserve the income they receive, and that by and large, the rich are deserving and the poor undeserving. Therefore, Le Grand concludes that the strategy of equality through public provision has failed primarily because it implicitly accepts the ideology of inequality. As an alternative strategy, Le Grand suggests an attack on that ideology.

Secondly, many researchers see a solution in an increase in public investments making an impact on total welfare (or total happiness). This idea might best be described as utilitarian[4]. Utilitarianism emphasises "total welfare with a just aggregation rule, such as that everyone should count for one and nobody for more than one" (Williams 1993).

[4] The indirect version of utilitarianism can be summed-up as follows: "even if we do not know that, we may know of the general impact institutions, values, and character have on the happiness of those affected by them" (Blackburn 1994).

However, as Le Grand argues, "most public expenditure on the social services in Britain (and elsewhere) is thus distributed in a manner that broadly favours the higher social groups, whether 'higher' is defined in terms of income or occupation". Thus, public expenditure on the social services has not achieved equality in any of its interpretations.

Thirdly, as with egalitarianism, inequality in health can be reduced by 'equal access' or 'redistribution'. For example, Wilkinson (1997) suggests that 'national mortality rates can be lowered by redistributing income'. Wilkinson also argues that "we need to reduce both the proportion of the population who fall behind, and the distance they fall behind, on each of these core criteria" (1999). Many studies on inequalities in health care may be included in the egalitarian regime. In addition to this, the solution for inequality of health care category looks to be more focused on 'equal access', or 'capacity to benefit'. Mooney G et al (1991) stress equal access for equal need as defining equality in delivery of health care. Culyer[5] (1991) suggests 'capacity to benefit' as the solution: 'if there is no effective care it cannot be held to be needed, but if there is, and it can benefit a particular individual, then the individual is in need (of health care)'. This concept of 'capacity to benefit' extends to cost-effectiveness or effectiveness of intervention.

The above are the main forms of the redistribution strategy in the contemporary era. However, one question concerning egalitarianism remains unanswered: what kind of equality is it possible to achieve without consideration of class relations? We still have no evidence that a redistribution policy would overcome inequality in health. Kunst et al (1998a) frankly confess that there is no evidence that mortality differences are smaller in countries with more egalitarian socio-economic policies. Focusing on redistribution may not be a strategy to overcome inequality on health at all if class differences remain in place despite the maximisation of egalitarian effects. Adler et al (1993), for example, point out that beyond providing access to care and using clinical practice to reduce social inequalities other inequalities associated with socio-economic status would remain.

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[5] Culyer (1988) argued that since the objective of health care services is to promote health, the equity goal of health care must be conceived in the same terms, i.e. in terms of equality of health. In addition, he develops the concept of vertical equity (unequal treatment of individuals who are unequal), being beyond the concept of horizontal equity (equal treatment of individuals who are equal), in which researchers have sought the solution of inequality in health. Based on this concept of equity, Culyer suggested 'capacity to benefit'.

On the other hand, based on our three 'core' concepts - libertarianism, utilitarianism and egalitarianism - the policy implications drawn out by many researchers' have often corresponded to contemporary government policies. All three might best be viewed as different versions of redistribution whose success seems to depend primarily upon government action. The question is therefore whether governments can solve inequality in health or not. As Le Grand (1982) points out, the objectives of equality of public expenditure, of use and of outcome only really make sense as a limited (and thereby supposedly more acceptable) version of the underlying aim of greater overall equality. If any strategy of equality is to succeed, it has to tackle these inequalities directly. Therefore, researchers' policy implications need to be focused on why government policies cannot solve inequalities in health rather than taking government action as a given.

Fourthly, several researchers focus on structural or class relations. This idea is closer to Marxism. In the Marxist view, equity cannot be achieved in a society without consideration of the basis of class relations (class conflict or struggle). In this perspective, class consciousness and class solidarity among lower class people is the key to solving the problem of health inequality. Muntanet and Lynch (1999) criticise Wilkinson's model for its focus on social cohesion rather than political change. They argue that Marxian class-based explanations, focusing on class exploitation, are preferable because they expose the social mechanisms of exploitation in a way that income distribution models cannot. Kaplan et al (1996) also criticise Wilkinson's relative income theory and argue that structural characteristics are more important in the relationship between income inequalities and inequalities in health than their psycho-social consequences. Krieger and Fee (1994) stress that the important thing is to force the issues of class and health to the centre of the political agenda. Navarro (1998) also points out that class is the most potent variable to explain mortality and morbidity differentials in the USA. Class and class relations are consequently also of primary importance in the understanding of world-wide relations and their impact on health.

If the main cause of inequality in health is class relations or class itself, the clue to the solution ought also to be located at the level of an analysis of class relations. Policy options need, therefore, to avoid the platitudes associated with the idea that any possible solutions must lie in government action. To tackle inequalities in health, the detailed mechanisms of how differences in class bring about inequality in health and widen the gap between rich and poor need to be investigated. Moreover, evidence of inequalities in health would be better received and discussed by the underprivileged themselves: manual labourers, workers' representatives or union leaders are in the best position to effect genuine changes in working conditions.

9.3.2 Toward further understanding of the relationship between socio-economic class and working conditions and taking the policy against inequality in health to the workplace

9.3.2.1 Work intensity: what are the forces driving it upwards?

The evidence gathered through in-depth interviews and walk-through surveys, this study indicates that work intensity has increased. There has been a marked tendency to speed-up work processes and to reduce the number of workers involved. These findings correspondent to evidence of an increased incidence of lower-back pain or herniated intervertebral discs in the same time period. Therefore, the workers' concerns regarding health and safety issues in car factories mainly focused on the intensification of the working experience: the speeding-up of processes and reductions in the number of workers. This study therefore suggests that work intensity can be seen as one of the sources of inequality in health in workplace.

Our evidence supports the contention that work intensity has increased through mechanisms which are specific to the capitalist mode of production in manufacturing . The fundamental mechanism for increasing work intensity is the same as in Marx's time. Marx (1981) argues that surplus value, which is the capitalist's property, is created by labourers' surplus labour in the process of production. Surplus labour is extra labour over and above the 'necessary' labour time, which is that amount needed to reproduce the value of labourer's labour-power during working day. The capitalist extracts this surplus value from the actual producer, the labourer. The working day includes necessary labour-time and surplus labour-time. Marx proposes that there are two ways of increasing surplus value: one he calls absolute surplus value, and the other relative surplus value. Absolute surplus value is produced by prolongation of the working day. Relative surplus value arises from the curtailment of the necessary labour-time, and from the corresponding alteration in the respective lengths of the two components (necessary and surplus labour time) of the working day. The objective of all developments in the productivity of labour, within the limits of capitalist production, is to shorten that part of the working-day during which the workmen must labour for his own benefit, and by that very shortening, to lengthen the other part of the day, during which he is at liberty to work gratis for the capitalist.

In this study, we found that the main cause of increased work intensity was related to this need of the capitalist to prolong working-time and increase absolute surplus-labour. By speeding-up the work process, and by therefore increasing work intensity, the proportion of surplus to necessary labour time is increased during the working day.

This study further found that work intensity also increased with renovation of technology: automation. In this case, as Marx states, only necessary labour time is shortened, and therefore, surplus labour-time is also prolonged. In reality, after automation, workers experienced that the production process speeded-up and the amount of work per worker was the same as before or even increased due to reducing the number of workers. Therefore, work intensity in this factory increased due to the increasing work density, resulting in prolonged surplus labour-time, and introducing new technology, with decreasing necessary labour-time, but increasing surplus labour-time.

This law of creating surplus value in capitalism already occurred in the early eras of industrialisation. The problem is that it still occurs - and more so, with the development of technology. According to Beynon (1973), speeding-up which had hit American car workers in the 1920s and 1930s only came to the European plants with real severity in the post-war period. In Ford car factories in Britain in the 1960s and 70s, frequent state was made of the fact that the line speed would be altered during the shift work without consultation or alteration in the allocation of work. Braverman (1974) also points out that modern management, which came into being on the basis of Taylorism[6], results in the exploitation of labour from the working class, through the mechanisation and intensification of labour, deskilling and stricter control. Nichols (1991 and 1997) states

[6] Taylorism : see note in the Chapter 2 : Literature review

that this intensification of labour was probably part of a wider deterioration of safety in British manufacturing in the first part of the 1980s, which also entailed increased corner-cutting, the neglect of maintenance and other injurious practices, such as the neglect of training (Nichols, 1986; 1989; 1991).

Recently, many researchers have asserted that the labour process has been intensifying with the introduction of the Japanese model of production[7], so called "lean production", which is worse than the traditional capitalist mode of production - Taylorim or Fordism – (Fucini and Fucini, 1990; Garrahan and Stewart, 1992; Graham, 1995; Moody, 1997; Rinehart et al, 1997; Delbridge, 1998; Danford, 1999; Parker and Slaughtor, 1988). This argument is supported by the evidence presented in this study. Nichols (1997) explains that "Marx's central idea about the intensification of labour is: that more labour is squeezed out a given time, or, the same idea looked at the other way round, that the porosity of the working-day is closed up as more labour gets squeezed into it". Nichols also states that there is a contemporary significance to all this as such a concept of intensification of labour means that workers may not only have had to 'work harder' during the 1980s, in a relatively uncomplicated and straightforward sense (being 'driven to it'), but also that the porosity of the working day may have been closed up in different ways in Britain. That is, just such contributions to labour intensification could be made by job enrichment/enlargement, the blurring of craft demarcation, as well as other forms of functional flexibility (1997).

This study indicates that the prolongation of the working day is still one of the main factors in the creation of surplus value through increasing work intensity in Korea. Furthermore, an interesting point which arises from this study is that several different ways of increasing work intensity have been appropriated which depend on the power relationship between workers and employers, for example, in an economic crisis. Working conditions in Korea may be worse and work intensity seems to be greater than in developed countries. Williams et al (1994) state that low wages were and are the secret of

[7] In this Japanese model –lean production –, many researchers find that the work process intensifies through the following mechanisms: increasing work pace, lengthening of the work day through overtime, increasing the amount of work, flexibility, management by pressure, reducing the number of workers (or removing 'excess operators' from the line), bell to bell working, strict supervisory control, squeezing working time and filling the porosity (Garrahan and Stewart, 1992; Graham, 1995; Fucini and Fucini, 1990; Moody, 1997; Danford, 1999; Nichols, 1997; Rinehart et al, 1997).

success for Asian 'new entrants' such as Korea. Korean capitalists, who have less capital and technology, are operating within a weaker economic infrastructure than their competitors in developed countries such as the USA or Sweden. The main initiative for competition with the big bourgeoisie in other countries was reducing labour costs through lowering wages and raising work intensity. In conclusion, therefore, the study proposes that inequalities in health in the workplace ought to be related quite directly to class relations, that is, to the basic conflict between employers and workers.

9.3.2.2 How is this study useful for making policy against inequality in health in workplace?

We explore workers' opinions, articulated in their own voices, concerning work intensity in one car factory in order to understand working conditions, thereby focusing on work intensity and the causes of workplace injury. Taking the worker's opinions and observations concerning the labour process in detail is an attempt to explore their needs in the occupational health research area. It appears that taking workers' opinions concerning their needs seriously can be useful for finding out what the main health problems of the workplace are and how these can be solved.

The concept of 'needs' adopted in this study come from the concept of 'needs' in Marxism. These needs include natural, necessary, social and radical needs. 'Natural needs' refers to the simple maintenance of human life such as food, clothing, fuel, and housing, and vary according to climatic and other physical conditions (Marx, 1981). 'Social needs' means 'socially produced' needs, the needs of 'socially developed humanity', average needs for material goods in a society or a class, and the social (or 'communal') satisfaction of needs (Heller, 1976). 'Radical needs' appear because of what Marx terms the alienation of needs under capitalism. Under capitalism, the alienation of labour and social needs cannot bring about radical needs: this is the driving force of revolution and only the working class embodies radical needs (Heller, 1976). The working class embodies radical needs because it has no particular goals of its own, nor can it have any, since its goal, by the very fact of being the working class, can only be general. In Marx's view, what characterises the working class is both its reduction to paltry particular needs and interests, and at the same time the rise of radical needs (Heller, 1976).

During this study, we realised that workers were experts in their own work, therefore, they already knew very well about the health problems created by the labour process. Also, there was a conflict between workers and employers in terms of the relationship between working conditions and work injuries. This suggests that taking the workers' opinion based on the concept of radical needs can help us to explore the fundamental mechanism of inequalities in health and draw the conflict between employers and labourers into questions of workplace health and safety. Several researchers stress the conflict between employers and workers as a central cause of hazardous working conditions. According to Nichols and Armstrong (1973), "there exists a fundamental conflict in conventional factories between safety and profit, and that, despite lip-service to safety rules, there is tremendous pressure on workers to pace production ahead of safety"(Sass, 1986). Sass (1986) points out that it is work organisation and the social relations, more particularly the power relations, within the workplace that determine the work environment with which the individual worker is faced, within which he must work, and all too often, which he must endure and suffer.

However, a limitation was still found in this study, that is that workers' participation was still not enough. During the research, workers usually asked us: "why do you ask me this question? What do you want to do with this results? Can you solve the problem with this study?" Perhaps this indicates that workers evidently did not believe that the study could be useful. To establish workers' participation in the research area, a kind of 'participatory approach' can be adopted as a further development of the methodology of particular needs assessment for workplace health and safety. For example, Ritchie (1996) undertook participatory action research to address the needs of low income workers in a work setting. Ritchie analysed several stages with steel workers in one large factory: entry - a research setting; getting to know each other - gaining each other's trust; generating concerns - individual interviews to learn from the steel workers themselves what they perceived as health concerns; participatory action - identifying concerns as a group; acting on concerns expressed - gaining some agreement with management and research groups (for the furnace area to be monitored for fumes, dust, gases, and noise levels, for example); reflection and evaluation – drafting a report summary which was fed back to the workers and sent to the union and the occupational health and safety department.

Such participatory action research can be undertaken to address workers' needs for workplace health and safety. Workers' needs can firstly be focused on their felt needs as expanded by them. Then in terms of a detailed methodology, participatory approaches can be adopted and modified for needs assessment in the workplace. Through this method, the processes can be integrated as follows: acknowledging the power relationship between the employer and workers with respect to the issue of workplace health and safety, confirming knowledge produced by 'shopfloor workers', developing a process of critical reflection on reality, placing the production of knowledge and action within a specific context and emphasising workers' action. In conclusion, taking workers' opinions in order to draw their needs for health and safety can be a method of exploring health problems created by the labour process. Also, a research method which adopts participatory action research organised by workers, workers' representatives and researchers (or professionals) may be a better way to address the workers' needs for workplace and health, and to take some action over such needs; in other words, to improve solidarity among workers themselves and to continue their action to obtain what they need for health and safety.

9.4 Methodological issues

9.4.1 Data completeness

9.4.1.1 Numerator-denominator bias: are there better methods?

An important limitation of this study is the problem of numerator-denominator bias. In the mortality data analysis (Chapters 4 and 6), the denominators (the Census of 1995 estimated the whole working population based on sampled survey) and numerators (National Death data, National Death data due to workplace injury) came from different sources and were not linked on an individual level. Therefore, we could not overcome the worrying problem of numerator-denominator bias.

In particular, the SMR for managers (Chapter 4) was too small compared to that of other occupational groups or other studies. Also, the SMRs showed big variations among the nine different occupational groups, which might have been due to numerator-denominator bias. Therefore, these nine different occupational groups were broadly combined into two groups: non-manual (managers, professionals, technicians, clerks, service workers, shop and market sales workers) and manual (agricultural workers, craft, plant and machine operators and labourers). Townsend et al (1986) also point out that this broader combination - manual and non-manual – also "helps to diminish some of the criticisms which have been made about changes in the classification of specific occupations (cf. Jones and Cameron, 1984), inconsistencies in the classification at census and death registrations (*OPCS*, 1986, p43), and serious bias in the calculation of the SMR for social class V (Ibid, p44)". However, a numerator-denominator bias might still effect the relationship between occupational class and health in this study.

Alternative means of overcoming numerator-denominator bias have been attempted. In Britain, several longitudinal studies (Fox et al, 1985; *OPCS*, 1978; Davey Smith et al, 1991b) have proved that the main results have not been distorted by numerator-denominator bias. Therefore, a longitudinal study based on individual identification would resolve the problem of numerator-denominator bias and help to explore how class differences effect, interact, and accumulate over the course of life to produce the observed pattern of mortality risk in Korea.

9.4.1.2 Validity of the possible risk factors

Another limitation is the validity of possible risk factors in the source of data employed in this study. Comparing national death data from the National Statistics Office to the death data due to workplace injury from WELCO, the Kappa indices for occupation and education were found to be low (Chapter 9). There is a possibility that the 'industrial workers: craft and related trades workers, plant and machine operators and assemblers and labourers' were promoted to 'clerks' in the national death data (Chapter 9). This may contribute to the numerator-denominator bias and attenuate the results. In the UK, the longitudinal study provided only a limited basis for identifying examples of deliberate promotion by the informant reporting a death (*OPCS*, 1978). However, the promotion may be greater, particularly in Korea, as manual work has been seen as inferior to non-manual work and people traditionally prefer to say that they do "non-manual work" rather than "manual work". In addition to this, limitations of the death data managing system in the National Statistics Office (Chapter 4) may have a role in preventing the collection of valid data. Therefore, this study acknowledges that the socio-economic variables used in this study, from National Statistics Office and WELCO need regular validity testing.

9.4.2 Classification of social class using occupation: which is the correct method?

The information concerning occupation from the Census, General Household Survey and death records for all causes and workplace injury in National Statistics Office and WELCO, which were employed in this study, had originally been recorded using the *Korean Standard Classification of Occupations (KSCO)*. Several limitations were encountered in attempting to utilise this classification system.

Firstly, the *KSCO* could not measure social class completely. It may be difficult to represent the grade (gap) of social class because this system was not devised for social class but for the classification of workers' job tasks. Therefore, the system omitted several important indicators: job position, ownership of property, control of work processes and detailed job tasks. This may result in broad and unclear categorisation of social class.

Secondly, to avoid ambiguities in the categorisation of social class (occupational class), our study made only two categorisations of occupational class (manual and non-manual) and made the 'the concept of class structure as simple as possible' as recommended by Townsend et al (1986) and Wright (1989a)[8]. However, the numerator-denominator bias may still exist because of the ambiguous categorisation of the *KSCO* which may not separate very poor people in the 'service workers and market workers' category and in the category of 'non-manual workers', from rich people who are in managers or professionals and in the category of non-manual workers. This may dilute the effect of class differentiation on health status. This diluting effect was shown for female workers (Chapter 6). The difference in injury deaths among different manual and non-manual workers was not higher for female workers than that of male workers. The reason for this may be that female workers have a different distribution of occupation, especially younger female workers who occupy a higher job proportion in service and sales than in industrial manual jobs. Wright (1989a) also states that this approach has the effect of putting a variety of highly routinised clerical jobs - key punch operators, typists in large semi-automated offices, etc - which in real terms involve less 'mental labour' than many skilled artisanal jobs, into the 'middle class'.

Thirdly, in *KSCO*, the manager group has a definition which is too broad. It was therefore difficult to discriminate between lower managers and clerks in higher positions, and lower managers and supervisors in the manual group. Fourthly, it was quite difficult to discriminate sales and service workers from office workers. Fifthly, it was difficult to discriminate among craft, machine operators and elementary workers.
These findings suggest that the methods for class categorisation should be improved in the research area related to the health as well as other areas in Korea.

Several measures of social class have been utilised in our research. Among the best-known and most-used for occupational class measurement is the British Registrar

[8] Wright (1989a) mentions that he would adopt the conventional blue-collar criterion for defining 'manual labour', and thus the working class, in spite of the fact that many theorists are hesitant to adapt this simplistic mental-manual distinction as the basis for defining the working class because of these ambiguities.

General's social class schema[9] (Krieger et al, 1997). However, the problem with this classification is that its five categories cannot adequately represent the social hierarchy. For example, Category II (managers/technicians/intermediate) is too broad for a single category; in a capitalist society, higher managers should go to the top.

Wright (1989a) develops several theoretically and methodologically rigorous measures of social class for research on class structure, mobility, income inequality and gender authority in workplaces. In this work, the measurement of social class was based on three dimensions of exploitation relations: exploitation based on control of capital, organisation and credentials/skills (Table 9.2). That is, firstly, according to the assets deployed as means of production, two principal classes in capitalism are categorised: workers and capitalists. Secondly, according to assets in organisation, which consists in the effective control over the co-ordination and integration of the division of labour, three basic positions are categorised: managers, supervisors and non-management. According to assets of credentials/skills, three groups are categorised: experts, skilled employees and non-skilled.

However, the following criticisms have been made: "Wright's work seems to be overlooked the structural dynamics of the relationship between capital and labour" (Becker, 1989); "Wright attempted to force these relations into the conceptual straitjacket of property ownership which seriously distorts his understanding of their operation" (Burris, 1989); "the redefinition of exploitation on which he bases his argument that contradictory class locations are contradictory" (Meiksins, 1989); "it is reasonable and useful, in differentiating managers from workers within capitalism, to say that they have a different relationship to the capitalist surplus extraction process" (Rose and Marshall, 1989). Wright begins correctly when he starts to categorise class according to assets in the means of production. Nevertheless, it is unclear why he places managers and craft workers in the same category (i.e., marginal group of skills). It may be reasonable for him to separate sales and service workers from the conventional middle class group, however, putting crafts and managers together in the same category for the simple reason that they are skilled may serve only to confuse the issue about the 'structural dynamics of the

[9] British Registrar General's social classes are: Social class I (professional), II (managers/technicians/intermediate), IIIN (skilled nonmanual), IIIM (skilled manual), IV (partly skilled), V (Unskilled)

relationship between capital and labour' (Becker, 1989). As Rose and Marshall (1989) state: 'managers and crafts have a different relationship to the capitalist surplus extraction process'.

Table 9.2 Criteria for operationalization of exploitation-asset concept of class structure

I. Assets in the means of production			
		Self employed	Number of employees
1 Bourgeoisie		Yes	10 or more
2 Small employers		Yes	2-10
3 Petty bourgeoisie		Yes	0-1
4 Wage-earner		No	
II Assets in organisational control			
		Directly involved in making policy decisions for the organisation	Supervisors with real authority over subordinates
1 Managers		Yes	Yes
2 Supervisors		No	Yes
3 Non management		No	No
III Assets in scarce skills/talent			
	Occupation	Education	Job autonomy
1 Experts	Professionals		
	Professors		
	Managers	B.A. or more	
2 Marginal	School teachers		
	Craft workers		
	Managers	Less than B.A.	
	Technicians		
	Sales	B.A. or more	Autonomous
	Clerical	B.A. or more	Autonomous
3 Uncredentialled	Sales	Less than B.A. or	Non-Autonomous
	Clerical	Less than B.A. or	Non-Autonomous
	Manual non-crafts		

Source : adapted from the book, classes, written by Wright (1989a), p150

Erikson and Goldthorpe (1992) derive a threefold division of class positions[10]: employers, self-employed workers and employees. Concerning the 'employers' group, they separate large from small proprietors. For the 'employed' group, sub-groups are divided by the employment contract: 'service' and 'labour', performing manual work versus non-manual work and working in an agricultural or non-agricultural setting[11]. Erikson and Goldthorpe

[10] Employers, who buy the labour of others and thus assume some degree of authority and control over them; self-employed workers, who neither buy the labour of others nor sell their own; employees, who sell their labour to employers and thus place themselves to some degree under their authority and control.

[11] Erikson and Goldthorpe (1992) divide social class into seven categories:

1. higher grade professionals, managers in larger industries, and large proprietors;
2. lower grade professionals higher grade technicians, managers in small industries, and supervisors in non-manual employees;
3. routine non-manual employees;

(1992) finally classify three categories: non-manual workers, farm workers, and manual workers. However, in our opinion, there is no clear-cut definition separating large employers and small employers (small employers).

In our opinion the concept and categorisation of social class should be based on an analysis of contemporary capitalist society with a framework provided by Marx for determining classes in capitalist society. Marx, in *Capital*, states that the law of development of the capitalist mode of production is more and more to divorce the means of production from labour, and more and more to concentrate the scattered means of production into large groups, thereby transforming labour into wage-labour and the means of production into capital (Marx, 1981). Classes in capitalist society, therefore, represent two main groups: the class of modern capitalists ('bourgeois'), the owners of the means of social production and employers of wage labour; and the class of modern wage-labourers ('proletariat') who, having no means of production of their own, are reduced to selling their labour power in order to live (Marx and Engels, 1976). Also, the conventional occupational classification system needs to be improved to reflect the existing relationship among different classes.

9.5 Needs for further study

9.5.1 Need for an extended study on inequality in health

A study on inequality in health needs to be wider and deeper in its conceptualisation, range (content) and methodology. Firstly, conceptually, further investigation is needed on the detailed mechanism and process linking class relations and health. This study mainly focuses on occupational class in order to explain the relationship between class and health. Another important finding from the in-depth interviews and the walk-through survey concerned the strength of the class conflict that exists in the labour process. The relationship between working conditions and workplace injury is mediated through class relations between employers and workers in this study. Further study is needed to extend

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4. small proprietors (employers) and farmers;
5. lower grade technicians and supervisors in manual workers;
6. semi- and un-skilled manual workers;
7. agricultural and other workers in primary production.

the detail mechanism of this class relationship if we are to understand the deepest reasons for inequalities in health and workplace injury.

Secondly, as for the range of the study area, we suggest that socio-economic variables as key determinants of health be integrated into every sub-area of study. This study shows the importance of interaction between occupation and education. The latter is strongly related to occupational class and mortality and morbidity in Korea. To extend this insight, a further study is needed which would investigate how socio-economic factors (occupation, education, income, deprivation), working conditions and other factors are inter-related in terms of health differentials. In addition to this, how class relations are related to these factors needs to be explored. As Krieger (1994) points out, much contemporary health research has focused on individual-level determinants of health and has been unable to account for broad or class-based inequalities. Krieger therefore suggests that more and better indicators of social class are included in national data sets. In addition, Macintyre (1997) suggests that "we need more fine grained micro-level research exploring not only their relative importance in different social contexts but also their possible interactions or additive effects". This study suggests that in all studies related to health, socio-economic variables need to be included as determinants of health. It helps to get some broader conceptual as well as detailed understanding of the mechanisms of inequality in health. In particular, regarding occupational epidemiology, the detailed mechanisms underpinning work conditions and their relation to socio-economic factors need to be investigated. This kind of study would reveal the weakest links in the chain, the points where inequality in health could potentially be solved.

Thirdly, in terms of methodology, a longitudinal study needs to be set up as national cohort data in Korea. This study will help to strip away the numerator-denominator bias from the cross-sectional data, and will contribute to an understanding of the accumulating effect of socio-economic factors on health. Davey Smith et al (1994) also state that it is likely that increased understanding of the relationship between social circumstances and health will depend upon studies which explore influences acting throughout the course of life. Ford et al (1994) state that detailed and careful process or longitudinal studies which acknowledge the complex differential processes affecting a wide range of different dimensions of health are needed to understand the creation and development of inequalities. Especially in Korea, a longitudinal study can be set-up using a unique identifier: social security number as part of the regular Census.

9.5.2 Need to investigate the workers' needs for workplace health and safety

Conventional studies on workplace health and safety have mostly been oriented according to manager's preference and tended to end with researcher's or professional's interest or curiosity. Ritchie (1996) states that not only did management decisions on health promotion favour programmes for executives rather than workers, but that when workers were included the programme it was rarely tailored to their needs. For further study, this study implies that a key to solving the problems of health and safety in the workplace lies in addressing workers' needs for workplace health and safety, and this can be expressed by workers' opinions and actions at the shop floor level. It can be done in each factory, and combined together to address a general concept of workers' needs among different types of industries at national level. Participatory action research[12] can be one of the methods to address workers' needs for health and safety.

De Koning and Martin (1996) point out that action for social change requires an educational process in which researcher and participants develop a critical awareness of circumstances influencing their lives, reflect on what this means in their individual and communal situation and decide what action it would be most important and feasible to take. According to Maguire (1987), "the purpose of participatory research is not only to describe and interpret social reality, but radically to change it"(Ritchie 1996). Hell (1993) states that "participatory research attempts uniquely to combine the traditionally isolated practices of research, education, and action" (Maguire 1996). Rahman (1993) also argues that "participatory research is geared ideologically towards structural change and social transformation (Ineke Meulenberg-Buskens, 1996)". Khanna (1996) writes concerning participatory action research that "there is no distinction between the researcher and the researched"; "this process has the effect of transforming each and all of us"; "the politicisation and transformation processes resulted in many of us initiating concrete action to change the situation that we saw around us". The detail process of participatory

[12] Participatory research or participatory action research have been used to involve communities, and at field level in needs assessment, planning and the evaluation of programmes (De Koning K and Martin M 1996).

approach is various and depends on each subject. Key point is that education has played an important role in the development of the concept of participatory research (de Koning and Martin 1996). de Koning and Martin (1996) pointed out that action for social change requires an educational process in which researcher and participants develop a critical awareness of circumstances influencing their lives, reflect on what this means in their individual and communal situation and decide what action would be most important and feasible to take.

In summary, we suggest undertaking participatory research for the workers' needs for workplace health and safety. The main advantage of this type of research[13] in the workplace are: firstly, workers in the workplace perceive the information as true, their own, not alien; secondly, workers' representatives can conduct this research with workers continuously; thirdly, it helps to encourage workers' solidarity in action to obtain their needs for workplace health and safety.

9.6 Summary conclusions

Firstly, this study provides evidence that manual workers have higher mortality, morbidity, and deaths due to workplace injury, compared to non-manual workers among the whole population in Korea. There were inverse relationships of education and income with mortality (education only available), morbidity, and deaths due to workplace injury in both male and female workers in Korea. Also, an inverse relationship of deprivation and mortality was found. After adjusting for education, the occupational effect on mortality and morbidity reduced. This study suggests that occupation and education are closely related to each other as regards mortality and morbidity. Occupation and education appear to be stronger determinants of health in Korea than in other European countries.

[13] According to Khanna (1996), the advantages of the participatory action research are:

1. PAR requires attitudes of mutuality, openness, and a commitment to learning on the part of all those involved;
2. PAR results in all the actors going through a process which transforms them at a very personal level and politicises them with respect to relationships at another level;
3. PAR calls a form of organisation which not only allows space for this kind of transformation, but which can also respond to it by changing itself;
4. PAR can succeed in or through organisations whose ultimate objective is empowerment;

Secondly, health behaviours do not confound the relationship between occupational class and morbidity.

Thirdly, workplace injury (severe injury and lower-back pain) are related to hazardous working conditions (in one car factory). In particular, there seems to be a tendency for repetitive strain injury (lower-back pain and HIVD) to increase according to increasing work intensity.

Finally, in-depth interviews and walk-through surveys show that one of the main causes of workplace injury is the tendency to increase work intensity, which depends on power relationship between workers and employers.

5. PAR is an entire process which includes education, pain and struggle and results in empowerment.

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Appendices

Contents

Appendix 1: Deprivation indices developed in the literature

Index	Content
Townsend Index (Townsend P et al, 1979)	- Material deprivation 1.Dietary deprivation (6 indicators) 2.Physical and mental health (5) 3.Clothing (4) 4.Housing (8) 5.Household facilities (9) 6.Environment (5) 7.Work (conditions, security and amenities) (12) - Social deprivation 8.Social-family activities (4) 9. Social-support and integration (4) 10. Social-recreational (2) 11. Social-educational (1)
Townsend Index (Townsend P et al, 1986)	<Main four indicators : material deprivation index> 1.Unemployment : The percentage of economically active residents aged 16-59/64 who are unemployed 2.Car ownership (lack of resources) : The percentage of private households which do not possess a car 3.Home ownership (lack of resources and residential insecurity) : The percentage of private households which are not owner occupied 4.Overcrowing : The percentage of private households with more than one person per room Note : index does not weight variables, uses long transformation of % unemployment and % overcrowding : uses Z score for standardization <Others > -Unemloyed persons 16-59/64 (%) -Households not owner occupied (%) -Households with no car (%) -Households with more persons than rooms (%) -Households with head in manual class (%)-IIIM, IV, V -Households without exclusive use of bath & WC (%) -Households with single parent family (%) -Unemloyed persons 16-24 (%) -17 year olds not in full time education (%)
Department of Environment (1983)	1. Percentage of economically active persons who are unemloyed 2. Percentage of households defined as overcrowd 3. Percentage of households with single parent family 4. Percentage of households lacking exclusive use of two basic amenities 5. Percentage of pensioners living alone 6. Percentage population change 7. Standardised Mortality ratio 8. Percentage of households in which the head was born in the New Commonwealth or Pakistan
Jaman index (Jarman,1983, 1984)	1.Percentage of elderly living alone (weighting 6.62) 2.Percentage of population aged under five (4.64) 3. Percentage one parent families (3.01) 4. Percentage in social class V (3.74) 5. Percentage unemployed (3.34) 6. Percentage overcrowded (2.88) 7. Percentage changing address within past year (2.68) 8. Percentage ethnic minorities (2.50)
Carstairs index (Carstairs and Morris, 1989)	-Unemployment among men -Not having a car -Low social class : Proportion in social classes IV and V -Overcrowding Note : these are combined into a single score for each postcode sector by means of the Z score technique
Breadline index (Krieger et al 1997)	-Unemployment : % economically active population unemployed -No car : % households with no car -Rented : % households not owner occupied

	-Lone parents : % lone parents as proportion of all households -Long-term illness : % households with a person with a limiting Long-term illness -Low social class : % persons in social class IV or V Note : index estimates % poor using derived from a validation survey
DOE 91 Index of Local Conditions (Krieger et al, 1997)	-Unemployment : % unemployed persons -Poor children : % households with no earner or one parent in part-time employment -Overcrowding : % households with >1 person per room -Lack amenities : % households lack or share baths/shower and/or water closet, or in non-permanent housing -No car : % households without access to a car -Flat children : % children living in flats, not self-contained or non-permanent housing Note : index does not weight variables ; uses X2-standardization
US census-based Measures of socioeconomic position (Krieger et al, 1997)	-Social class : % working class Defined as % of employed persons in 8 of 13 census-defined occupational groups : Administrative support Sales Private household service Other service (except protective) Precision production, craft, repair Machine operators, assemblers, inspectors Transportation and material moving Handlers, equipment cleaners, labourers -Working class neighbourhood : >=66% of employed persons in working class occupation -Poverty : % persons below poverty line -Poverty area : >=20% of persons below poverty -Additional measure : % of persons at <50%, 50-100%, 101-200% of poverty line -Wealth : % of households owning home % of households owning 1 or more cars % of households with annual family income >=$50,000 or more -Education : % of adults age 25 and older with less than a high school degree -Undereducated neighbourhood : >=25% of adults with less than a high school degree -Alternative : % of adults age 25 and older who have completed >=4 years of college -Crowding : % of persons living in households with >=1 person/room -Population density : persons/square mile

Appendix 2: The Korean death registration system

The Korean death registration system was established in 1909 and has continued since then (Kim, 1986). The reporting system has legal force and is based on the Census Registration Law which states that deaths should be reported within one month, or immediately in the case of deaths due to accidents and criminal acts, or of those in prison, of no fixed above or where the identity of the deceased is unknown.

Deaths are reported to local Civil Offices. The family of the deceased should report to the village registrar with the death certificate. For national statistics, death reports are submitted to the National Statistical Office along with the death certificates. Since the 1990s, village officers directly encode death information into the computer of the provincial office to be electronically transmitted to the National Statistics Office.

Present regulations permit a deceased person's neighbour to report the death when it is impossible to have death certificates recognised by a medical doctor (National Statistical Office, 1991). In 1991, only 4.9% of cases were submitted with death certificates according to the *Annual Report for Death Registration* (National Statistical Office, 1991).

Figure A.1. The national reporting system for deaths in Korea

Reporter ↓	- Reports to the village office located either where deaths occurred or where the deceased lived
Village office ↓	- Confirms the reported information, checks for error, missing information - Records on computer and produces a tabulation of population movement - Monthly report sent to statistics office at city level and sends records through network
Statistics office at city level ↓	- Confirms reported information from village offices - Combines the data from the village office with data directly collected from the statistics office at city level - Compares reported data from the village office with the tabulation of population movement - Monthly report sent to statistics office at province level
Statistics office at province level ↓	- Compares reported data from Civil Office and tabulation of the population movement - Monthly report sent to the National Statistics Office
National Statistics Office	- Collects data on movement of population from the statistics office at province level - Confirms reported records: checks for duplicates, missing, recording error - Publishes annual statistics tables

Source : National Statistics Office, 1999

Appendix 3: Numbers of men and women aged 20+ by employment state from 10% sample of the *Census* and death data

Age group	<19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-59	70-74	75~
Men													
Census													
Unemployed	8953310	4629455	1842805	632170	508895	429170	450935	596295	930585	1169110	1064090	909330	1013290
	(93.18)	**(56.18)**	**(17.97)**	**(5.92)**	**(4.86)**	**(5.45)**	**(7.17)**	**(11.61)**	**(20.17)**	**(34.73)**	**(50.58)**	**(61.94)**	**(78.08)**
Total	9608585	8240445	10255855	10686760	10478265	7871110	6290300	5134315	4613395	3366670	2103650	1468200	1297815
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Deaths													
Unemployed	8984	5507	4158	4326	6155	7202	8518	12248	19072	25192	31585	39756	90552
	(82.16)	**(39.58)**	**(24.24)**	**(19.75)**	**(20.33)**	**(20.90)**	**(21.40)**	**(23.05)**	**(28.16)**	**(36.65)**	**(45.52)**	**(51.36)**	**(60.95)**
Total	10935	13913	17150	21904	30277	34454	39798	53127	67718	68745	69385	77411	148561
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Women													
Census													
Unemployed	8305735	4784055	6238010	6858695	5980735	4972670	3292265	2876235	2878715	2638575	2320620	1974835	2693615
	(88.54)	**(46.33)**	**(60.60)**	**(65.84)**	**(58.92)**	**(54.64)**	**(54.76)**	**(55.60)**	**(58.17)**	**(64.25)**	**(74.49)**	**(84.24)**	**(93.95)**
Total	9280370	10326685	10294265	10416515	10151000	7453205	6011765	5173230	4948530	4106565	3115430	2344175	2866945
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Deaths													
Unemployed	3808	3446	4557	6135	7599	7845	9384	13278	18656	25666	36724	52447	214731
	(86.76)	**(59.11)**	**(67.95)**	**(74.30)**	**(72.77)**	**(70.63)**	**(70.62)**	**(68.62)**	**(69.62)**	**(72.82)**	**(78.53)**	**(81.99)**	**(86.18)**
Total	4389	5830	6706	8257	10443	11107	13288	19349	26796	35248	46766	63965	249179
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Appendix 4: Men and women working part-time (per 100 employees) by occupational group, from the *Census*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75+
Men, employed													
Non-manual work													
Part time workers	23740	69210	62800	34620	26785	22175	19585	16510	18995	13520	8455	4910	2975
	(13.1)	**(4.80)**	**(1.35)**	(0.6)	(0.49)	(0.57)	(0.68)	(0.81)	(1.35)	(2.13)	(4.16)	(6.07)	(8.34)
Total workers	181290	1443340	4654455	5788815	5467810	3862075	2898030	2035415	1402985	634680	203385	80915	35690
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Manual work													
Part time workers	35100	53940	35230	21925	21215	18880	18560	21280	28360	27265	21385	18090	16735
	(7.41)	(2.52)	(0.95)	(0.52)	(0.48)	(0.54)	(0.64)	(0.86)	(1.25)	(1.75)	(2.56)	(3.79)	(6.74)
Total workers	473510	2140005	3690100	4178180	4433580	3515870	2903530	2480525	2274330	156150	835510	477510	248425
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Women, employed													
Non-manual work													
Part time workers	46220	190400	280900	418145	509735	363020	247955	164050	100355	49355	23870	10905	5050
	(6.69)	(4.09)	(8.40)	(17.23)	(20.36)	(19.77)	(19.36)	(19.66)	(19.45)	(20.95)	(24.86)	(31.55)	(34.21)
Total workers	690445	4653400	3345350	2426465	2503630	1836410	1280975	834510	516060	235545	96025	34555	14760
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Manual work													
Part time workers	33605	73955	172565	377540	510180	448205	413270	467945	535675	455145	261195	128520	66850
	(8.75)	(8.33)	(24.33)	(33.41)	(30.63)	(29.04)	(28.74)	(32.01)	(34.49)	(36.94)	(37.38)	(38.41)	(42.20)
Total workers	383945	887980	709370	1130080	1665680	1543260	1438105	1461835	1553350	1232080	698740	334625	158430
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Appendix 5: Percentage of the uneducated by age group between the *Census* and the NSO death data for men and women

	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75+
Men													
Census													
Uneducated	12955	18195	22035	31575	44510	51320	71450	131000	220850	326720	405805	502615	665400
	(0.13)	(0.22)	(0.21)	(0.30)	(0.42)	(0.65)	(1.14)	(2.55)	(4.79)	(9.70)	(19.29)	(34.23)	(51.27)
Total	9608585	8240445	10255855	10686760	10478265	7871110	6290300	5134315	4613395	3366670	2103650	1468200	1297815
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Deaths													
Uneducated	669	372	406	499	899	1222	1649	3107	4894	7348	13380	23144	72104
	(6.12)	(2.67)	(2.37)	(2.28)	(2.97)	(3.55)	(4.14)	(5.85)	(7.23)	(10.69)	(19.28)	(29.90)	(48.53)
Total	10935	13913	17150	21904	30277	34454	39798	53127	67718	68745	69385	77411	148561
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Women													
Census													
Uneducated	10395	14385	22485	35705	64555	97920	204145	476750	955200	1423080	1620320	1580535	2309680
	(0.11)	(0.14)	(0.22)	(0.34)	(0.64)	(1.31)	(3.40)	(9.22)	(19.30)	(34.65)	(52.01)	(67.42)	(80.56)
Total	9280370	10326685	10294265	10416515	10151000	7453205	6011765	5173230	4948530	4106565	3115430	2344175	2866945
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Deaths													
Uneducated	352	279	347	391	479	642	1096	2734	5992	11945	22649	39273	197721
	(8.02)	(4.79)	(5.17)	(4.74)	(4.59)	(5.78)	(8.25)	(14.13)	(22.36)	(33.89)	(48.43	(61.40)	(79.35)
Total	4389	5830	6706	8257	10443	11107	13288	19349	26796	35248	46766	63965	249179
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Appendix 6: Diagnostic rates for specific diseases in death reports between 1993 and 1997 by occupation and sex for men and women aged 20-64 years

	Cause 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Men																				
Non-manual																				
MD*	**82.8**	**90.5**	**85.1**	**94.7**	**72.3**	**78.4**	**86.9**	**100.0**	-	**82.8**	**87.8**	**85.2**	**75.0**	**82.5**	**88.6**	-	-	**97.4**	**87.2**	**94.9**
OMD*	2.6	0.7	1.5	0.0	1.8	1.8	1.7	0.0	-	2.2	0.9	1.3	0.0	2.1	1.5	-	-	2.6	1.2	0.3
Unclear	14.6	8.8	13.5	5.3	23.0	19.8	11.4	0.0	-	14.9	11.3	13.4	25.0	15.5	10.0	-	-	0.0	11.7	4.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Manual																				
MD	**54.3**	**63.5**	**57.7**	**77.2**	**47.0**	**52.0**	**56.2**	**33.3**	**50.0**	**51.6**	**66.3**	**55.3**	**81.3**	**42.1**	**65.2**	-	-	**78.0**	**67.1**	**89.2**
OMD	1.2	0.8	1.2	0.0	1.4	1.0	1.1	0.0	0.0	1.50	0.8	1.0	0.0	2.0	1.1	-	-	2.0	0.9	0.3
Unclear	14.5	35.8	41.1	22.8	51.5	47.1	42.7	66.7	50.0	46.9	32.8	43.8	18.8	55.8	33.7	-	-	20.0	32.0	10.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Women																				
Non-manual																				
MD	**82.1**	**86.7**	**84.6**	**94.2**	**77.9**	**66.0**	**88.8**	**100.0**	**100.0**	**81.8**	**90.6**	**78.8**	**91.7**	**89.3**	**84.5**	**97.5**	-	**92.9**	**86.1**	**93.6**
OMD	1.4	0.8	1.4	0.0	2.6	0.0	0.0	0.0	0.0	1.0	1.2	1.8	0.0	0.0	1.2	0.0	-	0.0	0.0	0.3
Unclear	16.4	12.5	14.1	5.8	19.5	34.0	11.2	0.0	0.0	17.2	8.2	19.5	8.3	10.7	14.3	2.5	-	7.1	13.9	5.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Manual																				
MD	**29.1**	**49.4**	**43.7**	**61.7**	**36.6**	**25.1**	**36.6**	**100.0**	**0.0**	**34.2**	**45.3**	**38.2**	**50.0**	**30.9**	**47.8**	**55.9**	-	**61.1**	**45.8**	**84.1**
OMD	0.0	0.4	0.6	0.0	0.4	0.4	0.7	0.0	0.0	1.0	1.0	0.5	0.0	0.5	0.9	0.0	-	0.0	1.7	0.2
Unclear	70.9	50.2	55.7	38.3	63.1	74.5	62.7	0.0	100.0	64.9	53.8	61.3	50.0	68.6	51.3	44.1	-	38.9	52.5	15.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

0 Unknown
1 Certain Infections and parasitic diseases
2 Neoplasms
3 Diseases of hematopoietic
4 Nutrition
5 Mental disorder
6 Diseases of neurovascular
7 Diseases of eye
8 Diseases of ear
9 Diseases of circulatory systems
10 Diseases of respiratory systems
11 Diseases of digestive systems
12 Diseases of skin
13 Diseases of musculoskeletal
14 Diseases of urogenital
15 Diseases in the childbirth period
16 Diseases in the perinatal period
17 Diseases of congenital malformation
18 Diseases of others
19 Injury, poisoning and certain other consequences of external causes

MD* : Dignosed by medical doctor
OMD* : Dignosed by oriental medical doctor

Appendix 7: Age-specific death rates among men and women between 1993 and 1997 in Korea

Table A7-1. Age specific death rates among men and women between 1993 and 1997 in Korea

	Male			Female			Total		
	Deaths (%)	Person years (%)	Death rate	Deaths (%)	Person years (%)	Death rate	Deaths (%)	Person years (%)	Death rate
0	5457 (0.81)	1749915 (1.62)	311.84	4431 (0.86)	1548105 (1.40)	286.22	9888 (0.83)	3298020 (1.50)	299.82
<=4	5246 (0.78)	7357730 (6.80)	71.30	3958 (0.77)	6481735 (5.84)	61.06	9204 (0.78)	13839465 (6.31)	66.51
5-9	3804 (0.57)	8133405 (7.52)	46.77	2487 (0.48)	7344775 (6.62)	33.86	6291 (0.53)	15478180 (7.06)	40.64
0-14	3624 (0.54)	9566255 (8.84)	37.88	2271 (0.44)	8989355 (8.10)	25.26	5895 (0.50)	18555610 (8.47)	31.77
5-19	10935 (1.63)	9608585 (8.88)	113.80	4389 (0.85)	9280370 (8.45)	46.79	15324 (1.29)	18988955 (8.66)	80.70
20-24	13913 (2.07)	8240445 (7.61)	168.84	5830 (1.13)	10326685 (9.31)	56.46	19743 (1.66)	18567130 (8.47)	106.33
25-29	17150 (2.55)	10255855 (9.48)	167.22	6706 (1.30)	10294265 (9.28)	65.14	23856 (2.01)	20550120 (9.38)	116.09
30-34	21904 (3.26)	10686760 (9.87)	204.96	8257 (1.60)	10416515 (9.39)	79.27	30161 (2.54)	21103275 (9.63)	142.92
35-39	30277 (4.51)	10478265 (9.68)	288.95	10443 (2.03)	10151000 (9.15)	102.88	40720 (3.43)	20629265 (9.41)	142.92
40-44	34454 (5.13)	7871110 (7.27)	437.73	11107 (2.16)	7453205 (6.72)	149.02	45561 (3.84)	15324315 (6.99)	297.31
45-49	39798 (5.93)	6290300 (5.81)	632.69	13288 (2.58)	6011765 (5.42)	221.03	53086 (4.48)	12302065 (5.61)	431.52
50-54	53127 (7.91)	5134315 (4.74)	1034.74	19349 (3.76)	5173230 (4.66)	374.02	72476 (6.11)	10307445 (4.70)	703.14
55-59	67718 (10.08)	4613395 (4.26)	1467.86	26796 (5.21)	4948530 (4.46)	541.49	94514 (7.97)	9561925 (4.36)	988.44
60-64	68745 (10.24)	3366670 (3.11)	2041.93	35248 (6.85)	4106565 (3.70)	858.33	103993 (8.77)	7473235 (3.41)	1391.54
65-69	69385 (10.33)	2103650 (1.94)	3298.31	46766 (9.09)	3115430 (2.81)	1501.11	116151 (9.79)	5219080 (2.38)	2225.51
70-74	77411 (11.53)	1468200 (1.36)	5272.51	63965 (12.43)	2344175 (2.11)	2728.68	141376 (11.92)	3812375 (1.74)	3708.34
75-79	67138 (10.00)	802395 (0.74)	8367.20	74961 (14.57)	1475855 (1.33)	5079.16	142099 (11.98)	2278250 (1.04)	6237.20
80-84	48140 (7.17)	355670 (0.33)	13535.02	78897 (15.34)	874625 (0.79)	9020.67	127037 (10.71)	1230295 (0.56)	10325.73
85>=	33283 (4.96)	139750 (0.13)	23816.10	95321 (18.53)	516465 (0.47)	18456.43	128604 (10.84)	656215 (0.30)	19597.85
Total	671509 (100.00)	108222670 (100.00)		514470 (100.00)	110952650 (100.00)		1185979 (100.00)	219175320 (100.00)	

Appendix 8: SMRs of specific causes of death by occupation, men and women aged 20-64

Table A8-1. SMRs of malignant neoplasms death by occupation, men and women aged 20-64

	Men					Women				
	Deaths	SMR	(95%CI)	PMR	(95%CI)	Deaths	SMR	(95%CI)	PMR	(95%CI)
Stomach ca										
Non-manual	5044	81	79-83	109	106-112	733	70	65-75	87	81-94
Manual	10162	113	111-115	96	94-98	2194	117	112-122	105	101-110
Liver ca										
Non-manual	7772	86	84-87	116	114-119	361	65	58-72	84	75-93
Manual	13390	111	109-113	93	91-94	1381	116	110-123	105	100-111
Lung ca										
Non-manual	3452	81	79-84	108	104-112	299	85	76-95	109	97-123
Manual	7487	112	109-114	97	95-99	793	107	100-115	97	90-104
Colon ca*										
Non-manual	1263	114	108-121	154	146-163	207	97	84-111	122	106-140
Manual	1325	89	85-94	75	71-79	410	102	92-112	92	83-101
Leukaemia										
Non-manual	802	102	95-109	137	127-146	223	90	79-103	105	92-120
Manual	854	98	92-105	80	75-85	249	111	98-126	96	84-109

Colon ca* : Colon, rectum and anal cancer

Table A8-2. SMR of Cardiovascular diseases by occupation, men and women aged 20-64

	Men					Women				
	Deaths	SMR	(95%CI)	PMR	(95%CI)	Deaths	SMR	(95%CI)	PMR	(95%CI)
CVA										
Non-manual	7138	85	83-87	114	112-117	1266	81	77-86	105	99-111
Manual	13260	111	109-112	94	92-95	3781	108	105-112	98	95-102
IHD										
Non-manual	3385	106	102-110	144	139-149	230	103	90-117	128	112-146
Manual	3831	95	92-98	79	76-81	373	98	88-109	88	79-97
HTN										
Non-manual	944	48	45-51	64	60-68	159	29	25-34	39	33-45
Manual	3992	135	131-139	115	112-119	1722	128	122-135	117	112-123

Table A8-3. SMRs of specific causes of death by occupation, men and women aged 20-64

	Men					Women				
	Deaths	SMR	(95%CI)	PMR	(95%CI)	Deaths	SMR	(95%CI)	PMR	(95%CI)
TB										
Non-manual	1061	54	51-57	74	69-78	137	62	52-74	74	62-87
Manual	3388	136	132-141	113	109-117	319	135	121-151	118	106-132
Liver dis										
Non-manual	7083	55	54-57	76	74-78	304	56	50-63	72	64-81
Manual	21272	137	135-139	112	110-113	1303	122	115-129	110	104-116
DM										
Non-manual	1985	79	76-83	107	102-112	151	53	45-63	70	59-82
Manual	4074	114	111-118	97	94-100	803	120	111-128	109	101-117
Mental dis										
Non-manual	497	36	33-39	50	45-54	19	91	55-143	112	67-176
Manual	2449	158	152-165	126	121-131	34	106	73-149	94	65-133
CWP										
Non-manual	37	14	10-19	17	12-24	-	-	-	-	-
Manual	690	156	145-168	135	125-145	3	123	25-405	115	23-376
Asbestos										
Non-manual	38	90	63-123			7	203	81-434		
Manual	59	108	82-140			3	108	22-354		
Asthma										
Non-manual	346	68	61-76	90	81-100	49	66	49-87	83	61-110
Manual	967	120	113-128	104	98-111	172	117	100-136	106	91-123

Table A8-4. PMRs of malignant neoplasms by occupation, men and women aged 20-64

	Men				Women			
	Deaths	Exp	PMR	CI	Deaths	Exp	PMR	CI
Stomach Ca								
Legislators, Senior officials & managers	100	93.6	107	87-130	2	2.8	70	8-306
Professionals	541	463.2	117	107-127	104	78.2	133	109-161
Technicians & Associate Professionals	383	345.1	111	100-123	61	51.4	119	91-153
Clerks	1645	1369.9	120	114-126	164	148.4	111	94-129
Service workers & shop and Market Sales	2375	2363.0	101	97-105	402	560.9	72	65-79
Skilled Agricultural & fishery workers	6314	6353.9	99	97-102	1993	1800.7	111	106-116
Craft & related Trades Workers	2071	2189.5	95	91-99	107	147.3	73	60-88
Plant & Machine Operators & Assemblers	670	668.1	100	93-108	5	7.0	72	23-178
Elementary Occupations	1107	1359.7	81	77-86	89	130.4	68	55-84
Liver Ca								
Legislators, Senior officials & managers	179	130.7	137	118-159	1	1.5	69	1-561
Professionals	739	625.2	118	110-127	42	35.7	118	85-160
Technicians & Associate Professionals	565	494.5	114	105-124	16	25.1	64	36-105
Clerks	2445	1989.3	123	118-128	46	61.6	75	55-100
Service workers & shop and Market Sales	3844	3450.2	111	108-115	256	306.8	83	74-94
Skilled Agricultural & fishery workers	7744	8165.0	95	93-97	1249	1147.8	109	103-115
Craft & related Trades Workers	3074	3300.8	93	90-96	59	79.8	74	56-96
Plant & Machine Operators & Assemblers	1060	1021.0	104	98-110	5	3.4	149	48-370
Elementary Occupations	1512	1985.4	76	72-80	68	80.5	84	66-107
Lung Ca								
Legislators, Senior officials & managers	84	69.1	122	97-151	.	0.9	.	.
Professionals	332	341.1	97	87-108	40	23.5	170	122-232
Technicians & Associate Professionals	270	235.0	115	102-129	18	16.2	111	66-177
Clerks	1011	907.8	111	105-118	39	41.3	94	67-130
Service workers & shop and Market Sales	1755	1643.0	107	102-112	202	191.5	106	91-121
Skilled Agricultural & fishery workers	4743	4925.5	96	94-99	707	718.3	98	91-106
Craft & related Trades Workers	1437	1433.0	100	95-106	46	49.4	93	68-125
Plant & Machine Operators & Assemblers	454	420.5	108	98-118	3	2.2	137	28-449
Elementary Occupations	853	964.0	88	83-95	37	48.7	76	53-105
Colon Ca								
Legislators, Senior officials & managers	30	15.5	193	130-277	.	0.6	.	.
Professionals	164	77.0	213	182-248	33	14.9	221	152-312
Technicians & Associate Professionals	96	61.6	156	126-191	16	10.2	156	89-257
Clerks	448	249.8	179	163-197	37	28.8	129	91-178
Service workers & shop and Market Sales	525	413.7	127	116-138	121	115.2	105	87-126
Skilled Agricultural & fishery workers	642	1006.0	64	59-69	350	387.6	90	81-100
Craft & related Trades Workers	356	403.3	88	79-98	37	30.4	122	86-168
Plant & Machine Operators & Assemblers	144	126.9	114	96-134	2	1.4	143	16-622
Elementary Occupations	183	234.3	78	67-90	21	27.9	75	47-116
Leukemia								
Legislators, Senior officials & managers	14	8.4	167	91-285	1	0.7	151	2-1234
Professionals	83	46.1	180	143-223	38	22.8	166	118-229
Technicians & Associate Professionals	62	47.2	131	101-169	20	15.1	132	81-206
Clerks	323	208.9	155	138-172	91	62.3	146	118-180
Service workers & shop and Market Sales	320	276.4	116	103-129	73	111.3	66	51-83
Skilled Agricultural & fishery workers	375	495.9	76	68-84	196	204.1	96	83-111
Craft & related Trades Workers	302	321.1	94	84-105	37	35.0	106	74-146
Plant & Machine Operators & Assemblers	117	110.4	106	88-127	.	1.5	.	.
Elementary Occupations	60	141.6	42	32-55	16	19.1	84	48-138

Table A8-5. PMRs of cause-specific mortality by occupation, men and women aged 20-64

	Men				Women			
	Deaths	Exp	PMR	CI	Deaths	Exp	PMR	CI
TB								
Legislators, Senior officials & managers	13	25.9	50	27-87	.	0.6	.	.
Professionals	69	129.9	53	41-67	8	19.5	41	18-84
Technicians & Associate Professionals	88	110.0	80	64-99	14	12.6	111	61-189
Clerks	238	451.5	53	46-60	41	48.8	84	60-114
Service workers & shop and Market Sales	653	724.8	90	83-97	74	104.6	71	56-89
Skilled Agricultural & fishery workers	2029	1625.7	125	119-130	274	218.0	126	111-142
Craft & related Trades Workers	700	737.4	95	88-102	32	31.2	103	70-146
Plant & Machine Operators & Assemblers	154	238.7	65	55-76	1	1.5	68	0.9-556
Elementary Occupations	505	405.1	125	114-136	12	19.3	62	32-110
Liver dis								
Legislators, Senior officials & managers	96	169.1	57	46-69	.	1.4	.	..
Professionals	561	812.2	69	63-75	28	35.7	78	52-114
Technicians & Associate Professionals	469	698.8	67	61-73	17	24.8	69	40-111
Clerks	1812	2858.2	63	61-66	34	63.8	53	37-75
Service workers & shop and Market Sales	4145	4765.0	87	84-90	225	296.3	76	66-87
Skilled Agricultural & fishery workers	13234	9948.3	133	131-135	1214	1030.0	118	111-125
Craft & related Trades Workers	4103	4842.0	85	82-87	36	77.1	47	33-65
Plant & Machine Operators & Assemblers	906	1559.8	58	54-62	3	3.45	87	17-285
Elementary Occupations	3029	2701.6	112	108-116	50	74.5	67	50-89
DM								
Legislators, Senior officials & managers	44	37.5	117	85-158	2	0.7	270	30-1169
Professionals	203	183.0	111	96-127	9	18.9	48	22-93
Technicians & Associate Professionals	141	137.5	103	86-121	10	13.0	77	37-145
Clerks	454	544.1	83	76-91	19	34.6	55	33-87
Service workers & shop and Market Sales	1143	951.7	120	113-127	111	148.8	75	61-90
Skilled Agricultural & fishery workers	2593	2497.3	104	100-108	742	657.0	113	105-121
Craft & related Trades Workers	722	886.5	81	76-88	24	39.1	61	39-92
Plant & Machine Operators & Assemblers	264	171.1	97	86-110	2	1.7	121	14-524
Elementary Occupations	495	550.3	90	82-98	35	40.2	87	61-122
Mental dis								
Legislators, Senior officials & managers	1	16.7	6	0.1-49	.	0.05	.	.
Professionals	18	81.8	22	13-35	1	1.6	63	0.8-512
Technicians & Associate Professionals	35	77.0	45	32-63	1	1.0	96	1-784
Clerks	104	320.9	32	26-39	2	3.1	65	7.3-282
Service workers & shop and Market Sales	339	507.0	67	60-74	15	11.2	133	75-223
Skilled Agricultural & fishery workers	1184	928.9	127	120-135	28	30.4	92	61-134
Craft & related Trades Workers	601	548.5	110	101-119	2	3.0	67	7-291
Plant & Machine Operators & Assemblers	109	183.5	59	49-72	.	0.1	.	.
Elementary Occupations	555	281.6	197	181-214	4	2.5	160	43-444
CWP								
Legislators, Senior officials & managers	.	4.7	.	.	.	0.0	.	.
Professionals	.	22.6	.	.	.	0.0	.	.
Technicians & Associate Professionals	1	15.6	6	0.1-52	.	0.0	.	.
Clerks	15	61.0	25	14-41	.	0.0	.	.
Service workers & shop and Market Sales	21	110.6	19	12-29	.	0.3	.	.
Skilled Agricultural & fishery workers	143	324.2	44	37-52	2	2.4	82	9-356
Craft & related Trades Workers	450	95.6	471	428-516	1	0.1	1475	19-12035
Plant & Machine Operators & Assemblers	12	27.5	44	22-78	.	0.0	.	.
Elementary Occupations	85	65.1	130	104-162	.	0.1	.	.
Asthma								
Legislators, Senior officials & managers	4	8.0	50	13-138	.	0.2	.	.
Professionals	28	40.9	69	46-100	5	5.2	95	31-236
Technicians & Associate Professionals	27	28.7	94	62-138	2	3.7	54	6-235

Clerks	98	112.0	87	71-107	12	10.9	110	57-196
Service workers & shop and Market Sales	189	194.7	97	84-112	30	39.1	77	52-110
Skilled Agricultural & fishery workers	701	588.9	119	110-128	150	141.4	106	90-125
Craft & related Trades Workers	141	174.9	81	68-95	9	10.4	86	39-169
Plant & Machine Operators & Assemblers	40	52.5	76	54-104	.	0.5	.	.
Elementary Occupations	85	112.4	76	60-94	13	9.5	137	73-238

Table A8-6. PMRs of cardiovascular diseases by occupation, men and women aged 20-64

	Men				Women			
	Deaths	Exp	PMR	CI	Deaths	Exp	PMR	CI
CVA								
Legislators, Senior officials & managers	120	125.1	96	80-115	2	4.1	49	6-215
Professionals	674	616.8	109	101-118	76	100.6	76	60-95
Technicians & Associate Professionals	490	465.6	105	96-115	61	70.5	87	66-111
Clerks	2035	1852.2	110	105-115	174	175.8	99	85-115
Service workers & shop and Market Sales	3819	3192.0	120	116-123	953	852.4	112	105-119
Skilled Agricultural & fishery workers	7352	8400.7	88	86-90	3259	3389.9	96	93-99
Craft & related Trades Workers	3055	2989.9	102	99-106	252	220.3	114	101-129
Plant & Machine Operators & Assemblers	939	919.0	102	96-109	9	9.5	95	43-185
Elementary Occupations	1914	1836.6	104	100-109	261	224.1	116	103-132
IHD								
Legislators, Senior officials & managers	77	42.9	182	144-228	.	0.6	.	.
Professionals	373	226.2	172	154-190	13	16.3	80	42-138
Technicians & Associate Professionals	285	189.6	151	134-170	15	11.0	136	76-228
Clerks	1071	769.7	140	131-149	41	33.0	124	89-169
Service workers & shop and Market Sales	1809	1301.9	139	133-146	161	118.1	136	116-159
Skilled Agricultural & fishery workers	1807	2976.2	58	55-61	298	363.5	82	73-92
Craft & related Trades Workers	1244	1234.5	100	94-106	42	32.7	133	95-180
Plant & Machine Operators & Assemblers	504	389.0	130	119-142	1	1.4	70	0.9-569
Elementary Occupations	649	689.1	93	86-101	32	27.3	117	80-166
HTN								
Legislators, Senior officials & managers	16	30.7	52	30-86	.	1.4	.	.
Professionals	84	151.6	55	44-69	9	33.5	27	12-53
Technicians & Associate Professionals	51	109.5	47	35-61	3	23.3	13	3-42
Clerks	209	429.9	49	42-56	14	51.6	27	15-46
Service workers & shop and Market Sales	584	757.6	77	71-84	132	298.2	44	37-53
Skilled Agricultural & fishery workers	3109	2122.8	146	141-152	1640	1310.9	125	119-131
Craft & related Trades Workers	440	687.6	64	58-70	45	75.4	60	44-80
Plant & Machine Operators & Assemblers	122	207.0	59	49-70	1	3.3	30	0.4-248
Elementary Occupations	321	439.3	73	65-82	36	82.5	44	31-61

Table A8-7. The SMRs of malignant neoplasms by education, men and women aged 20-64

	Men					Women				
	Deaths	SMR	(95%CI)	PMR	(95%CI)	Deaths	SMR	(95%CI)	PMR	(95%CI)
Stomach ca										
University	2155	54	52-56	114	109-119	540	65	59-70	125	115-136
High	4671	78	76-80	103	100-106	1733	77	73-81	104	100-110
Middle	4148	110	107-114	97	94-100	1509	87	83-92	91	87-96
Elementary	9154	144	141-147	97	95-99	6073	121	118-124	99	97-102
Liver ca										
University	2996	54	52-56	121	117-125	179	50	43-58	98	84-113
High	7135	83	81-85	113	110-115	790	75	70-81	104	96-111
Middle	6135	116	113-119	101	99-104	943	90	84-96	101	94-107
Elementary	10929	141	138-144	89	87-90	4104	115	112-119	99	96-102

Lung ca										
University	1429	51	49-54	104	99-110	180	69	59-80	134	115-155
High	3273	79	76-81	103	99-106	635	84	78-91	115	106-124
Middle	3077	109	105-113	99	96-103	699	98	91-106	108	100-116
Elementary	7254	138	135-141	98	96-100	2694	109	105-113	94	90-97
Colon ca*										
University	665	86	80-93	188	174-203	151	74	63-87	145	123-170
High	1127	98	93-104	129	122-138	589	103	94-111	141	130-152
Middle	725	108	100-116	92	85-99	541	108	99-117	117	107-127
Elementary	1129	107	100-113	69	65-73	1545	100	95-105	84	80-88
Leukaemia										
University	532	79	73-86	179	164-195	180	65	56-75	125	108-145
High	810	91	85-97	109	101-116	568	92	85-100	118	108-128
Middle	440	132	120-145	90	81-98	343	109	98-122	101	90-112
Elementary	506	129	118-141	67	61-73	728	118	110-127	85	79-92

Colon ca* : Colon, rectum and anal cancer

Table A8-8. The SMRs of cardiovascular diseases by education, men and women aged 20-64

	Men					Women				
	Deaths	SMR	(95%CI)	PMR	(95%CI)	Deaths	SMR	(95%CI)	PMR	(95%CI)
CVA										
University	3252	53	51-55	112	109-116	371	35	32-39	68	61-75
High	7632	83	81-85	109	107-112	2083	67	64-70	92	88-96
Middle	6840	118	115-121	104	101-106	2855	90	86-93	100	97-104
Elementary	13361	134	132-137	91	90-93	14877	116	114-118	102	101-104
IHD										
University	1578	72	69-76	162	154-170	103	53	43-64	101	82-123
High	3096	95	92-98	126	122-131	410	76	69-83	102	93-113
Middle	2154	119	115-124	98	94-102	519	109	100-118	118	108-128
Elementary	3103	117	112-121	72	69-75	1889	111	106-116	96	91-100
HTN										
University	377	30	27-33	63	57-70	32	15	11-22	30	20-42
High	1112	59	56-63	78	73-83	214	34	29-39	47	40-53
Middle	1276	104	99-110	93	88-98	419	62	56-68	70	63-77
Elementary	3726	175	169-181	120	116-124	3685	130	126-134	116	112-120

Table A8-9. The SMRs of cause-specific mortality by education, men and women aged 20-64

	Men					Women				
	Deaths	SMR	(95%CI)	PMR	(95%CI)	Deaths	SMR	(95%CI)	PMR	(95%CI)
TB										
University	403	22	20-24	51	46-56	92	30	24-37	58	47-71
High	1590	59	56-62	78	75-82	478	66	60-72	86	79-94
Middle	1754	122	116-127	98	94-103	444	111	101-122	105	95-115
Elementary	4229	211	204-217	125	122-129	1213	153	144-161	111	105-118
Liver dis										
University	2342	26	25-27	61	59-64	151	34	29-40	66	56-78
High	8206	58	57-59	80	79-82	827	64	60-68	88	82-94
Middle	9742	125	123-128	103	101-105	1090	90	85-96	100	94-106
Elementary	20715	208	205-211	119	117-120	4531	124	120-128	104	101-108
DM										
University	1015	49	46-52	106	100-113	71	26	20-32	49	38-62
High	2477	79	76-83	106	102-110	512	65	59-71	88	80-96
Middle	2327	119	114-124	105	100-109	690	90	83-96	99	91-106
Elementary	4548	141	137-145	94	91-97	3884	117	113-121	104	101-107
Mental dis										
University	157	13	11-15	32	27-37	3	14	3-46	28	6-92
High	939	50	47-53	70	65-74	35	57	40-80	80	56-112
Middle	1186	127	120-135	98	93-104	38	81	57-111	85	60-117
Elementary	2812	266	256-276	138	133-143	155	152	129-178	117	100-138
Asthma										
University	154	40	34-47	81	69-95	37	59	42-82	114	80-157
High	364	65	58-72	83	75-92	101	59	48-72	80	65-97
Middle	379	105	95-116	93	84-103	140	94	79-111	101	85-120
Elementary	1102	160	150-169	114	108-121	655	119	110-128	103	95-111

Appendix 9: Statistical significance of potential determinants of mortality and interactions between them in national mortality analysis

Table A9-1. Statistical significance of potential determinants of mortality and interactions between them in national mortality analysis

Test for	Adjust for other effects	Male			Female		
		Df	X2	p-value	Df	X2	p-value
Occupation	Age, Education, Area	1	814.5	0.000	1	6.97	0.088
Age	Occupation, Education, Area	8	58266.25	0.000	8	7801.44	0.000
Education	Occupation, Age, Area	3	42967.5	0.000	3	1589.88	0.000
(Resident) area	Occupation, Education, Age	1	16480.75	0.000	1	5000.50	0.000
Occupation*Age	Occupation, education, age, area	8	3420.00	0.000	8	100.22	0.000
Occupation*Education	Occupation, education, age, area	3	136.50	0.000	3	72.06	0.000
Occupation*Area	Occupation, education, age, area	1	93.50	0.000	1	195.69	0.000
Education*Age	Occupation, education, age, area	24	16644.50	0.000	24	1107.09	0.000
Education* Area	Occupation, education, age, area	3	1123.25	0.000	3	35.03	0.000
Area* Age	Occupation, education, age, area	8	2947.75	0.000	8	193.28	0.000
Occupation*Age	Age*Educ, Age*Area, Edu*area, Occu*area, Occu*Educ	8	391.00	0.000	8	83.66	0.000
Occupation*Education	Age*educ, Age*Area, Edu*area, Occu*age, Occu*area	3	122.75	0.000	3	31.12	0.000
Occupation*Area	Age*educ, Age*Area, Edu*area, Occu*age, Occu*educ	1	599.25	0.000	1	339.03	0.000
Education*Age	Occu*area, Age*Area, Edu*area, Occu*age, Occu*educ	24	12575.50	0.000	24	944.78	0.000
Education* Area	Occu*area, Age*Area, Edu*age, Occu*age, Occu*educ	3	450.00	0.000	3	48.38	0.000
Area* Age	Occu*area, Edu*Area Edu*age, Occu*age, Occu*educ	8	670.25	0.000	8	670.25	0.000
Occupation*Age*Education	Occupation, education, age, area	35	409.75	0.000	35	234.84	0.000
Occupation*Age* Area	Occupation, education, age, area	17	3061.75	0.000	17	575.06	0.000
Occupation*Education*Area	Occupation, education, age, area	7	677.75	0.000	7	422.19	0.000
Occupation*Age*Education	Occ*Age, Age*Educ, Age*Area, Edu*area, Occu*area, Occu*Educ	24	74.50	0.000	24	63.91	0.000
Occupation*Age*Area	Occ*Age, Age*Educ, Age*Area, Edu*area, Occu*area, Occu*Educ	8	212.25	0.000	8	71.34	0.000
Occupation*Education*Area	Occ*Age, Age*Educ, Age*Area, Edu*area, Occu*area, Occu*Educ	3	14.25	0.000	3	14.34	0.002

Education : University/High school/Middle school/Elementary)
Occupation : Manual/Non-manual
Resident area : Urban/Rural
Age : 5 year groups

Appendix 10: Age adjusted odds ratios (and 95% CI) of morbidity according to health behaviours

Table A10-1. Age adjusted odds ratios (and 95% CI) of medically confirmed chronic disease according to health behaviours

		Adjust for age		Adjust for age and occupation		Adjust for age and education		Adjust for age and income	
Men	Case*	RR	CI	RR	CI	RR	CI	RR	CI
Smoking									
None	60	1.00		1.00		1.00		1.00	
Ex-smoking	69	1.32	0.89-1.97	1.31	0.88-1.96	1.36	0.91-2.04	1.33	0.89-1.98
Present	276	1.27	0.93-1.74	1.23	0.89-1.69	1.22	0.89-1.68	1.23	0.89-1.69
Log likelihood		2.59	P=0.2743	2.13	P=0.3454	2.44	P=0.2955	2.20	P=0.3321
Alcohol									
None	149	1.00		1.00		1.00		1.00	
Ex	58	1.62	1.11-2.37	1.55	1.06-2.27	1.62	1.11-2.37	1.62	1.11-2.37
Present	198	0.73	0.58-0.94	1.70	0.55-0.90	0.71	0.56-0.91	0.72	0.56-0.92
Log likelihood		20.24	P=0.0000	21.13	P=0.0000	21.90	P=0.0000	21.75	P=0.0000
BMI									
<25	289	1.00		1.00		1.00		1.00	
>=25	73	1.20	0.89-1.61	1.22	0.91-1.66	1.22	0.90-1.64	0.24	0.92-1.67
Log likelihood		1.41	P=0.2357	1.76	P=0.1850	0.62	P=0.2037	1.90	P=0.1684
Exercise									
Heavy	65	1.00		1.00		1.00		1.00	
Moderate	66	0.75	0.51-1.10	0.74	0.50-1.09	0.74	0.51-1.09	0.74	0.50-1.09
No exercise	264	0.95	0.69-1.31	0.84	0.60-1.16	0.82	0.59-1.14	0.88	0.64-1.22
Log-like		2.89	P=0.2356	2.34	P=0.3097	2.34	P=0.3103	2.39	P=0.3028
Diet									
Yes	379	1.00		1.00		1.00		1.00	
No	25	1.02	0.65-1.62	1.07	0.67-1.70	1.00	0.63-1.59	1.04	0.65-1.65
Log likelihood		2.23	P=0.1357	2.35	P=0.1251	2.02	P=0.1548	2.28	P=0.1308
Women									
Smoking									
None	407	1.00		1.00		1.00		1.00	
Ex-smoking	11	2.06	0.88-4.32	2.12	0.91-4.96	2.08	0.89-4.89	1.99	0.84-4.73
Present	49	1.26	0.83-1.92	1.28	0.84-1.96	1.24	0.81-1.89	1.17	0.76-1.78
Log-like		3.70	P=0.1572	4.02	P=0.1338	3.59	0.1658	2.75	P=0.2530
Alcohol									
None	395	1.00		1.00		1.00		1.00	
Ex-drinking	13	1.69	0.81-3.53	1.79	0.85-3.74	1.69	0.80-3.54	1.61	0.76-3.38
Present	59	1.42	0.98-2.05	1.50	1.03-2.18	1.42	0.98-2.05	1.42	0.98-2.06
Log likelihood		4.87	P=0.0877	6.22	P=0.0446	4.78	P=0.0917	4.53	P=0.1036
BMI									
<25	247	1.00		1.00		1.00		1.00	
>=25	63	1.33	0.92-1.91	1.26	0.87-1.82	1.29	0.90-1.85	1.35	0.94-1.94
Log-like		2.33	P=0.1272	1.52	P=0.2173	1.83	P=0.1756	2.53	P=0.1114
Exercise									
Heavy	24	1.00		1.00		1.00		1.00	
Moderate	33	0.85	0.45-1.61	0.85	0.45-1.60	0.87	0.46-1.65	0.88	0.47-1.67
No exercise	407	0.94	0.56-1.58	0.85	0.50-1.43	0.82	0.48-1.40	0.88	0.53-1.48
Log likelihood		0.28	P=0.8690	0.39	P=0.8223	0.53	P=0.7662	0.22	P=0.8960
Diet									
Yes	419	1.00		1.00		1.00		1.00	
No	48	1.73	1.16-2.60	1.92	1.27-2.88	1.84	1.23-2.77	1.79	1.19-2.69
Log likelihood		6.96	P=0.0083	9.43	P=0.0021	8.45	P=0.0037	7.70	P=0.0055

Log likelihood : log likelihood test for heterogeneity of health behaviours, Case* : morbidity cases

Table A10-2. Age adjusted odds ratios (and 95% CI) of perceived general health according to health behaviours

		Adjust for age		Adjust for age and occupation		Adjust for age and education		Adjust for age and income	
Men	Case*	RR	CI	RR	CI	RR	CI	RR	CI
Smoking									
None	32	1.00		1.00		1.00		1.00	
Ex-smoking	41	1.41	0.85-2.33	1.42	0.85-2.37	1.51	0.90-2.53	1.39	0.83-2.33
Present	162	1.42	0.94-2.13	1.32	0.88-2.00	1.40	0.92-2.12	1.33	0.88-2.02
Log-likelihood		3.06	P=1.2167	2.24	P=0.3257	3.13	P=0.2093	2.14	P=0.3433
Alcohol									
None	72	1.00		1.00		1.00		1.00	
Ex-drinking	41	2.38	1.53-3.71	2.27	1.44-3.57	2.37	1.50-3.75	2.20	1.39-3.49
Present	122	1.02	0.75-1.40	0.98	0.71-1.36	0.98	0.71-1.35	0.94	0.68-1.30
Log-likelihood		16.44	P=0.0003	15.24	P=0.0005	16.65	P=0.0002	15.33	P=0.0005
BMI									
<25	166	1.00		1.00		1.00		1.00	
>=25	36	1.00	0.67-1.47	1.05	0.71-1.57	1.10	0.74-1.64	1.07	0.72-1.59
Log-likelihood		0.00	P=0.9811	0.07	P=0.7980	0.22	P=0.6413	0.11	P=0.7437
Exercise									
Heavy	20	1.00		1.00		1.00		1.00	
Moderate	25	1.00	0.54-1.84	1.02	0.55-1.88	0.96	0.52-1.77	1.03	0.55-1.92
No exercise	181	2.35	1.44-3.83	1.87	1.13-3.09	1.77	1.07-2.93	2.02	1.21-3.35
Log-likelihood		25.00	P=0.0000	11.28	P=0.0035	10.53	P=0.0052	14.40	P=0.0007
Diet									
Yes	224	1.00		1.00		1.00		1.00	
No	11	0.80	0.42-1.53	0.87	0.45-1.68	0.81	0.42-1.56	0.78	0.41-1.51
Log-likelihood		0.95	0.3300	0.43	P=0.5122	1.18	P=0.2775	1.03	P=0.3102
Women									
Smoking									
None	325	1.00		1.00		1.00		1.00	
Ex-smoking	8	1.47	0.61-3.54	1.41	0.58-3.43	1.46	0.60-3.55	1.35	0.54-3.34
Present	44	1.43	0.93-2.17	1.49	0.97-2.29	1.40	0.92-2.13	1.25	0.82-1.92
Log-likelihood		3.28	P=0.1937	3.75	P=0.1535	2.94	P=0.2305	1.41	P=0.4945
Alcohol									
None	318	1.00		1.00		1.00		1.00	
Ex-drinking	13	2.03	0.99-4.14	2.21	1.07-4.58	1.98	0.96-4.10	1.81	0.87-3.77
Present	46	1.20	0.82-1.76	1.24	0.84-1.83	1.20	0.81-1.77	1.19	0.81-1.76
Log-likelihood		4.07	P=0.1306	5.02	P=0.0811	3.77	P=0.1517	2.96	P=0.2280
BMI									
<25	194	1.00		1.00		1.00		1.00	
>=25	38	0.91	0.60-1.38	0.89	0.59-1.35	0.88	0.58-1.33	0.95	0.63-1.45
Log-likelihood		0.19	P=0.6594	0.32	P=0.5740	0.36	P=0.5507	0.05	P=0.8254
Exercise									
Heavy	13	1.00		1.00		1.00		1.00	
Moderate	25	1.22	0.58-2.58	1.23	0.58-2.62	1.26	0.59-2.68	1.29	0.61-2.74
No exercise	337	1.63	0.88-3.05	1.51	0.79-2.86	1.34	0.71-2.54	1.48	0.79-2.79
Log-likelihood		3.74	P=0.1540	2.11	P=0.3475	0.88	P=0.6450	1.80	P=0.4057
Diet									
Yes	340	1.00		1.00		1.00		1.00	
No	37	1.41	0.92-2.15	1.56	1.02-2.40	1.54	1.00-2.35	1.38	0.90-2.12
Log-likelihood		2.45	0.1172	3.98	P=0.0460	3.74	P=0.0531	2.10	P=0.1469

Log likelihood : log likelihood test for heterogeneity of health behaviours, Case* : morbidity cases

Appendix 11: Possible denominators for national death rates due to workplace injuries in Korea

A11-1. *Survey Report on Establishment Labour Conditions*

As an alternative denominator source, we consider data from the *Survey Report on Establishment Labour Conditions.* This report has been collected since 1968 and surveys the entire working population and all workplaces employing more than 5 workers. Its objective is to establish the distribution of workers and workplaces by geographical area, industry and establishment scale. It is, in effect, a census for all factories employing more than 5 workers. It is usually collected in May of each year and employs self-reports as its chief data collection methodology. For newly established and smaller establishments, officials from the local branch of the Ministry of Labour make visits personally to collect information. The data thus collected includes 5-year bands of age distribution by industry and administration area.

The information included in this survey covers both industry and employment type: regular, temporary and daily workers, upper managers, employers and houseworkers, for example.

Variables are defined as follows:

Industry:	site of economic activity, produces the products or services.
Regular workers:	employed for wages, by contract and for more than one month; or temporary and daily workers who have worked for more than 45 days during the previous three months.
Temporary workers:	employed for wages and by contract for less than one month.
Daily workers:	employed for wages and on a day-to-day basis; have worked for less than 45 days during the previous three 3 months.
Upper managers:	higher managers receiving regular wages.
Employers:	factory and workplace owners.
Houseworkers:	family members of employers working less than one third of normal working hours without payment.

A11-2. Methods used in the *Survey Report on Wage Structure*

In Chapter 6, we employ tabulated data from the *Survey Report on Wage Structure*. The detailed methods for this survey are as follows:

Workplaces are classified according to factory scale (size) and the Korean *Standard Industrial Classification*. Thus, in the two-stage stratification, the sample size is decided by Bowley's proportional sampling according to industrial classification. In 1997, 3400 workplaces were included in the stratified sample taken from 128,812 companies employing more than 10 people, a total workforce of 5,828,868. In 1996, 3400 workplaces from among a possible 122,351 were sampled, employing a total of 5,781,962 workers. In 1995, 3400 from among 117,658, employing 5,742,130.

Among these sampled industries, employed workers are selected by systematic sampling from complete lists supplied by each factory. For those industries scaled 10-29 and 30-99 workers, 100% of the total workforce are included; those scaled 100-299, 80%; 300-499, 70%; 500-999, 50%; 1000-4999, 30%; 5000-9999, 20% and industries scaled above 10,000, 10% of the total workforce are included.

This data was collected from information supplied by the factories themselves. The survey form is distributed at a factory-wide level and not to individual workers. Information is collated from factory units by government officials; for example, from factory documents for each employed person rather than from personal interview. On the basis of this survey, the total number of workers in each occupation, at every educational and income level and for each factory size in Korea, is estimated. The variables are: age, sex, married status, occupation, educational level, length of working day, days worked per year, period in employment, level of qualifications, position in work hierarchy and average monthly wage. As stated above, it should be noted that our information is drawn from already tabulated data, collected from the *Annual Report* published by the Ministry of Labour, not from individually recorded data. There may, therefore, be limitations to this approach, as information cannot be linked to individual death data due to workplace injury.

Figure A11-1. Example of the form deployed by the *Survey Report on Wage Structure*

1. Name of the industry				
2. Address (Tel) of the industry				
3. Major product				

Workers	Number	Selection rates	subjects
Male			
Female			
Total			

Others

No	Name	Sex	Education	Occupation	Position	Qualification	Tenure I,II	Working hours	Income per month			Special income	
				Name and code				Average	Over work	Total	Excess	Regular	Actual
1													
2													
3													
4													
5													

Data source : survey report on wage structure, Ministry of Labour, Korea, 1997

The definition and contents of variables are as follows:

Regular workers are defined as workers who are:

1. wage earners employed for more than one month; or:
2. temporary and/or daily workers who worked for more than 45 days in the previous three months; or:
3. upper managers who are employed by the industry and receive regular wages; or:
4. family of employers who work regularly and receive regular wages at the same standard as other workers.

Age variables in the data are calculated from information on birth-date in the survey.

Educational variables are defined in terms of final graduation level at regular school.

Occupational variable are defined in terms of the workers' present occupation and coded according to the *Korean Standard Classification of Occupations*. To classify occupations, information on job status is also employed.

Income variables include three different categories: monthly, total and annual special wages. Monthly wage is defined as wage earned in a single month; total wage, as the sum of regular wages based on regulations or law, excessive wages for excessive working time, and allowances in kind; annual special wages are defined as special pay regardless of regulations or law. From this information, the total monthly wages, as employed in this study are calculated as follows: regular wages + excess wages + (Annual special wages for previous year)/12.

Appendix 12: Estimation of number of workers for national death rates due to workplace injuries in Korea

1. Estimating 'Total amount of wages for each factory for one year' from previous or following years

The numbers of workers in each factory are used to categorise 'factory size for each industry' in Chapter 6. For 435 missing values concerning information on the numbers of workers among 5123 injury deaths, the estimation of the numbers of workers is calculated using the total wages of each factory per year divided by one worker's average annual wage.

The formula:

Estimated number of workers = total wages of each factory per year / (average total wages per person per year*12months)

Information concerning 'average total wages per person per year' comes from the *Report on the Monthly Labour Survey*, (1998: 79), published by the Ministry of Labour. Information on 'total wages of each factory per year' comes from the death data due to workplace injuries collected by *WELCO*. However, another problem is that the latter information is collected every year. For certain past years, the information is missing. Therefore, the estimation of total wages uses adjacent years, with weighting for 'increasing rates of total wages compared to the previous year' (Table A12.1). To estimate the total amount of wages of each factory per year from adjacent years, the following formulae are used:

Formula: % increase from Y to Y+1 = X (%)

To estimate wages for Y (year) from Y+1 (next year) (pe1~pe8):

First year: wages of Y = wages of Y+1 * (100/100+X of Y+1)

Second year: wages of Y = wages of Y+2 * (100/100+X of Y+1) *(100/100+X of Y+2)

To estimate wages for Y+1 (next year) from Y (previous year) (ne1~ne8)

First year: wages of Y+1 = wages of Y * (100+X of Y+1/100)
Second year: wages of Y+2 = wages of Y * (100+X of Y+1/100) *(100+X of Y+2/100)

Table A12.1 Increasing rates of total wages compared to previous years and average total wages per person per year (unit : won, %)

Year	Total wages per one person per one year	The increasing rates of total wages comparing to previous year
1985	324,283	9.2
1986	350,966	8.2
1987	386,536	10.1
1988	446,370	15.5
1989	540,611	21.1
1990	642,309	18.8
1991	754,673	17.5
1992	869,284	15.2
1993	975,125	12.2
1994	1,098,984	12.7
1995	1,222,097	11.2
1996	1,367,501	11.9
1997	1,463,300	7.0
1998	1,426,797	-2.5

This table were obtained from (modified? from) the table in the "report on monthly labour survey, 1998 p79, Ministry of Labour

2. Error rates

Error rates are calculated comparing total wages for previous and present years or between following and present years.

Error rates between this year and the next years (Perror1c~Perror4c)
= (Total wages of next year/ Total wages of this year)*100

Error rates between this year and the previous years (Nerror1c~Nerror7c)
= (Total wages of this year/ Total wages of previous year)*100

Thus, the results of error rates are shown in Tables A12.1 and A12.2. These indicate that the estimated value of total wages is reasonable, as error rates between the years are not significant.

Table A12.2 Error rates between income levels for present and following years

	No	Mean	SD	Median	90%	95%
Perror1c*	5201	6.19	4.53	5.18	11.97	14.79
Perror2c	3679	12.51	6.72	12.86	20.61	22.69
Perror3c	2314	18.4	8.60	19.31	28.82	31.12
Perror4c	1073	24.50	9.58	25.54	35.90	38.34

* Perror1c-4c : error rate between this year and the next year
Perror1c : error rate between this year and the next year
Perror2c : error rate between this year and the next second year
Perror3c : error rate between this year and the next third year
Perror4c : error rate between this year and the next forth year

Table A12.3 Error rates between income levels for present and previous years

	No	Mean	SD	Median	90%	95%
Nerror1c	5428	6.38	4.97	5.19	13.61	16.35
Nerror2c	5103	9.50	7.66	7.59	20.28	24.50
Nerror3c	4852	12.43	9.94	10.00	26.57	31.98
Nerror4c	4639	15.53	12.61	12.52	32.81	40.63
Nerror5c	3319	18.02	14.76	14.29	37.90	46.34
Nerror6c	2136	20.11	16.88	15.76	42.72	51.90
Nerror7c	1021	21.62	17.23	18.12	43.83	52.84

Nerror1c-7c : error rate between this year and the previous year
Nerror1c : error rate between this year and the first previous year
~ Nerror7c : error rate between this year and the seventh previous year

3. Estimation error factor

Some of the estimated total wages are found to be different between previous years and present of following years. Therefore, 'estimation error factor' is calculated as follows: Those, which show a significant difference in estimated total wages between neighbouring years are excluded. We exclude data when the estimation error factor is more than 0.25.

Estimation error factor = | Yi+1 –Y i | / ((Yi+1 –Y i)/2)

Those which show a significant difference in estimated total wages between neighbouring years are excluded. We exclude data when the estimation error factor is more than 0.25

4. Validity of estimated factory sizes

To confirm the completeness of the estimations for factory size, we compare the actual numbers of workers to factory sizes from the estimated numbers of workers. Table A12.4 shows the results of the validity test on factory sizes.

Table A12.4 Distribution of factory sizes and estimated factory sizes

	Estimated number of workers					
The number of workers in original data set	>500 workers	300-499 workers	100-299 workers	30-99 workers	10-29 workers	Total
>500 workers	1080 (86.40)	80 (6.40)	77 (6.16)	12 (0.96)	1 (0.08)	1250 (100%)
300-499 workers	151 (58.53)	52 (20.16)	51 (19.77)	4 (1.55)	0 (0.00)	258 (100%)
100-299 workers	94 (10.46)	100 (11.12)	438 (48.72)	252 (28.03)	15 (1.67)	899 (100%)
30-99 workers	53 (4.71)	19 (1.69)	168 (14.93)	619 (55.02)	266 (23.64)	1125 (100%)
10-29 workers	91 (9.97)	22 (2.41)	61 (6.68)	158 (17.31)	581 (63.64)	913 (100%)
Total	1469	273	795	1045	863	4445

Table A12.5 shows the Kappa statistics between actual factory sizes and actual worker numbers and estimated factory sizes and estimated worker numbers. The Kappa indices are between 0.51 and 0.63 among the categories of factory size. It is not therefore unreasonable to use the estimated factory sizes for 435 cases. We thus use 435 estimated factory sizes for the missing values of original number of workers in Chapter 6.

Table A12.5 Kappa statistics and correlation coefficients among different factory sizes: more than 20 years of age

Category	Total numbers	Agree ment	Expected agreement	Kappa Index	Z	P	Correlation coefficient	
							Pearson	Spearman
Factory sizes 5*	6228	62.56	23.27	0.51	75.15	0.00	0.77 (p<0.00)	0.76 (p<0.00)
Factory sizes 4*	6228	67.29	26.80	0.55	74.38	0.00	0.75 (p<0.00)	0.75 (p<0.00)
Factory sizes 3*	6228	76.43	35.88	0.63	69.00	0.00	0.70 (p<0.00)	0.71 (p<0.00)
Factory sizes 31*	6228	75.47	37.31	0.61	66.35	0.00	0.68 (p<0.00)	0.70 (p<0.00)

Factory sizes 5* : 10-29, 30-99, 100-299, 300-499, >500 workers
Factory sizes 4* : 10-29, 30-99, 100-299, >300 workers
Factory sizes 3* : 10-29, 30-299, >300 workers
Factory sizes 31* : 10-29, 30-499, >500 workers

Appendix 13: Checklists for in-depth interviews in one car factory

I. Questionnaire for the interviews

<Main issues>

1. Changes in the production process and their impact on health

1.1 The effect of changes in working processes on health

1.1.1 How has the work process changed due to Neo-Liberalism (Globalisation)?

- In terms of changes at the level of technical rationalisation: changes in production techniques, technology, automation, raw materials
- In terms of changes in labour utilisation: manpower numbers, working hours and work pace

1.2 The organisation of production: labour management systems

1.2.1 How have management strategies changed?

- Ways of controlling the work place
- Changes in the management of individual workers
- Changes in workers'consciousness
- Management deployment of labour power
- Rationalisation of work organisation

1.3 Changes in the labour market and their impact on health

1.3.1 What impact has the economic crisis had on health?

- Changes in occupational health policy in each factory: policies pursued by governments, employers, labour unions and workers in the workplace
- The impact of unemployment

2. Workers' perception of workplace health and safety needs

2.1 How do workers' perceive hazardous conditions and illnesses?

- Relations between working hours and job tasks

2.2 What are the workers' health and safety needs in the workplace?

3. Control: the conflict between workers and employers

3.1 How do workers and employers come into conflict?

- Changes in worker/employer relations since the economic crisis and subsequent re-organisation of the factory
- Changes in the role of the labour union

3.2 How did the change of government affect occupational health services?

1. Detailed questionnaire for interviews

1. Changes in the production process and their impact on health

1.1 What effect have changing work processes had on health?

1.1.1 How has the work process changed due to Neo-Liberalism (Globalisation)?

- Changes at the level of technical rationalisation: production, technology, automation and raw materials
- Changes in labour utilisation methods: manpower numbers, working hours and work pace

1. What is your department, job, and age?
2. How have working conditions changed in terms of the work process?
   (i) In terms of production techniques, new technologies, automation and ways of processing raw materials, how has technology changed? What impact have these changes had on health, comparing conditions before and after the the economic crisis (for example, the New Autonomisation Concept)?
   (ii) How have the methods for utilising labour resources changed? What impact have these changes had on health, comparing the situation before and after the economic crisis (for example, New Autonomisation Concept)? In terms of changes in working hours, work processes, the numbers of workers involved in the work process and changes in working conditions, such as rotation of duties, re-arrangement and versatility of workers, increasing use of part-time workers, changes of task time, 'the standardisation of the working process'
   (iii) What kinds of hazards do you face in your workplace?

1.2 The organisation of production: labour management systems

1.2.1 How have management strategies changed?

- Ways of controlling the work place
- Changes in the management of individual workers
- Changes in workers'consciousness
- Management deployment of labour power
- Rationalisation of work organisation

1. How have management strategies changed during the structural re-organisation which followed the economic crisis?

   (i) How have the methods for controlling the workplace altered? How have changes in the number and style of supervisors and managers impacted on the work process?

   (ii) How have these changes affected the labour union, workers' representatives and individual workers?

   (iii) What differences have you noticed at the level of particular job tasks as a result of these management changes?

1. Have you felt in any sense more isolated from your colleagues or more alienated from your activity in the workplace since these changes have been introduced?

1.2.2 Changes in work intensity

1. Has the pace of work increased or has work intensity changed in relation to the broader changes in your working environment that have occurred?
2. Compared to your working life before the economic crisis, how have working conditions changed since 1998?

1.3 Changes in the labour market and their impact on health

1.3.1 What impact has the economic crisis had on health?

- Changes in occupational health policy in each factory: policies pursued by governments, employers, labour unions and workers in the workplace
- The impact of unemployment

(i) How has occupational health policy changed since the economic crisis, in terms of relations between government, managers, workers and labour unions? For example, the treatment of occupational injury, the treatment of health care in the factory clinic. The activity of labour union,

(ii) Are you worried about unemployment? Do you have any place to go if you become unemployed? What did you do when laid-off during the crisis? How did this period affect you?

(iii) Do you know of any examples in which the economic crisis impacted on workers' solidarity?

2. Workers' perception of workplace health and safety needs

2.1 How do workers' perceive hazardous conditions and illnesses?

- Relations between working hours and job tasks

2.2 What are the workers' health and safety needs in the workplace?

(i) Have you been ill or contracted a disease due to your place of work? Was this illness or disease directly related to hazardous material used in the work process, in your opinion?

(ii) Have you witnessed any accidents in this factory? If so, in which department, who was injured, when, where, how and what happened?

(iii) What improvements would you recommend to improve health and safety in the workplace?

(iv) Have your health and safety needs been met by the employers?

(v) What are the most important health and safety problems which you feel cannot actually be solved in the workplace today?

(vi) What kinds of workers should be given priority in terms of workplace health and safety?

(vii) What would make the biggest difference if the workforce is to satisfy its health and safety requirements?

For part-time or subcontracted workers

1. What are your most pressing concerns concerning the work environment and health and safety issues?
2. Have your needs been met?

3. Control: the conflict between workers and employers

3.1 How do workers and employers come into conflict?

- Changes in worker/employer relations since the economic crisis and subsequent re-organisation of the factory
- Changes in the role of the labour union

3.2 How did the change of government affect occupational health services?

(i) Could you tell me how 'unemployment phobia' affects workers' health?

(ii) Have you witnessed a case in which your employer or manager has simply altered the workplace health and safety arrangements without consultation?

(iii) Has the relationship between workers and employers changed, in relation to the maintenance of a safe working environment, during the conflict over work pace changes?

(iv) Are you satisfied with the role played by the labour union in workplace health and safety issues?

(v) Comparing the periods before and after the economic crisis, how has the activity of the workers' representatives changed?

(vi) Have you discussed with your colleagues in the workplace the hazardous working environment?

(vii) Do you think the occupational health services - regular medical examinations and exposure monitoring - organised by the Government, meet workers' needs?

II. Walk-through survey of the assembly line

1. Changes in work intensity according to time and model of car

Time --→

▲

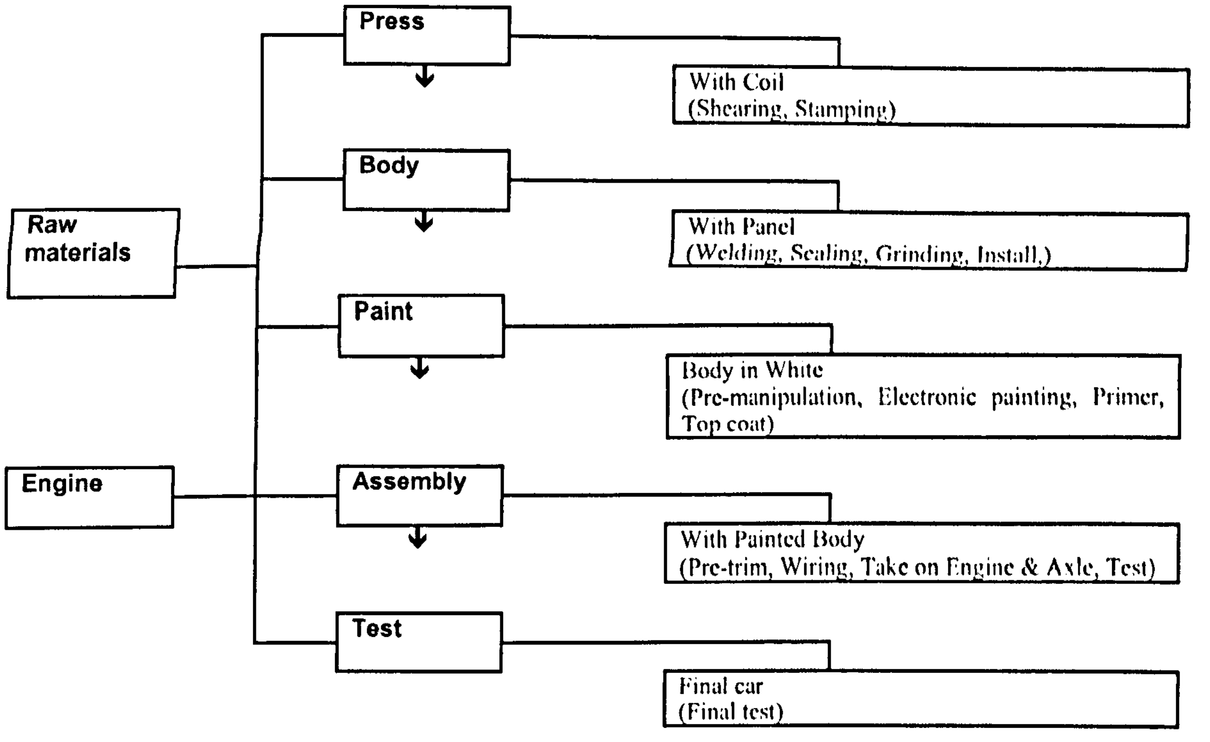
New car model

According to time and the introduction of new car model → changes in:

- Amount of work
- Task time (work pace)
- Number of workers
- Work posture
- Repetitiveness
- Weight of tools
- General work intensity

Appendix 14: The work process of one car factory

Figure A14-1. The work process of car factory



Appendix 15: The change of the employer's management in one car factory

Table A15-1. The change of the employer's management

	NAC I (1992-1995)	NAC II (1996-1997)	NPS-G I (1998-1999)
Aims	1.Three improvements in conditions 2.Factory innovation 3.Four system innovations	1.Establishment of company culture 2.Continuous factory innovation 3.Developing a man of ability	1.Creative and active factory culture 2.Best quality of products, technology, and after sale service 3. Reducing costs 4. Renovation of all working processes
Objectives	1.Three improvements in conditions -Meetings ensuring co-operative and harmonious production relations -Movement for making 'one fence' -Innovation movement 2.Four factory renovations - Increasing the productivity - Quality control - Reducing of the cost -Improvement of service 3. Four system innovations -Of the system of production and raw material utilisation -Of after sale service system -Of KD system -Of general management	1.Campany culture -Establishing new labour-employer relations -New management culture 2.Four factory innovations -Quality control -Productivity increases -Cost reduction -Improvements in after sale service 3. System innovations -Of the system of production and raw material utilisation -Of after sale service system -Of KD system -Of general management 4. Developing a man of ability -Career development programme	1. Production and sale of 750,000 cars 2.Achievement of quality index:DIQS 350 3. Cost reduction

Appendix 16: Evidence of intensified work in one car factory

1. Changes in working hours

Table A16-1 shows that working hours increased from 1992 to 1997. In 1998, during the economic crisis, many workers were put on part-time work, working 14 days per month, for example. The figures for working hours are therefore lower than expected.

Table A16-1. Working hours for manual workers in the car factory

(Unit : numbers)

	92	93	94	95	96	97	98
Extended working hours	23.8	36.2	39.4	42.1	38.2	32.5	13.62
Working hours in holiday	11.6	10.5	9.4	12.8	7.8	6.9	2.03
Extended working hours in holiday	1.0	0.6	0.2	0.9	0.8	0.5	0.38
All night working hours	36.4	35.6	36.3	36.9	37.1	35.2	21.82
Total working hours per week	52.38	54.89	55.28	56.84	57.07	57.30	45.90

Source : Daewoo labour union from 1996 to 1999

2. Changes in work pace

Table A16-2 shows that work pace in most departments dramatically increased from 1992 to 1995. Since 1995, the increase of work pace has remained static.

Table A16-2. Job Per Hour changes by different department and year

(Unit** : numbers)

	90	91	92	93	94	95	96	97	98
Assembly line I	42**	42	46	46	54	60	60	60	60
Assembly line II	15	18	20	33	27	34	36	45	42-45
Body welding	<10	10	14	19	22	23	26	45	
Paint	38	42	48	52	54-60	60	60	60	
Press									
Engine (Susp)	32	35	45	60	75	60	55		
Engine (T/A)	28	30	30	30	40	70	70		
Engine (Assembly)	32	32	32	62	68	75	75		
Pad line	30	38	40	48	54	60	60		

Departments*

Source : Daewoo labour union from 1996 to 1999

Unit** : The numbers of cars or accessories coming out as products per unit time (per minute)

3. Changes in number of cars produced per worker

Table A16-3 shows that the total number of cars produced per worker increased year-by-year, but especially between 1992 and 1997. From the interviews with workers[1] in the car factory, we find that work intensity increased sharply from 1994 to 1997. However, these increases ceased when the economic crisis hit home in 1998.

Table A16-3. Number of cars produced per person in the Daewoo car factory

(Unit : numbers,person)

	91	92	93	94	95	96	97	98
Total number of cars	204,281	179,020	300,094	340,707	454,353	447,581	420,546	273,453
Productive workers1)	9921	9,943	10,472	10,445	10,847	11078	10,333	9,962
Cars/Prod.workers 2)	21.0	18.0	28.7	32.6	41.9	40.4	41	28

1) : Total workers in productive line
2) : Total number of cars productive workers
source : Korean Automobile Manufacturing Industries Association, 1999,
Daewoo Labour Union, 1999
Daewoo LTD, "Quality management", 1996

[1] Interview with workers in Daewoo: I and several people from the Korean Institute for Labour Studies and Policy, interviewed workers and surveyed the work process in the Daewoo car factory in Incheon in May 1996. I carried-out interviews and walk-through surveys, with workers from the factory, in March - May, 1999 to investigate the change of work intensity

Appendix 17: The distributions between occupation, education, income, and deprivation index in Korea

Table A17.1 total wages by occupational group among whole working population in Korea

(unit: 1000 won)

	1995	1996	1997
All	927.9	1049.9	1131.6
1 Legislators, Senior officials & managers	1746.1	2042.6	2170.4
2 Professionals	1232.7	1382.8	1470.8
3 Technicians & Associate Professionals	1046.6	1197.2	1285.5
4 Clerks	882.6	999.5	1045.7
5 Service workers & shop and Market Sales Workers	734.1	838.1	877.2
6 Craft & related Trades Workers	837.6	961.1	1054.6
7 Plant & Machine Operators & Assemblers	854.5	945.7	1006.4
8 Elementary Occupations (labourers)	658.0	700.9	748.0

Reference : Survey report on wage structure, 1997, Korea, The Ministry of Labour

Table A17.2 Annual income difference among different educational group (unit: %)

	All	Less than Middle school	High school	College	University
1997	108.5	88.5	100.0	106.0	145.5
1995	107.8	90.9	100.0	108.7	146.8
1990	108.0	87.7	100.0	116.7	174.6
1985	104.5	79.3	100.0	129.5	214.7
1980	96.9	72.2	100.0	145.7	217.3

Reference : Survey report on wage structure, 1997, Korea, The Ministry of Labour

Table A17.3 Proportion of different occupational group at differing categories of deprivation

(unit: %)

	Occupational class	Deprivation category				
		1 (affluent)	2	3	4	5 (deprived)
Men	Non-manual	64.47	55.99	54.21	41.80	35.26
	Manual	35.53	44.01	45.79	58.20	64.74
	Total	100.00	100.00	100.00	100.00	100.00
Women	Non-manual	75.82	72.21	68.19	50.61	41.20
	Manual	24.18	27.79	31.81	49.39	58.80
	Total	100.00	100.00	100.00	100.00	100.00

Table A17.4 Proportion of different educational group at differing categories of deprivation

(unit: %)

	Education	Deprivation category				
		1	2	3	4	5
Men	University	43.01	32.68	30.87	22.42	17.47
	High school	43.55	49.01	46.61	44.76	40.13
	Middle school	9.17	12.11	13.83	16.50	18.57
	Elementary school	4.28	6.20	8.70	16.33	23.83
	Total	100.00	100.00	100.00	100.00	100.00
Women	University	29.24	23.23	21.90	13.37	9.92
	High school	46.80	46.21	42.24	32.69	25.55
	Middle school	13.60	15.98	16.41	17.03	15.72
	Elementary school	10.36	14.58	19.45	36.91	48.81
	Total	100.00	100.00	100.00	100.00	100.00