EARLY CHILDHOOD DEVELOPMENT (ECD) IN PAKISTAN:

The relative contribution of neighbourhood, socioeconomic inequalities and home environment to growth and psychomotor development

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October 2007

There is always one moment in childhood when the door opens and lets in the future.

Graham green

ABSTRACT

Child development is a process of positive change in psychomotor, cognitive, linguistic, social, emotional, and behavioural aspects in a well nourished child. The word psychomotor refers to the psychological and motor aspects of action. Psychomotor abilities have a pivotal role in the achievement of holistic development of well balanced children during the early phases of life. Many children live in underprivileged conditions prevailing in the developing countries. It is estimated that about 11 million children under 5 die every year, but that at least 200 million of those suffer from developmental delays.

Aims and objectives

The overall aim is to contribute to an understanding of the social environment in which a child grows and develops in Pakistan; and in particular to evaluate the relative contributions of socio-economic status, rural-urban neighbourhood and home environment on growth and psychomotor development.

Methodology

A cross-sectional study was conducted from May to November 2002 in 15 rural and 11 urban communities of Sindh, Pakistan. 1,244 children aged less than 3 were assessed at home visits using: Bayley's Infant Developmental Scale for psychomotor development, the Home Observations for Measurement of the Environment inventory (HOME), basic anthropometry for growth status, and a questionnaire collecting a variety of socio-economic and demographic factors. A socio-economic index was created using principle component analysis, and the study hypotheses explored through multiple regression modelling.

Key Findings

Sub-optimal growth and development were prevalent among the study children. Overall the mean psychomotor development (PD) index was 96.0 (SD 16.7) with 23% assessed as having delayed development, and 52.3% of children were found to be undernourished with 39.8% stunted, 30.9% underweight, 18.1% wasted, and 7.4% with severe acute malnutrition. There were no differences between males and females, but the mean PD index decreased significantly with age (p value < 0.001).

Stunting and underweight, but not wasting, were strongly negatively associated with PD index with stunting having a larger negative effect than being underweight, and the simultaneous presence of both having a greater negative effect than either alone. Furthermore there was a strong relationship between nutritional status and PD index even among well nourished children; when the analysis was restricted to this subgroup, it was estimated that PD index increased by 2.07 points with every unit increase in z score for height-for-age. Although low birthweight children have a lower mean psychomotor score, this appears to be largely mediated through its impact on postnatal growth and current nutritional status.

Lower socio-economic status, living in a rural rather than urban neighbourhood and poorer sensory stimulation provided in the home environment were all found to have strong associations with lower psychomotor scores and with undernutrition. Rural urban differences in undernutrition were found to be mediated by the lower socio-economic status of families in rural areas. In contrast, rural-urban differences in psychomotor scores remained strong (P<0.001) even after controlling for differences in socio-economic status and home environment. It was estimated that rural

residence accounted for 21% of cases of delayed psychomotor development among study children.

On average, our study households provided 60% of the ideal sensory stimulation as assessed by the HOME inventory. The level of sensory stimulation had a strong and independent association with psychomotor development and with stunting and underweight, that was not explained by rural-urban neighbourhood or by socio-economic status. The association with psychomotor development was only marginally mediated through an effect on nutritional status.

Implications

The study emphasizes the fact that improvement in socio-economic status is vital to achieve optimal growth and development during early childhood. However, it also highlights the additional importance of the level of sensory stimulation provided in the home, and identifies the need to integrate this neglected area into child survival and developmental initiatives. Last but not least the findings draw attention to the importance of paying attention to contextual needs, in particular those relating to differences between rural and urban neighbourhoods, in the formulation and implementation of early child care and development interventions. It calls for urgent research to identify the specific processes (for example differences in parental expectations concerning child development milestones or in parenting approaches) which distinguish rural neighbourhoods from urban ones and to develop and test context-specific interventions that address these differences and promote an enabling home environment.

Acknowledgments

At the very first, I would like to simply admit that I consider myself extremely fortunate that my PhD is being supervised by Betty Kirkwood. During the last three years I have learnt so many marvelous things from her: passion for research and child health, her restless quest for perfection, and belief in doing good. I found her always available with intellectual suggestions and emotional support. She is a teacher, mentor, friend, and family to her students. I sincerely believe that any expression of gratitude would be an underestimation of my sentiments.

It is important to acknowledge the support and love I received from my friends throughout this period. Bushra Khan and Arshad Altaf were always there sorting out challenges back home for me, at times even without my knowledge. While Haroon and Ahsan continued to shower their affection and simply maintained their unfaltering faith in me.

My experience would have been unfulfilled without the wonderful times I shared with my PhD colleagues, who never failed to generate stimulating discussions and made sure that I should get regular breaks from prolong thesis writing sessions. I will look forward to the professional collaboration and their friendship in the future.

It is a bit clichéd to take singular credit of a thesis when so many people have contributed directly or indirectly to enable me to make it happen. Dr. Camer Vellani and Franklin White who nurtured me at the beginning of my career and encouraged me to work in the field of child health and development, so that I could make this not only as my career but my life long passion. My field research team deserves a special mention. They enthusiastically collected the data and considered this work as a mission rather than a job.

The acknowledgment would be incomplete without the mention of the two funders of this project. The International Maternal and Child Health Research and Training programme (NIH-IMCHRT) supported the project under the Fogarty Fellowship for the National Institute of Health-Fogarty Institute. Support was also given by the University Research Council of the Aga Khan University

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Chapter One

Introduction

1.1 Overview

Human development is the process by which individuals, families, social groups, and populations generally progress towards achieving their optimal potential of physical, mental, and social well-being and economic productivity (1, 2). Early childhood is a vital phase with long term trajectories affecting the entire human life cycle (3-6). This thesis focuses on the influences and relative contribution of three key determinants of early childhood development and growth; in particular socio-economic status, whether the child's neighbourhood is rural or urban, and the level of sensory stimulation available at home. It further explores the extent to which these influences may be mediated by an effect of a child's growth. The overall conceptual framework is illustrated in figure 1.1, which will provide the foundation for the rest of the thesis. The framework derives its inspiration from the Urie Bronfonbrenner bio-ecological model (refer to section 2.5 and 2.6 for details), while linkages among the given factors are elaborated and investigated in detail in chapters 4-6.

1.2 Study Aims and Objectives

The general aim is to develop an understanding of the social environment in which a child grows and develops in Pakistan.

Study Objectives

The following are the overall objectives for the thesis, while specific objectives are mentioned in the respective chapters.

- To establish the affect of socio-economic inequality and rural or urban neighborhood on the growth and psychomotor development of the child.

- To examine the role of undernutrition as a determinant of psychomotor development.

- To identify the role and pathways of sensory stimulation which influence the growth and psychomotor development of the child.

1.3 Layout of the thesis

The thesis has been arranged into seven chapters, the following is a brief overview of its structure and contents:

The rest of this chapter highlights the significance and rationale for studying early child growth and development, especially psychomotor development.

Chapter two describes the main existing theoretical frameworks of child development; these are reviewed for their suitability in epidemiological research and public health initiatives. Here it is important to highlight that literature relevant for the specific determinants is discussed in chapters four to six.

Chapter three introduces the study setting and data collection methodology. It also includes the overall analytical plan; specific details of analyses are given in the respective results chapters.

Chapters 4-6 contain the main results. Chapter 4 addresses the rural urban neighborhood differential on psychomotor development after adjustment for socio-economic status. It also presents the background of the study participants, especially socio-economic characteristics which are summarized as a socio-economic index developed by principal component analysis.

Chapter five assesses the influence of undernutrition on psychomotor development. Apart from the individual anthropometric indicators of stunting, wasting and being underweight; the composite index of anthropometric failures has been formed to assess the effect of various combinations of undernutrition on psychomotor development. In addition, it also assesses whether low birth weight is a determinant of psychomotor development during the early childhood phase.

Chapter six examines the role of sensory stimulation on growth and development. In particular it explores whether sensory stimulation differs by socio-economic status and neighborhood. The chapter then seeks to establish whether sensory stimulation affects psychomotor development directly or if it influences it through the nutritional status of the child.

Chapter seven draws the results in three chapters together and estimates the impact or contribution on the psychomotor development of the child of the three determinants considered in the thesis, i.e. rural/urban neighborhood, socioeconomic inequality, undernutrition and sensory stimulation available at home. Finally, wraps up the thesis with main conclusions and recommendations for future early childhood research and public health initiatives

1.4 Public Health Perspective: Beyond Child Survival

Globally, about 11 million children under the age of 5 die every year (7). Primarily these deaths are a consequence of the underprivileged living conditions which prevail in developing countries. Most international and national public health initiatives are focused on reducing childhood mortalities, hence translated into improving survival rates (8). The critical dilemma concerns the vast majority of children who survive in these underprivileged conditions and are more prone to developmental delays, faltering growth and socio-emotional difficulties (9). During adulthood, with limited abilities and lifespan, they are unable to compete with rest of the healthy population for the same opportunities and resources. Differentials at the baseline characteristics (early childhood) lead to unfair starts and finishes, resulting in a vicious cycle of deprivation and intergenerational poverty (10).

From the public health perspective, long term vision requires focus not merely on child survival but preventive and remedial efforts which are vital to improve the quality of life of survivors as early in life as possible (11).

Investments in interventions to improve the quality of childhood care, growth and development can have long-term beneficial effects on health, mental and physical performance, and productivity (12). In addition, interventions in early childhood can help to avoid future costs of remedial education and programmes that deal with social problems like violence and crime (13). The field of early childhood development is in need of preparation and implementation of effective national policies and international co-operation, especially in the context of developing countries (14, 15). The benefits gained from investing in early childhood are directly linked to an increase in the efficiency of education and future productivity

of children. In addition, the reduction of health care service costs is indirectly related to the promotion of gender equities and community development(16).

1.5 Rationale: Focus on Psychomotor Development and Growth

The emphasis on early childhood development (ECD) is derived from considerations of human growth; particularly the critical formative period of early childhood characterized by rapid cognitive and social development. The first three years of life are critically important for the development of neuronal connections within the brain, which are rapidly moulded and conditioned by stimuli to all modalities of sensation (17). Inadequate nutrition before and after birth, prenatal infections, problems of parturition and birth injury, poor social environment, mode of communication, lack of autonomy to explore and express, and lack of affection, stimulation and play can seriously interfere with brain development and can result in neurological and behavioural disorders, learning disabilities and mental retardation (18). In addition, environmental, physical, behavioural, socio-economic, and cultural influences in the early years of a human life have a long lasting and perhaps a larger than suspected impact on brain development. Learning ability and social behaviour in early life, in turn, determine the capacity for adaptation and change in response to environmental conditions, potentially recreating the very conditions of life that are either beneficial or detrimental to the achievement of a child's full genetic potential.

Understanding the dynamics of early childhood development is an essential step prior to the design of any enrichment programs for children. There is a need for collecting specific information about the settings in which children develop so that the advantageous and harmful components of their environment can be identified. Such information would eventually help to establish the relationship between what is

included in an intervention program and how a child can respond within a particular setting. In addition, the insight gained from early childhood development research lays the foundations for educating the care-givers in the community on desirable child rearing practices (19).

Development during early childhood is dependent upon physical growth and health and a variety of sensory stimuli from the social environment. All the domains of child development: psychomotor, cognitive, emotional and social abilities are vitally linked with a continuous cycle of nutrition and sensory input from the social environment. In a special series of articles on child development in developing countries published by the *Lancet* , it has been estimated that at least 200 million children under five suffer delayed development (20). However, this estimate is based on a limited aspect of development i.e. cognition, despite the fact that other aspects are equally vital for the future and well being of children. If we consider delayed development holistically by including other relevant domains of development the magnitude of the problem is colossal.

Psychomotor abilities have a pivotal role in the achievement of holistic development of well balanced children during the early phases of life. It is well interconnected with the sphere of growth and development in a holistic manner (21). As it is linked with other developmental aspects, every organised and purposive effort to influence psychomotor development will eventually affect the overall development of a child. Conceptually, psychomotor development refers to the psychological and motor aspects of action (22).

A well nourished child in a predictable and structured environment with the support of a nurturing caregiver achieves better coordinated movement and command over tasks (*psychomotor development*). This regularity of newly acquired skills by the child forms the basis for better effect and self-esteem

(*emotional development*). Pleasant emotions and an ability to respond to and socialise with others result in better relations (*social development*). A well coordinated and confident child is more likely to explore their environment i.e. hear, see, move towards, touch, smell and even taste new stimuli (*curiosity*). A regular and meaningful interaction with the environment results in enhancement of language, memory, learning and problem solving abilities (*cognitive development*) (21).

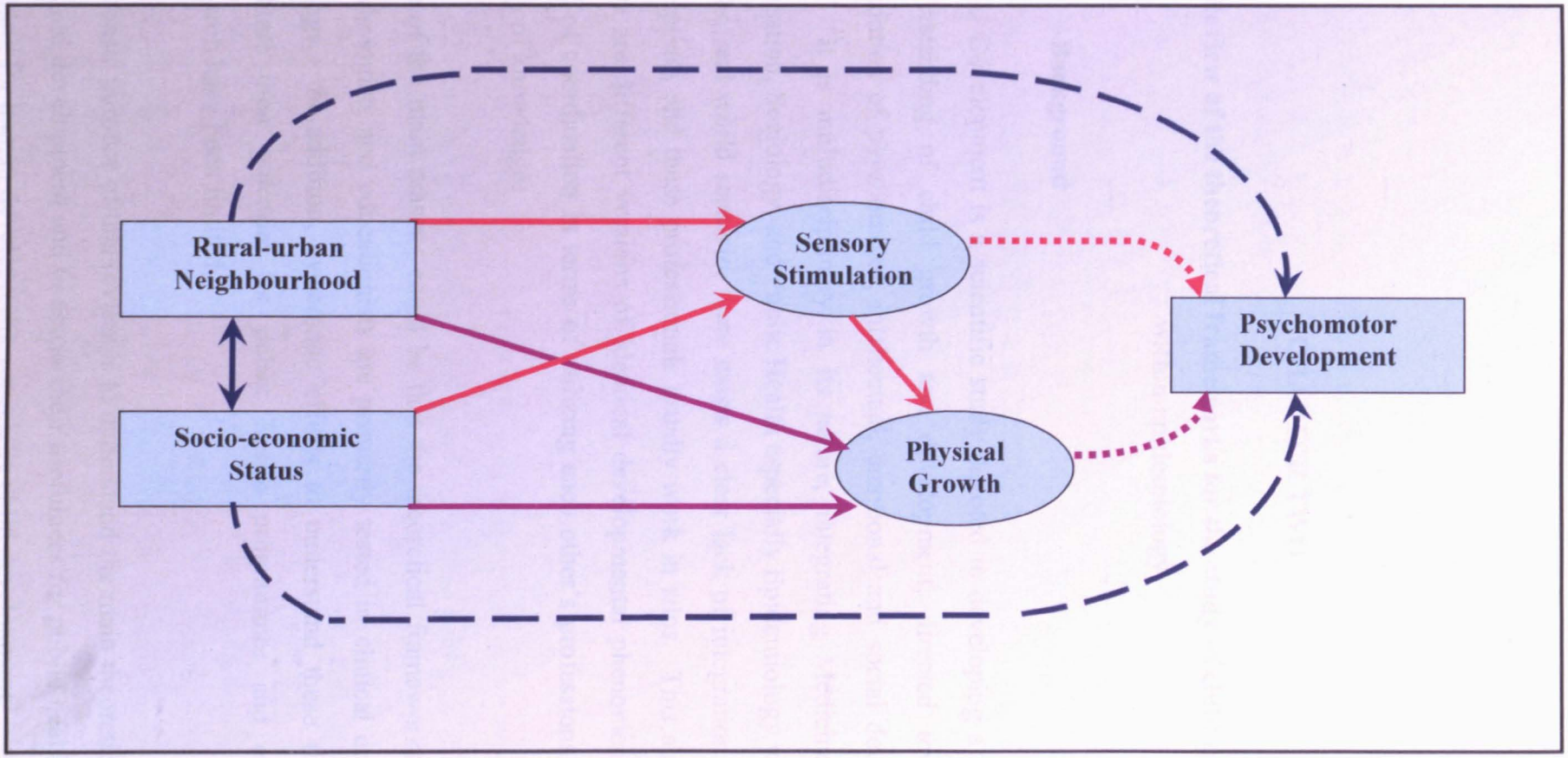
1.6 Gaps in the scientific evidence

Physical growth of a child is a fairly coherent concept and its assessment is relatively straightforward so there is ample research based evidence in public health for child nutrition and survival. On the other hand, one of the main reasons for the neglect of child development initiatives is that child development is neither a simple concept, like growth, nor a unitary concept like "mortality". It requires enormous resources to comprehensively evaluate child development, especially at the community level. Some domains of child development have more cultural interpretations, i.e. cognitive, social and emotional development (23). In addition, culturally appropriate instruments are not widely available for various diverse settings especially from developing countries. On the other hand, psychomotor development is relatively independent of cultural background during early years of life. In addition, its assessment is a robust measure as compared to mental development during ECD (24).

Another paradox is that most of the ECD research in the discipline of psychology is not adequately based on its social context. Evidence is collected under stringently laboratory like conditions, which does not work well for public health initiatives. Instead community based evidence collected under the

epidemiological paradigm is required. However, most of the ECD evidence collected through epidemiological research concerns social context without a proper assessment or integration of evidence of child development. The common deficiency in both psychological and public health research is that they rarely address the growth and development of the child together. The study of early childhood growth, development and social environment integrated in a scientific theoretical framework is important to identify associations and pathways of development (25). Such an effort would help to identify points of intervention to enhance child growth and development.

Figure 1.1: Conceptual framework of relationship between psychomotor status, sensory stimulation and undernutrition



CHAPTER TWO

Review of the theoretical frameworks for the study of child development within epidemiology

2.1 Background

Child Development is a scientific study devoted to developing a comprehensive understanding of child growth and development, directed towards lifelong promotion of psychomotor, intellectual, emotional and social development (26-28). It is multidisciplinary in its nature, integrating Medicine, Psychology, Education, Sociology, and Public Health especially Epidemiology within that. But in the real world scenario, there exists a clear lack of integration between these disciplines and these professionals usually work in silos. This also implies that there are different versions of identical developmental phenomena, but there is lack of coordination in terms of utilizing each other's professional expertise and body of knowledge.

One of the main reasons could be that the theoretical frameworks developed by psychologists and educationists are primarily tested in clinical or facility based settings. In addition, systematic efforts to understand these theories and to evaluate their potential for public health programmes and epidemiological research have been limited.

The basic purpose of this review is to understand the main theoretical frameworks of child development and to assess their usefulness for public health professionals working for human development, especially child development.

2.2 Criteria to evaluate theoretical frameworks

Several theoretical frameworks exist in the scientific literature which analyse, rationalise and predict diverse aspects of child development. These theories can be broadly grouped into 3 categories on the basis of contents and approach:

- Descriptive theories
- Psychological construct based theories
- Context based theories

The main theories in each of these categories are described in sections 2.3 – 2.5. Each of the theories has been evaluated for its potential to contribute to our public health understanding of child development using the following criteria:

1. **Concepts:** clear and non-overlapping conceptual domains with a reasonable cross-disciplinary comprehension.

2. **Scope**: the ability to address all the important domains of child development (i.e. cognitive, psychomotor, emotional, social, and behavioural).

3. **Lifelong perspective**: the ability to address and link with all other phases of human development (i.e. newborn, infancy, toddlerhood, middle and late childhood, adolescence, early, middle, and advanced adulthood).

4. **Epidemiological research perspective**:
    a. Potential to be assessed empirically.
    b. Potential to create research based evidence for public health interventions. An ability to provide practical guidance in solving daily concerns regarding child rearing for caregivers. Moreover, in terms of

determination of primary agents influencing the development of the child, theories in general are either inclined towards Nature (Pre-deterministic i.e. genetic) or Nurture (Probabilistic i.e. social influences). Ideally, theories which acknowledge nature, but give emphasis to the role of nurture are more suitable for public health initiatives.

The critical appraisal of the three groups of theories on the basis of the given criteria is stated in section 2.3-25; included is a general description of the group, some examples of the relevant theoretical frameworks, and summary remarks for that group. This evaluation is summarised in table 2.1. Finally the relevance of the review to the thesis is discussed in section 2.6.

2.3 Descriptive Theories

According to the descriptive theories, the underpinning of human development is a biological process which is principally genetically determined i.e. it automatically results in the appearance of sequential developmental stages over time in a predictable manner on the basis of genetic potentials.

Gessell's framework is the prime example of descriptive theories. The suggested descriptive developmental gradients are about the observable changes in child growth and behaviour from birth into adolescence (29, 30). It includes motor abilities, personal hygiene, emotional expression, fears and dreams, self and sex, interpersonal relations, play and pastimes, school life, ethical sense, and philosophical outlook. The primary achievement of the theory was the systematic observation and cataloguing of developmental norms and age specific behaviours (31-33). These normative studies are helpful in identifying "normal development"

i.e. what to expect for a specific age group, but unable to give guidance about how to intervene in order to improve developmental gradients (34-36). For example, it can be concluded that successively advanced motor milestones in children emerge with maturation of the body and brain. Consequently, underdevelopment is interpreted as a child requiring more time to achieve a specific milestone as compared to normally developed children.

Descriptive theories are important for understanding the patterns of development from birth to adolescence. They are based on direct observation and therefore are verifiable through observational studies. These theories however lack the epidemiological potential to identify the associated risk factors which can affect child development.

2.4 Psychological Construct Based Theories (PCB)

PCB theories focus on the generic principles to explain the layout of child development based on psychological structures (constructs) and usually do not address the reasons behind developmental changes. The proposition is that a child periodically moves up from one identifiable development stage to another, rather than development by undetectable small augmentations. Moreover, the role of social influences is assumed but not explained explicitly. They primarily address learning and behavioural aspects of development; Piaget, Kohlberg, Freud and Erikson are the main theorists in this category.

Piaget's theoretical framework has cognition as its central point and primarily refers to how children acquire knowledge, but at a secondary level it also addresses social and emotional development (37-42). It postulates that cognitive development is a spontaneous process that results in modifications to and

reorganisation of abstract psychological structures (constructs) i.e. schema, assimilation, accommodation, adaptation (43). In addition, development is seen as a discontinuous process characterised by spontaneous changes; progression by interrelated yet independent achievements in a series of stages i.e. sensory motor, preoperational, concrete operational, formal operational (44-49).

This theory of cognitive development is limited to 0-16 years (50). The model cannot account for the complexity and variety of human thought phenomena. Basic concepts are abstract, difficult to comprehend, and cannot be empirically assessed. In terms of child rearing, the theory has proven to be of interest among educators. However, it is unable to give guidance about a variety of problems that confront parents and other caregivers (51-54).

Kohlberg adopted Piaget's approach to the concept of moral judgment (55). He considers only one facet of child development; the process of socialisation by which children learn to conform to the expectations of their culture (56). He has hypothesized 6 stages of orientation of moral reasoning from childhood to adulthood: punishment and obedience, naïve instrumental, good boy and nice girl, law and order, social contract, and universal ethical principle (57-59).

The theory assumes cognitive prerequisites for the moral reasoning but doesn't directly address any other developmental domains (60-62). It is even limited in its basic construct of "moral" as it is primarily based on the theme of fairness or justice, while ignoring the several other important domains of morality such as sympathy, courage and autonomy (63, 64). Age related changes in moral reasoning follow a consistent developmental sequence but most researchers have been unable to demonstrate such distinctiveness in the moral stages in older age groups (65, 66).

Freud's theory of psychoanalysis proposed two substantial claims about human development. Firstly, the initial few years of life are the most important for the formation of basic personality. Secondly, this development primarily involves psychosexual stages i.e. oral, anal, phallic, latent and adult genital periods. The process of satisfying the desire in each stage creates the basis of personality formation. The early interaction between the psychological structures (constructs) known as child drives i.e. id, ego, and superego, and his social environment set the pattern for later learning, social adjustment, and coping with anxiety. Emphasis is on biological influences, especially drives, but recognition is also given to the contribution of experiences (67-69).

Freud's perspective of human nature is completely opposite to Piaget's theory of cognitive development. Piaget focuses on the rational child, calmly searching for truth and comprehension. Freud is concerned with emotions, particularly their contribution in shaping personality and thought, as the child strives to cope with them. Psychoanalytical theory focuses on antecedence and the consequences of irrational thought processes of the child, which occur more frequently than the rational ones. In general this theoretical perspective is helpful in dealing with the emotional development of children, but provides no information regarding cognitive or psychomotor development of children (69).

There are several inherent weaknesses in the theory including over-emphasis on childhood sexuality (70-72). Overall, it focuses on a search for developmental causes and cures for neuroses (deviant behaviours), rather than directly identifying normative pattern of social development. Theoretically, social factors are considered important, but there is practically no demonstration of their role. The theory is based on subjective observations, limited data, and inadequate scientific methodology. Freud's model of childhood personality development and related psychological structures are difficult to validate empirically; in addition no

rationale is given for the sequence, timing, and occurrence of stages. The theory has practical implications for psychologists in terms of addressing neuroses but little practical value for care providers (73-75).

Erikson's psychosocial theory suggests that a person passes through eight stages of emotional development. In each stage, there is a psychosocial crisis with two possible outcomes: 1. Trust versus mistrust. 2. Autonomy versus shame and doubt. 3. Initiative versus guilt. 4. Industry versus inferiority. 5. Identity repudiation versus identity diffusion. 6. Intimacy and solidarity versus isolation. 7. Generativity versus stagnation and self-absorption. 8. Integrity versus despair (76, 77).

This psychosocial theory is an extension of Freudian work in many ways. Firstly, the psychosocial concept is a broader theory and encompasses Freud's psychosexual framework. Secondly, the same psychological constructs which were coined by Freud (e.g. ego) are used in the explanations. Thirdly, he proposes that psychological development is the consequence of the interaction between biological needs and societal demands. The role of social influences has been explicitly identified on personality development. Fourthly, focus is on development of the healthy personality (normality), in contrast to Freud's emphasis on addressing neurotic behaviours (deviance). Finally, the proposed framework is based on observations of a diverse sample of all age groups (78, 79). However the theory lacks a specific mechanism of development and is unsystematic - one developmental stage is not conceptually linked to the other. Moreover, child developmental domains are not addressed comprehensively (80, 81).

In summary, PCB theories primarily address only one or other facet of human development. Some of them have a potential to explain specific developments from a lifelong perspective.

Primarily these theories are derived from the psychology discipline and therefore address the clinical needs of similar professionals, not the community level care providers. It is difficult to empirically validate most of the psychological structures as they are imprecise and not very clearly spelled out. In addition, it is not clear how they are translated into behaviour. In the absence of identifiable linkage and pathways between concepts and behaviour, it is difficult to identify points of intervention from public health perspective.

2.5 Context Based Theories (CBT)

CBT have received significant recognition in the recent years. From a contextualism perspective, developmental changes occur on the basis of give-and-take (bi-directional) relations between the child and the context i.e. the environment changes the child and the child changes the environment. It implies that children are the product of their social environment and they have the potential to influence their own environment and are thus producers of their own environment. CBT explain how children develop, rather than what they are at different stages of development. Prominent theorists in this category are Bandura, Vygotsky and recently Bronfrenner.

The social learning theory by Bandura emphasizes social variables as the primary determinants of behaviours and personality (82, 83). It explains human behaviour in terms of continuous reciprocal interaction between social environment and cognitive and behavioural aspects of the child. Children are

more eager to replicate a behaviour if it results in outcomes they value i.e. the role model is related to them and has well-liked status and the behaviour has functional value. The process of observational learning from modelling (imitation) has five underlying component processes: 1. Attention, 2. Memory coding, 3. Memory retention, 4. Motor Reproduction and 5. Overarching concept of Motivation (84, 85). Thus it signifies the value of observing and modelling behaviours, attitudes, and emotional reactions on the basis of templates provided by others (86).

The theory gives due recognition to cognition, but inadequate attention to child mental and physical processes apart from those involved in imitation. It thus limits its scope in holistic child development (87). However, this framework has been successful in the study of common behavioural problems such as anger and consequently often forms the basis of behaviour change techniques used in professional training programs (88-95).

Vygotsky's framework is a general theory of cognitive development (96). It emphasizes that social interactions contribute a fundamental role in the development of cognition. Most of the original work was done in the context of language learning and acquisition in children, although later applications of the framework have been broadened by extending them to other developmental domains (97, 98).

It is based primarily on two principles: Firstly, at any given age cognitive development is genetically limited to a certain range. Secondly, optimal cognitive development requires social interaction. The potential for cognitive development depends upon the "zone of proximal development" i.e. the existing developmental status of the child when new environmental stimuli are provided determines the direction, magnitude, and nature of response of child development. In general

Vygotsky's propositions are supportive of and expand the horizon of the social learning theory by Bandura (99).

Urie Bronfenbrenner's bio-ecological theory for human development further extends these concepts by Vygotsky (100, 101). It is very generic in its description; it has the capacity to address any domain of development and every possible environmental context in which development can occur throughout life. It proposes development as a gradual and reciprocal adjustment between an active, growing child and the evolving characteristics of the contextual settings in which the developing child lives. It is an extension of Vygostky and Banduras's work especially in terms of a more structured description of environment and social interactions.

The social environment is visualized as five distinct concentric systems: micro-system, meso-system, macro-system, exo-system and chrono-system (for details see appendix 2.1). Each layer has its own specific set of determinants which form the basis of the interaction with the child. The quantity and quality of these interactions between child and the environment determine the input stimuli and are necessary for child growth and development. This explicit visualization of the social environment provides multiple venues for caregivers to examine and modify their child rearing practices.

The bio-ecological theory for human development is a relatively recent addition to the literature of child development (102). Therefore very limited scientific research has been done to validate it. But another promising feature of this theory is that it gives clear guidelines for future research in terms of laying out the framework of analysis i.e. the bio-ecological model. It suggests that child development should be explored and explained in its ecological context; that is in the actual environments in which children live their lives. A critical distinction is

made between the concepts of "environment", "child", and "process", with the latter occupying a central position with specific meaning in the developmental dynamics (103), it is the interaction between child and environment and is considered as the primary mechanism for producing development in children. It is important to note that conceptually these categories could be overlapping, and a characteristic can change its class with change in the hypothesis considered. It is important to emphasise that this model is generic in its nature and is applicable to lifelong human development. However, the content of this model can be made specific by stipulating:

a. Age group : early childhood development, adolescent, adulthood etc
b. Developmental domain: psychomotor development, mental development, social development etc.

In summary, CBT are evolved into frameworks that are relevant for all the domains of child development. The concept of environmental context, process, child characteristics and outcomes are straightforward and their cross disciplinary communication is clear. Although CBT recognises the importance of "nature" (child characteristics) its main emphasis is "nurture" in the form of environmental context and proximal processes, which are modifiable factors in terms of public health interventions. It is noted that although these concepts are already independently in use in epidemiological research, only CBT has successfully established the linkage between the concepts in an organised way to predict child growth and development outcomes.

From the evaluation criteria it is fairly straightforward to conclude that, among the theoretical frameworks of child development, CBT and especially its bio-ecological model can contribute more to public health programmes owing to its ability to attend to all the facets and phases of child development and consequently

human development. The concepts are comprehensive but simple enough that they can be effortlessly communicated from policy makers to grassroots workers in ECD programmes. Hence, it is more likely to create successful multidisciplinary and cross-sector partnerships. Last, but not least, epidemiological researchers can develop their projects based on this framework and empirically verify it in community based research. In addition, its focus on the exploration of the social environment provides opportunities to develop effective interventions to address child growth and development together.

At the end, it is important to clarify that the purpose of this critical appraisal was to assess the child development theoretical frameworks for their adaptability to epidemiology and public health disciplines. By any means, my intention is not to rank any theory intrinsically superior or challenge its contribution in their respective disciplines.

2.6 Relevance for the thesis

The theoretical framework (refer to figure 1.1) used in this thesis fits into the bio-ecological model. The thesis framework has three domains. The first being the outcomes of physical growth and psychomotor development. The Second, that sensory stimulation available at home is a main proximal process, while physical growth is also a proximal process for the development. The third, that socio-economic status and rural versus urban neighbourhood are the context.

The description in terms of the bio-ecological model predicts that sensory stimulation and undernutrition (proximal processes) will differ in their effect on the psychomotor development and physical growth (child outcomes) depending on the nature and quality of the rural/urban neighbourhood and socio-economic inequalities (context). The primary assumption is that social context provides different opportunities and

challenges for growth and development. Therefore, it will be important to identify context specific proximal processes; a prerequisite to conceptualise socio-culturally relevant interventions for promotion of child development.

Table 2.1 = Theoretical frameworks to study child development: comparison form Public Health Perspective.

Theories	Concepts	Scope	Lifelong perspective	Epidemiological Perspective	
Categories				**Empirical Assessment**	**Intervention**
Descriptive					
Gessel	+	±	-	+	-
Psychological construct based					
Piaget	±	±	-	-	-
Kohlberg	+	-	+	-	-
Freud	±	-	-	-	-
Erikson	±	-	+	-	-
Context based					
Bandura	+	±	+	+	+
Vigotsky	+	+	+	+	+
Bronfrenner	+	+	+	+	+

+ = adequately addressed, - = neglected, ± = inadequately addressed

Chapter Three

STUDY METHODOLOGY

3.1 Overview of the study design

A cross-sectional approach was adapted to study and understand the dynamics of growth and psychomotor development in Sindh Province, Pakistan. All families with children under the age of three years were included from 26 communities; 613 children from 15 rural and 621 children from 11 urban. This included five Karachi based communities, which represented the middle class urban communities. Maternal interview and child's physical and psychometric assessments were performed in the home setting.

3.2 Study Setting

Sindh is one of the four provinces of Pakistan, situated in the western part of South Asia. It stretches between the Arabian Sea and the province of Punjab (see figure 3.1). The river Indus has been its sole means of sustenance. Sindh comprises a vast fertile agricultural tract stretching westward from the narrow strip of flood plain on the right bank of the Indus river and a vast expanse of desert stretching eastward from the left bank. It has a continental type of climate, characterized by extreme variations of temperature. The average diurnal variation in temperature ranges between 11°C to 37°C. However, winters can be cold with a minimum temperature of about 4 °C in January.

Sindh has been the heart of the Indus Valley civilizations dating back to third millennium B.C. The native population of Sindh is called Sindhi. Historically Sindhi culture has been influenced by that of the Greeks, Iranians, Arabs, and Europeans. Successions of races migrated here like the Dravidians, the Aryans,

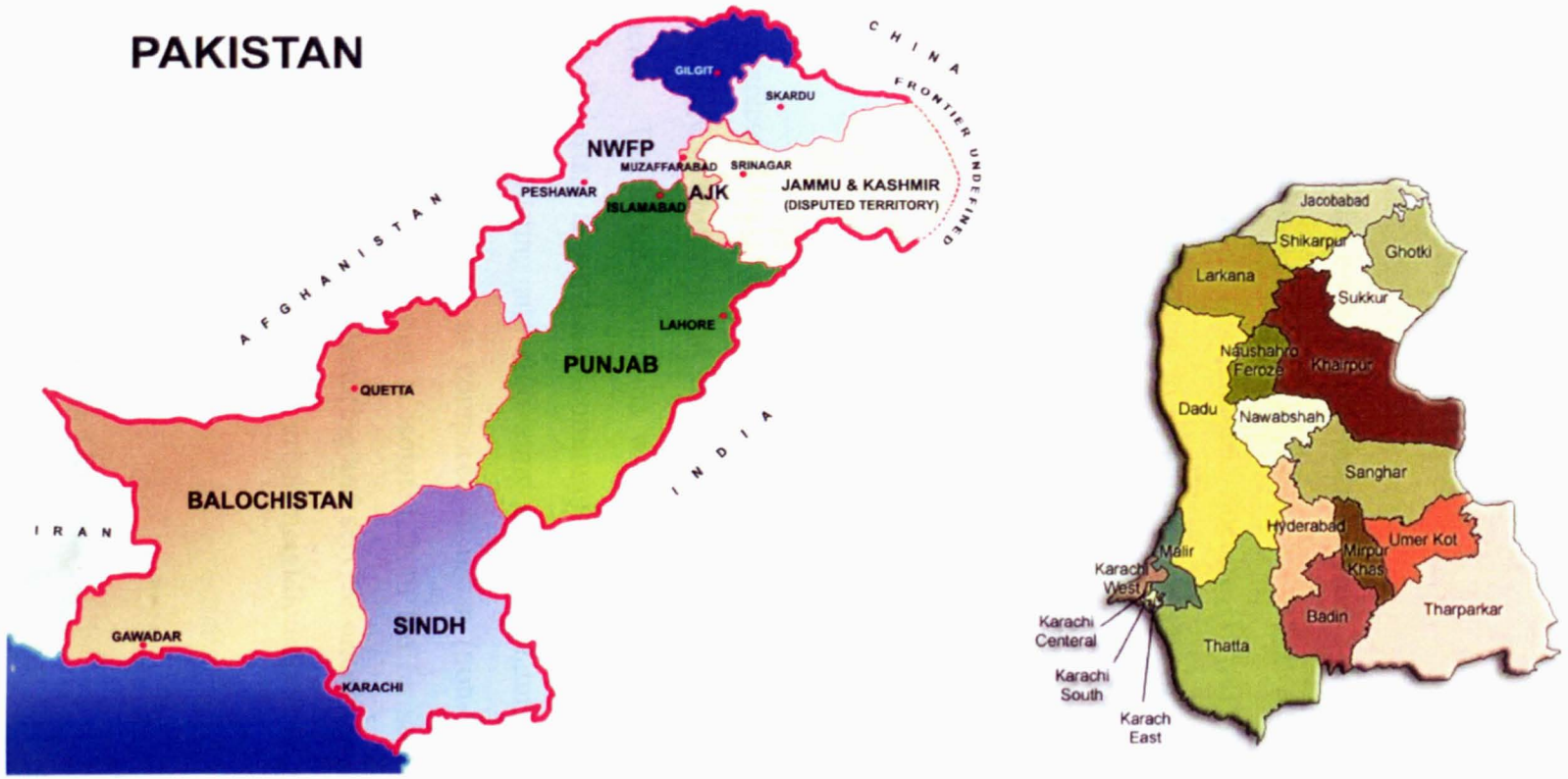
the Iranians, the Greeks, the Caucasians, the Semitics, the Moghals, and the Turks. The condition of children and women in Sindh is influenced by the strong feudal culture and traditional norms and values, as well as the sharp economic and social contrast which exists between rural and urban areas.

Traditionally Sindh's culture has developed in relative isolation from the rest of the Indian subcontinent. However, after Pakistan's independence in 1947 its culture has progressively assumed a new complexion with the influx of Muslims from India, comprising about $1/6^{th}$ of the total population of the province, mainly concentrated in the urban centres.

Sindh has an estimated population of over 37 million, 50% of which lives in rural areas. The capital of the province is Karachi, the country's largest city and main business hub representing a vast array of socio-economic classes. With a total population of approximately 12 million it represents a mix of all the indigenous ethnic groups from Pakistan and Mohajirs, descendents of Urdu speaking Muslims who migrated from the Indian part of subcontinent at the time of partition. Karachi ranks as the 2^{nd} most populous city in the world in terms of population by city proper (districts), and ranks 22^{nd} in terms of population by total urban area.

The figure 3.1 shows the map of Pakistan and its Sindh province, data was collected in Karachi, Thata, Mirpurkhas, Hyderabad and Dadu districts.

Figure 3.1: Geographical map of Pakistan and its Sindh province



3.3 Selections of the study communities

The study communities were all those whose two health services were provided by two non-governmental organizations (NGO); Aga Khan Health Services, Pakistan (AKHS, P) and Health & Nutrition Development Society (HANDS). These organizations have a strong commitment to conducting research relevant to environments in which they exist and have an accomplished record of working in partnership with other agencies in the development of communities and the enhancement of their health. Both NGOs cooperated with us in providing access to their field sites and guidance with the help of their field staff.

Study field sites were selected based on communities served by the collaborative NGOs which serve equally in both type of communities either by health staff or volunteer arrangements. The target population was the typical rural and urban communities of Sindh, Pakistan. Farm-based communities are considered as rural areas, generally linked to harvesting and cultivating available natural resources through farming, raising livestock, etc. as compared to urban (non-farm-based) areas, where the majority of the population is isolated from the farming culture and livelihood is linked more to the manufacturing and service-oriented sectors. A list of field sites by respective NGO and rural urban neighbourhood is given in Appendix 3.1.

3.3.1 The Aga Khan Health Service, Pakistan (AKHS,P)

AKHS,P is the largest not-for-profit private health care system in Pakistan, since 1912. Its goal is to supplement the Government's efforts in health care provision,

especially in the areas of maternal and child health and primary health care (PHC). The AKHS,P provides preventive health care to over 600,000 people nationwide. Its health care system is decentralized; and services vary according to regional needs. The volunteer and paid staff provide services along established treatment algorithms at the community level, with referral available for secondary or tertiary health care centres. In Sindh, it operates through approximately 52 PHC centres. These PHC programs provide immunization, antenatal care, growth monitoring, micronutrient supplementation, family planning, curative services for most common infectious diseases and nutritional deficiencies, and health awareness and development services.

Overall 13 AKHSP communities were assessed; 329 children from 5 urban communities and 290 children from 8 rural communities (for details, refer to appendix 3.2)

3.3.2 Health and Nutrition Development Society (HANDS)

HANDS is the largest NGO, in Sindh, working since 1979. It is a community development oriented organization with a strong commitment to develop the underprivileged communities with community-based organizations (CBOs). HANDS focuses on women and children health, and literacy through community participation by strengthening CBOs, establishing PHC and secondary health care delivery systems, girls education, and community bank programs. HANDS is a Sindh based organization, benefiting more than 500,000 people of 275 villages. PHC programme is delivered through more than 50 Primary Health Care Centres and its literacy programme has more than 29 informal schools. Its networks include a unique force of about 2000 highly enthusiastic village volunteers.

Overall HANDS 13 communities were assessed; 302 children from 6 urban communities and 323 children from 7 rural communities (for details, refer to appendix 3.3)

3.4 Selection of study children

There was no comprehensive sampling frame available in the localities being considered for the study. The field team members first approached the communities by contacting their local leaders. With their cooperation, the team visited door to door and prepared the list of eligible children in the communities.

All households with any child aged less than three years at the time of assessment were included. The mother-child dyad has been considered as a sampling element. In case of more than one eligible child between the ages of 0 and 3 years in a household, the single child was randomly selected in order to maintain consistency. Inclusion criteria also included that a family should have been residing in the same study field site for at least six months, with the assumption that it will give a reasonable amount of exposure to the local social environment to the child. Informed consent was obtained from the eligible mother and appointments were set for the maternal interview and child assessment at convenient times.

Exclusion criteria were applied to twins and to adopted children because of their different inherent potentials and change of biosocial environment as compared to the majority of children. Exclusion of physically handicapped children was due to their inability to perform psychomotor activities or children already diagnosed as severely mentally disabled because of their lack of comprehension of instructions. Finally, children were also excluded if their adult caregivers refused to give informed consent.

3.5 Sample size

We were constrained by the total number of eligible children in communities, thus analysis was conducted on a fixed sample size of 1,244 children. The following are estimates showing how much of the difference in psychomotor development can be captured with the different levels of exposure. The basic assumptions made are:

a. The tolerable level of error in rejecting the one sided null hypothesis was 5% provided it is true.
b. The desired level was at least 80% power, for rejecting the null hypothesis when it is true.
c. The average value of psychomotor scores is 100 points and standard deviation 15 points (104).
d. The comparative exposure groups are assumed unequal in size and exposure ranges from 10% to 90%.

Table 3.1: Estimates of least detectable psychomotor differences for the entire sample at 80% and 90% statistical power

Exposure rate			Mean Psychomotor difference detectable	
			80% power	90% power
10%	or	90%	3.97	4.60
20%	or	80%	2.98	3.45
30%	or	70%	2.60	3.01
40%	or	60%	2.43	2.82
50%			2.38	2.26

At the given sample size and exposure, the least detectable mean psychomotor difference ranged from 2.38 to 3.97 points at 80% power and 2.26 to 4.60 points at

90% statistical power. Statistically, 50% of the exposure is able to detect a minimum mean difference between the two groups. We are assuming rural urban neighbourhood exposure is 50% and the rest of the exposure rate will fall into the range of 10% to 50%.

It is important to mention here that the estimated detectable mean psychomotor difference is quite small and non-functional in practical terms. For our study it means that analyses have far greater statistical power to detect the functional or meaningful (bigger) differences at the given sample size.

Further, we estimated the least detectable difference between first (lowest) and fifth (highest) socio-economic quintiles. The estimates are calculated for the psychomotor and sensory stimulation scores. We are using the same assumptions that are used for the above calculations and these additional assumptions:

a. categorization of the sample size by socio-economic quintiles does not always result into equal number of study participants in each quintiles therefore we are considering 240 instead of 250 study participants in each quintile which will give us more conservative estimates.
b. The standard deviation of sensory stimulation available at home is assumed as 7.5 points (105).

Table 3.2: Estimates of least detectable psychomotor and sensory stimulation differences for extreme socio-economic quintiles

Exposure rate	least detectable difference between lowest and highest socio-economic quintiles	
	80% power	90% power
Psychomotor status	3.78	4.44
Sensory stimulation available at home	1.89	2.22

It must be emphasised that the sample size calculations between first and fifth quintiles give a conservative estimate. In reality if we consider all the 5 quintiles in the sample size we can detect much smaller differences at the given statistical power or conversely the statistical power of the sample is sufficient to detect functional differences among study groups.

3.6 Conduct of household visits

Data collection was conducted from May to November 2002. The field team visited 1,244 households in the 26 communities of rural and urban Sindh. The assessment was done in the home setting and included:

- A questionnaire developed for maternal interview, which mainly included questions on the socio-economic status of the family (refer to appendix 3.4). .
- Psychomotor development of the child was assessed by observation and recorded in accordance with the psychomotor developmental index (PD index) of the Bayley's Infant Developmental Scale (refer to appendix 3.5). .
- Basic anthropometric measurements considered in the study are body weight and height of the child. They were recorded according to the standard procedures recommended by the World Health Organization.
- The Home Observations for Measurement of the Environment (HOME) inventory was used to assess the stimulation potential of the child's environment (refer to appendix 3.6). .

Details for these data collection instruments are given in the next section.

3.7 Study Instruments: Pretesting, adoption and procedures

3.7.1 Questionnaire

A detailed questionnaire was developed for interviewing primary care givers e.g. mothers. The questionnaire was based on a detailed literature review and suggestions by experts. A structured English questionnaire along with a manual of instructions to guide the interviewers was prepared. Translators not related to the study translated the questionnaire from English into Urdu and Sindhi. Other independent translators were asked to translate it back into English, to check that the contents were the same as in the translated Urdu and Sindhi versions.

Pre-testing of the questionnaire was done in two phases. Initially pre-testing of 50 questionnaires in each language at sites, not the study areas i.e. Sultanabad and Rehri goth, Sindh. These were similar to the field sites served by the collaborative NGOs. Based on the feedback, ambiguities were removed from the questionnaire and some new questions were added. Finally, pre-testing was conducted on 10% of the pre-tested samples, before the finalization of the questionnaire.

2.7.2 Psychomotor: Bayley Scale of Infant Development II (BSID II)

The primary purpose was to assess an infant's current level of psychomotor performance from observation of the infant's interaction with stimuli designed to engage him/her. Psychomotor assessment yields a normalized, standardized score called the Psychomotor Development Index (PD index) evaluating the degree of body control, large muscle coordination, fine motor skills, dynamic movement, dynamic praxis, postural imitation, and stereognosis. PD index can be categorized

into normal, delayed or accelerated psychomotor development as compared to the normative standard of the Bayley's scale in psychomotor performance. In the thesis PD index is mainly used as a continuous variable, however for a few estimates it also has been categorized. The study participants were assessed according to the standardised recommendations as suggested by the scale manual.

a. Specific measures for PD index

- All the age appropriate test materials required for the assessment were organized before the initiation of assessment, in order to avoid any possible hassle during the testing.
- Motor assessment was performed on the floor mat in the home environment.
- For standardization purposes, only material present in the testing was used for the assessment. A wooden ladder was made according to the given specification and was carried from household to household in the community.
- The age of the child at the time of assessment was $\pm$ 1 week for the respective month.
- It was ensured that the infant was not ill, hungry or sleepy. In addition, it was ensured that there was no urgency for defecation or micturition.
- If the child was ill, assessment was rescheduled.
- Examiners were friendly with the child during the whole assessment session.
- The primary caregiver was present during the assessment but was advised to avoid prompting during assessment of the child.
- The examiners were trained and advised to follow the exact assessment procedure, i.e. age appropriate instructions for the item that is given in the Bayley's administration manual
- Family members were cautioned to avoid the presence of any additional people in the room.

- There was no specific time limit for overall administration of the BSID-II, as it varies from child to child. However, average duration of assessment was 20 minutes for younger children and 30 minutes older children.
- To reduce the inter-observation variation, two examiners were present in the assessment session, one examiner assessed the child while the other observed and recorded the score. At the end of the session, the observer gave the feedback to the assessor and both finalized the score sheet.
- To reduce the intra-observation variation, examiners trained to strictly follow the instructions and record the observations in a standardized manner, without assuming the ability of the child and avoid being influenced by personal factors like mood and lack of motivation.
- The psychomotor assessment comprised a series of standardized age appropriate psychometric activities called items. The assessment started with the age appropriate items, if the child was successful then complex items of higher age groups were introduced gradually. Otherwise, if the child was not successful with age appropriate items, items of younger age groups were then introduced in a descending order of complexity.
- While testing, the examiner followed the child by considering basal and ceiling rules. The basal and ceiling rules suggested in the BSID II, for motor scale the basal rule is 4 or more credited items while the ceiling rule is to continue testing until the child has 2 or more no credit items.
- Assessment was noted on the specific PD index record. Credit was given only to those items which are correctly performed by the child in the assessment session, while no credit was given if the child performed incorrectly or refused.
- Scoring was done by computing the raw scores. These raw score were referred to the normative tables for motor scales from the BSID-II manual. It gives the estimate of the age specific motor index scores.
- If the psychomotor scores were on the higher level then the caregiver was congratulated on the child's performance. While for average or below average

scores the caregiver was advised to support the child with more sensory stimulation and interaction according to the local context.

- To ensure a valid assessment the supervisor directly observed at least 20% of the assessments on a regular basis. At the end of the assessment the supervisor shared her feedback with the examiners.

3.7.3 Anthropometry: height and weight measurements:

All children were weighed and measured by teams consisting of two field workers (FW), an assessor and a helper, according to the standard procedures recommended by the World Health Organization as described below (106). The measurements were taken in a room with sufficient light and at a comfortable temperature.

For a child less than 2 years of age, the linear growth is assessed in a recumbent position and is called Length, while for older children it is assessed in a standing position and is called as Height.

a. Length

- A specific scale called a length measuring board was used and marked with a centimetre scale. It has a firm, flat horizontal surface with a fixed head piece and a movable foot piece.
- This was placed on a hard flat surface either on the floor or on a steady table. The helper positioned themselves kneeling with both knees behind the base of the board, if it was on the ground. The assessor kneeled on the right side of the child, or stood if the board was on a table, so that she could hold the foot piece with her right hand.

- With the mother's (primary caregiver) help, the child was laid on the board with an adequate support to the back of the child's head.
- The mother was asked to kneel on the opposite side of board facing the child to provide reassurance.
- The Helper cupped the child's ears with her hands and held the child's head against the base of the board so that the child was looking directly upwards.
- It was made sure that the child was lying flat and in the centre of the board. The assessor placed their left hand on the child's shins (above the ankles) or on their knees and firmly pressed them against the board and, with their right hand, placed the foot piece against the child's heels.
- The measurement was recorded to the nearest 0.1 cm.

b. Height

- Height was measured using a Stadiometer, which comprises a vertical board with a movable horizontal headpiece and a metric rule attached to board.
- This board was placed against a smooth surface making sure that it was stable.
- The mother was asked to remove the child's shoes, to stand the child with their back against the board and to kneel in front of the child. The child's feet were placed flat and together at the centre of the board. It was ensured that the child's shoulders were levelled with their hands at their side and head, shoulder blades, and buttocks against the board.
- The helper placed their right hand just above the child's ankles on the shins, while their left hand was placed on the child's knees and pushed against the board.
- The child was asked to look straight ahead with their line of sight parallel with the ground so that their head was positioned so that line of vision was perpendicular to the body axis.

- The headpiece was lowered to the top of the child's head by the assessor and was pushed through the child's hair.
- The child's position was finally checked and measurement was recorded to the nearest 0.1 cm.

c. Weight

- Ideally, weight should be determined with the child wearing no clothes. However, due to socio-cultural constraints, this was done with the child barefooted, wearing only a single layer of garment.
- Two different types of weighing scales were used depending upon the child's ability to stand or their age. Both were recorded to the nearest 0.01 kg and were placed on a hard horizontal surface with no carpet underneath. They were adjusted so that the pointer was at zero.

    - If the child was unable to stand or less than 18 months of age, an infant weighing scale was used, which has a large tray for placement of the infant.
    - The child was held firmly but gently by the helper while the assessor recorded the measurement.
    - The measurements were taken with clean hands and clean scales every time.
    - If the child was able to stand, a bathroom (stand-on) scale was used.
    - The child's heels were put together and positioned on the centre of the scale so that the weight was distributed evenly on both feet.
    - The head was positioned so that the line of vision was at 90° to the body axis.
    - The child was directed and guided to maintain a fully erect posture.

d. Formation of Anthropometric Indices and Indicators

Height/length and weight were compared with the WHO growth standards using WHO Anthro 2005 software for SPSS (107). Three anthropometric indices were used: height for age (HAZ), weight for age (WAZ) and weight for height (WHZ), expressed in terms of z-scores i.e. the number of standards deviations of the observed value from the median value of the WHO reference population.

These z-scores were then used to form the four indicators; stunting (HAZ< -2), under weight (WAZ< -2), wasting (WHZ< -2) and severe acute malnutrition (SAM), WHZ< -3.

All the analyses in this thesis were based on comparisons with WHO growth standards. In addition, however, for a preliminary analysis we also constructed anthropometric indicators based on the previously widely used NCHS reference population in order to compare the levels of undernutrition.

e. Data management: Missing and Flagged Records

The proportions of the values that are missing or biologically implausible are used to ensure the assessment quality of the anthropometric measurements. There was only one birth weight record missing from our data set. The WHO Anthro 2005 software flags records (outliers) for each indicator (108) based on fixed exclusion range criteria is defined as:

Table 3.3: WHO criteria to identify the flagged anthropometric records

Anthropometric index	Biologically implausible z-scores
Length/height-for-age z-score	<-6 or >6
Weight-for-age z-score	<-6 or >5
Weight-for-length/height z-score	<-5 or >5

According to the above mentioned criteria, if more than 1.5% anthropometric index records are flagged then data is considered biologically implausible. The quality of our dataset was good; only 17 (1.37%) WHZ, 9 (0.72%) HAZ and 1(0.08%) WAZ records were flagged. The one missing record and all the flagged were excluded and analysis was performed on a sample of 1219 children.

f. Birth Weight

Birth weight was recorded for children where birth records were available, that is for those who were delivered in a maternity home or hospital. Birth weight below 2,500 grams was considered as low birth weight. Information on the birth weight was available for 53.6% children of the sample; therefore any analysis for birth weights is based on that sub sample.

3.7.4 Home Observation for Measurement of the Environment (HOME) inventory

The Home Observations for Measurement of the Environment inventory (HOME) was used to assess the stimulation potential of the child's environment. The

inventory was then applied to evaluate the quality and quantity of stimulation and support available to a child in the home environment.

The HOME inventory was initially developed by Bettye Caldwell and her colleagues in 1966, and was further modified in 1984 (109-114). It has four versions, each for a different age group: 0 – 3 years old (infant toddler), 3 – 6 years old (early childhood), 6 – 10 years old (middle childhood), and 10 – 15 years old (early adolescent). For this study, we used the infant toddler version. It has been widely used in a variety of clinical and research settings including to understand the existing opportunities of being stimulated and to evaluate the impact of the intervention programs (24, 115-118).

It is a reliable and valid instrument, which can assess the potential of sensory stimulation in the child's early environment. The internal consistency coefficients for HOME is 0.89 and the inter-observer agreement for each measure is 90% or higher. Apart from sound psychometric properties, other known strengths of the HOME inventory include extensive conceptual domains and its use in diverse populations (119).

Information is collected by observing child's interactions with the environment and people, assessment of the relevant available resources, and by asking questions to the primary caregiver. It contains 45 binary-choice items clustered into six subscales:

- **Responsivity:** the extent to which the parent responds to the child's behaviour by verbal, physical, and emotional encouragement for desired behaviours and communicating freely through words and actions.

- **Acceptance:** the extent to which the parent accepts less than desired behaviour from the child and avoids unnecessary restriction and checks.
- **Organization:** the extent to which there is regularity and predictability in the family's schedule without it being monotonous. It comprises a safe physical environment and a sound family support system including community services.
- **Learning Materials:** the extent to which age appropriate play and learning materials capable of stimulating development are available.
- **Involvement:** the extent to which the parent is actively involved in the child's learning and provides stimulation for increasingly mature behaviour.
- **Variety:** the extent to which events and people are routinely included in the child's life, which bring variety of experience without significant disorganization.

Higher HOME scores are interpreted as an availability of an enriched environment with adequate resources and experiences as essential sensory stimulation required for child development. It also represents the quality of parenting or child rearing practices. While lower scores can be regarded as child neglect (120, 121) .

a. Adaptation of the HOME inventory

Pre-testing of the HOME inventory was done in the communities of Rehri Goth (rural) and Sultanabad (urban): which were similar to our study population but were independent of the study field sites. The purpose was to determine whether the mothers understood the questions and to identify the culturally appropriate relevant objects for the observations. About 30 homes with at least one under three child were visited in each community. Each maternal interview was followed by detailed discussion about the understanding of the questions asked. At the end the collected information, along with the observations of the field workers, were discussed in focus group discussions with the principal investigator.

A few explanations and hints were added to include some culturally relevant observations but overall the integrity of the inventory was kept unchanged (see Appendix 3.6). A modified version was tested in the same communities in 10 households each. It was observed that interviewees were well receiving of HOME and demonstrated a good comprehension of its items. Moreover, it has all the essential elements of the culturally appropriate observations, therefore it was decided that the adapted version of HOME could be used for data collection in the study.

b. Conduct of HOME inventory assessments

- The assessment was based on the standardized protocol according to the administration manual of the HOME inventory (122).
- Information needed to score the inventory was between 45 to 60 minutes.
- Home visits were done during a time when the index child and the child's primary caregiver were present and awake. Other family members and even guests could be present; but their presence was not necessary. It was done to minimize intrusiveness from the interviewers and to allow family members to act normally.
- The assessment was based on a low-key semi-structured observation and maternal interview. Intensive training was given to the examiners to develop their skills in observational methodology.
- Throughout the course of the visit, parent-child interactions were observed. In addition, a discussion with the parent; probed about objects, events, and transactions with the child and were interpreted from the child perspective.
- A binary-choice (yes/no) format was used in scoring items for the HOME.

3.8 Study organizational and personnel

The field team was selected on the basis of their educational status, acquaintance with the community, and aptitude for comfortably dealing with children. All were qualified professionals including clinical psychologists, community health nurses, sociologists, physicians, and public health practitioners. A field supervisor (clinical psychologist) was responsible for quality assurance measures for the data collection. While a field coordinator (physician) was responsible for the administrative and logistic demands of the study. The field team consisted of ten members including clinical psychologists, community health nurses, sociologists and physicians.

Dr. Franklin White (ex chair of Department of community Health Sciences, AKU) and Dr. Camer Vellani (ex Rector, AKU) were the advisers and provided theoretical and conceptual feedback on the research project and they facilitated the smooth implementation of the project activities. While, the PhD thesis was guided and supervised by Professor Betty Kirkwood (LSHTM).

3.9 Training, supervision, and quality control measures.

The field staff were trained for four weeks before the start of data collection. The training included comprehensive conceptual orientation of the study questioner, interview techniques, and anthropometric and psychomotor assessments. In addition the field team was briefed regarding the observational approach used in the HOME inventory (for detailed training schedule please refer to Appendix 3.7). For practical learning experience they were trained in the day care centres, AKU hospital paediatric ward and clinics for practice trials. In addition, the team also practised in peri-urban communities of Karachi i.e. Rehri Goth and Sultanabad.

Apart from the specific quality control measures mentioned earlier in the respective sections of the study instruments, general measures included constant guidance and monitoring of the field teams by the study investigators and supervisors. The supervision was conducted by cross checks in the field and sit-ins during interviews in rotation. Refresher training was provided every week; discussions on PD index, HOME and the questionnaire were conducted by the clinic supervisors and investigator. This training not only gave the opportunity to the members of field to refresh their knowledge and skills but also to share their related concerns and challenges with the supervisor, which in turn helped them to perfect their assessment skills.

Data editing in the field was the responsibility of the field supervisor; forms were edited on the day of the data collection, and in case of missing or inconsistent information the field team would visit the house again to verify the information.

3.10 Data management

Preliminary field editing of the completed questionnaires was done immediately after completion of the interview. The questionnaires were checked by the field supervisor for issues concerning internal consistency, missing information, illegal entries etc. Data editing in the field was the responsibility of the field supervisor.

For the office editing, the completed questionnaires were double-checked in detail for the same factors i.e. internal consistency and missing information. During

editing when information was found to be incomplete the interviewers were asked to revisit and complete the information.

The software for data entry was developed with the help of experienced staff of the Information Systems Unit of the Department of Community Health Sciences. Two different data entry operators then entered the data simultaneously and a consistency check was performed on the two data sets and any discrepancies found were resolved. Subsequently, extensive range and consistency checks were performed, thus every effort was made to develop a clean data set eliminating every possible error.

3.11 Analysis plan

Parameters of interest

a. Exposure variables:

In the thesis, the following three factors are considered as the main independent variables

- Rural urban neighbourhood.
- Socio-economic status.
- Physical growth.

b. Outcome variables:

There are two dependent variables in the thesis

- Psychomotor status of the child aged less than three years assessed through BSID II
- Physical growth (anthropometric measurements for the undernutrition assessment)

It is important to mention that in this thesis, physical growth is considered both as an exposure variable for the psychomotor development and as an outcome variable for the other exposure variables.

For the analysis, we first looked at the influence of the social context, i.e. socio-economic inequalities and rural urban neighbourhood on the psychomotor development of the child. The undernutrition status of the child was explored in two ways; firstly, to what extent it is determined by the social context and secondly, to assess whether the role of the social context on the psychomotor development is mediated by the undernutrition status. In addition, the role of low birth weight as an independent predictor of the psychomotor status was analysed. Finally, the role of the HOME is also studied in two ways: its influence on the undernutrition status and its role in determining the PD index over and above the social context and undernutrition status of the child (refer to thesis theoretical framework in chapter 1).

To answer these questions, detailed plans of analysis are given in the respective sections of chapters 3-6. In brief, descriptive statistics were calculated for the categorical variables, the proportion of each response was revealed. For continuous variables, the shape of distribution was examined through mean and standard deviation. This was followed by inferential statistics; a socio-economic index was formed using the principle component analysis. Multivariate linear regression was applied when the outcome was continuous e.g. PD index, while

Multivariate logistic regression was used for binary outcomes e.g. stunting, underweight.

3.12 Ethical considerations and study approvals

For the institutional approval, the study protocol was approved by the Ethics Review Committees of the Aga Khan University of Pakistan and University of Alabama, Birmingham USA (for the National Institute of Health, Fogarty Fellowship). For the PhD thesis, further ethical approval was obtained from the Ethics committee of London School of Hygiene and Tropical Medicine.

For the informed consent of the study participants, initial contact was made with the community leaders. The study aims, objectives, and significance were explained to them in order to seek approval to make contact with their community residents. Individual informed consent was then obtained from the primary care givers (mothers). As most of the study participants were illiterate, it was therefore considered sufficient to have a verbal informed consent in most cases. For detailed contents of the consent form, refer to appendix 3.8. Urdu and Sindhi translated versions were used in the field.

In the event a child was found to be sick at the time of data collection, the visit was rescheduled and guidance was provided to seek appropriate medical care. Furthermore, identification of any significant deficiency in growth and developmental status was followed by provision of advice to seek professional care and support. Members of the field teams were also trained to respond to queries from the caregivers that were related to the child nutritional and psychosocial well-being at the end of the assessment session.

3.13 Personal contributions and funding

The primary purpose of this study was to develop an understanding of the growth and developmental status of Pakistani children in order to provide the basis for the future activities of the Human Development Program of Aga Khan University (HDP-AKU). Being a faculty member of the Department of Community Health Sciences and HDP-AKU, I conceived and wrote the study protocol as the principal investigator of the project. I developed and adapted the data collection forms, trained the field staff and accompanied the data collection team to all the field sites during the entire period of data collection. Apart from direct observations of the data collection activities, I also organized refresher-training sessions for the field staff at regular intervals. Following data collection, I conducted all the data cleaning and performed the range and consistency checks. For this thesis I was responsible for the entire data analysis and thesis write up under the supervision of Betty Kirkwood.

The International Maternal and Child Health Research and Training programme (NIH-IMCHRT) supported the project under the Fogarty Fellowship for the National Institute of Health-Fogarty Institute and by the University Research Council of AKU.

Chapter four

Social inequality and child development

4.1 Introduction:

The public health efforts to promote child survival and to address social inequality have resulted in significant improvements in child mortality in most of the developing countries(8, 123). About 130 million children are born every year and 92% survive beyond five years (124, 125). Despite tremendous advancement there are still almost 11 million child deaths every year. Epidemiological evidence suggests that the probability of survival during the early years of life is dependent on socio-economic positioning and the geographical location of the child. Here it is important to acknowledge that death is just the tip of the iceberg in child health epidemiology. In fact, it points towards the broad base of accumulating problems of inadequate child growth and development among those who survive in the underprivileged regions of the world (126).

According to a recent conservative estimate, at least 200 million children under 5 years fail to achieve their developmental potential (20, 24, 127). The early years of a human life is the most formative phase characterised by long-term effects on health, mental and physical performance, and economic productivity (128). In the given context of child survival initiatives the next challenging step is the provision of better living conditions and an environment conducive to optimal growth and development for the children (129). World Health Report 2005 acknowledges that it is not sufficient to focus on child survival, but attention to child development is also crucial. As a matter of principle, WHO endorses in its general programmatic agenda that more attention should be paid to the development of children (108). The eventual aim is to achieve full developmental potentials in

children and therefore to break the poverty cycle in underdeveloped nations (9, 130-132).

Research on social distribution of health has been in the spotlight for quite a while now (133). Although the majority of children live in developing countries, a limited amount of the work on health inequalities has been conducted in these countries (134, 135). Socio-economic inequality is a context specific phenomenon and therefore determinants which explain the socio-economic status in the pervasively affluent set up of a developed country can not be generalised to the prevalent deprived conditions of an underdeveloped country. Although numerous studies have established the association between childhood nutrition, growth or common illnesses and socio-economic factors in developing countries (134, 136-139) evidence on specific socio-economic inequalities and child development are nearly non-existent to the best of our knowledge.

Child development is affected by variety of factors, especially family resources and neighbourhood context mutually create an environment conducive to the development by determining the social status of the child (100, 103, 140). Instead of focussing simultaneously on both, in most of the studies family resource indicators such as parental education, parental work, and economic status are considered as the only socio-economic factors influencing the child's development. In addition, generally research is being conducted to understand the neighbourhood effects on adolescents rather than young children. Another shortcoming of the existing literature is the urban bias and negligible attention given to rural communities (141).

The primary assumption of research in social inequalities is that health outcome varies with change in social context. Literature on child survival is suggests that

the prevalence of child mortality has vast regional variation and within each region survival is much higher in urban areas than in rural areas. Moreover, reduction in child mortality tends to be much slower in rural areas leading to a widening of the gap between urban and rural areas in most of the developing countries (142-144). Urban-rural context is considerably dissimilar in terms of culture, resources, infrastructure, and risk factors in a developing country (145) and is a distinct marker of neighbourhoods in such set ups. Therefore it is important to explore inequalities in child development in such social contexts of developing countries. Furthermore, if inequalities exist between urban and rural areas, do they just refer to inequalities in child development between family resources or are they also a reflection of a contextual effect of the neighbourhood.

Therefore the primary objective of this chapter is to examine the relationship between socio-economic characteristics and the rural or urban nature of the neighbourhood and child development in Pakistan. (See conceptual framework fig 4.1).

4.2 Objectives

The overall aim and objective of this chapter is:

- To examine the role of socio-economic inequalities and neighbourhood on the child development.

The specific objectives are:

I. To explain the characteristics of study participants.

II. To describe psychomotor status of the study participants by age and gender.

III. To examine whether socio-economic status determines the psycho-motor development.

IV. To assess whether rural/urban neighbourhood effects psychomotor development by socio-economic status.

4.3 Methodology

Psychomotor index (PD index) is the outcome variable and its assessment was based on the BSID II as described in chapter 3. Rural/urban neighbourhood and socio-economic variables are considered as independent variables in this chapter. Farm-based communities are operationally defined as as rural areas and non-farm-based communities as urban areas. Information on the socio-economic variables is collected through maternal interview and is used to form a single measure i.e. socio-economic index (SE index) details of which are given below.

Statistical analysis

First, distribution of mean psychomotor scores is described by age, gender, and neighbourhood.

Second, univariate analysis is carried out for individual level associations between each socio-economic variable and the PD index of the child. Multivariate linear regression analysis is then performed including all socio-economic variables with p value ≤ 0.25 identified via univariate analysis and also controlled for the age of the child.

In order to construct the SE index, univariate analysis and social plausibility reasoning are used to rank categories of the nominal variables (e.g. mode of transport) in an ascending order. We constructed the SE index using Principle Components Analysis (PCA). It is a statistical procedure to reduce multidimensional data sets into single linear form. The purpose is to replace the given set of correlated variables with a single component which represents certain

unobserved characteristics of the population. Practically, it means that on the basis of variance of the given variables, certain standardized weights are assigned to them. In our study, these standardized weight scores for the socio-economic variables are added by household to create the SE index. The mean value of the index is zero by construction and the standard deviation is 1. Then these scores are grouped to define socio-economic quintiles i.e. categorization of study participants into equal five groups. With value of 1 corresponding to lowest SE quintile and 5 represents highest quintile of socio-economic status.

Finally, the SE index is used at two levels. Initially, association of socio-economic status and PD index is assessed by rural/urban neighbourhood. Followed by the assessment of magnitude of differences between the lowest and the highest socio-economic status (SES) in terms of their child development; Lowest/Highest SES ratios are estimated as a measure of inequality. This is the ratio between mean psychomotor score obtained in the lowest quintile as compared to the highest quintile of SE index. Calculations are done for overall data and for urban and rural subgroups.

4.4 Results

4.4.1 Characteristics of study participant

A total of 1,244 children were recruited into the study, 50.6% are from urban areas while the rest of the sample was from rural areas of Sindh. 52% of the children were male in our study. No significant difference was found between boys and girls by yearly age groups (p value= 0.334), as shown in figure 4.2. Furthermore, there was no difference in the children's gender or yearly age groups by rural/urban neighbourhood (table 4.1). In this chapter we describe the characteristics of study participants under three domains: parental; family, and economic features.

Parental characteristics: Among maternal characteristics, average maternal age was similar in rural and urban areas; however education and occupation characteristics were markedly different (table 4.2). Illiteracy was almost double in rural areas, 73% of rural mothers were either absolutely illiterate or could barely read with no formal schooling as compared to 34% of urban mothers. Overall, the majority of women in our study were housewives (70%), but it was more common in urban mothers. Working mothers were most likely to be skilled workers (12%) followed by the professional workers (9%) in urban areas, while in rural areas 12% were skilled workers followed by 11% unskilled workers. About 11% of the rural women were agricultural workers but none in the urban ones. Figure 4.3 shows that families of housewives had significantly more per capita income as compared to the working mothers, which put them in an economically and socially advantageous position.

Paternal characteristics of age, education, and occupation were significantly different by rural/urban neighbourhood. The differential remains persistently

present across all education levels; almost half of the rural fathers were illiterate as compared to 18% of their urban counterparts. For higher educational levels, 45% of urban fathers had at least 12 or more years of formal education as compared to 21% of rural fathers. The majority of fathers in our study were skilled workers (46%). About 29% of rural fathers were directly involved in agriculture, although 2.5% of families were settled in an urban neighbourhood the father's occupation was agriculture - usually these fathers spent weekdays in the rural areas and the weekend with their families in the cities. About 2% of the fathers were jobless in our study, appendix 4.1 shows various relevant characteristics of these fathers, it is apparent that though they have low per capita income but other social support systems were very much intact.

Family characteristics: Rural areas were relatively more diverse in terms of religious faith composition as compared to the urban areas, the majority of the study population were of the Islamic faith (92%) 95% in urban and 88% in rural neighbourhoods (table 4.3). Among Non-Muslims, almost all were Hindus, except for 0.3% who were Christians in the rural areas. As the study was conducted in the Sindh province 90% of rural study participants were of the Sindhi ethnic group. The urban areas were relatively more heterogeneous in their ethnic distribution - 58% Sindhi, 29% Mohajir, 5% are Punjabi and Pathan/Balochi respectively. The majority of the families were of the extended type in our study (56%) and it is a more common phenomenon in urban (59%) as compared to rural neighbourhoods (53%). Family size was significantly higher in rural areas as compared to urban, which also meant more siblings and caregivers available to the child in the rural families. On average family members in urban areas were 8 (SD: 4, median: 7, mode: 6) while in rural areas were 9 (SD: 4, median: 8, mode: 6).

Economic characteristics: About 97% of houses were owned by the families in the rural areas as compared to 70% in urban areas (table 4.4). Renting houses was

a predominantly urban phenomenon, however it might not be a good reflection of socio-economic status as on average families residing in a rented home had significantly high per capita income as compared to the home owners (figure 4.4)

The number of rooms in rural and urban homes was almost same but due to large family size these rooms were relatively more crowded in the rural areas. The main sources of the water supply in the home was borehole; 92% in rural and 55% in urban areas. Tap water was available in 44% of urban and only 5% of rural families. Being surface water, canal and well sources were categorized together and about 3% of the rural families were dependent on this.

The majority of the families used public transport as their main mode of transport (86%). However ownership of vehicles was much higher in urban areas as compared to the rural. Overall, only 1% walked as their primary mode of transport and 1.4% used animals for transportation, due to the very small number these 2 categories were combined in the analysis

Average per capita monthly income was about twice as high in the urban as compared to rural areas. After categorising the monthly income into quintiles, 58% of rural families were in the lowest 2 quintiles as compared to 23% of urban families. The difference was much higher in the top quintile; 33% of the urban families belonged to this category while only 9% of the rural families could manage to reach this income level.

4.4.2 Psychomotor status by age and gender

The overall mean psychomotor score for all children was 96.0 (median: 97.0, mode: 94.0, standard deviation: 16.7); there was no difference between males and

females developmental status (table 4.5). However mean PD index significantly decreased with age (p value < 0.001).

Overall 23% of the study participants were assessed as having delayed psychomotor development, 65% as normal, and 12% as having accelerated development (figure 4.5). The delayed psychomotor development was markedly higher in the rural areas (31%) as compared to urban neighbourhoods (16%). In contrast, accelerated psychomotor development is observed more in urban children (16%) than rural children (7%). Delayed development increased with age from 16% among children in the first year of life to 41% in their third year (figure 4.6). The increasing trend suggests the contribution of environmental influences in producing developmental delays among children (p value < 0.001).

4.4.3 Association between socio-economic status and the psychomotor development

Univariate linear regression analysis of individual socio-economic variables with PD index are summarized in table 4.6, such as for every single increase in number of rooms in the house the mean psychomotor score was raised by 1.52 units. Religion, family type, number of co-residents in the family and fraction of monthly income spent on food were not significantly associated with the PD index. Overall nine socio-economic variables are identified as having a significant association with PD index. They can be grouped into two types. Four variables are concern the social status of the household: level of maternal education (5 categories), maternal occupation (4 categories), level of paternal education (4 categories), paternal occupation (5 categories), and 5 variables describe the economic characteristics of the household: source of drinking water (3 categories),

number of the rooms in the house (quantitative response), mode of transport (4 categories), crowding (number of people sharing the room with the child) rank order given to the data, and average per capita income: actual income (rupees) was categorized into quintiles i.e. higher the income the higher the quintile level. All these variables have p value < 0.001 for trend for PD index. Further multivariate linear regression analysis was performed on the variables found significant in the univariate analysis; maternal education and family income are the significant contributing factors for the child PD index, while paternal education was marginally significant e.g. for each quintile increase in per capita income the mean psychomotor score was increased by 1.02 units even when adjusted for other socio-economic factors.

Subsequently, the 9 variables identified in the univariate analysis were then used to construct the SE index. The nominal variables are rank categories in an ascending order on the basis of univariate analysis and social plausibility reasoning (refer to appendix 4.2 for graphs). PCA is used to assign scoring to these factors (table 4.7). Since all the SE Index variables are either continuous or nominal with at least 2 categories, the given scoring factor can be used as a weighting for the interpretation of each level of the variable. A move from one level of maternal education to another level, adds 0.82 in the index. A household that has access to tap water supply has an SE index higher by 0.48 units than one that does not. Using privately owned transport increases the index by 0.45. The scores of the all the 9 variables are aggregated by each study participant to form a linear index, which explained 39.28% of the variation in the socio-economic status of the household.

Interestingly, maternal education and per capita income are 2 factors which contributed the most in the formation of the SE index, and they were also the main significant factors in the multivariate analysis.

4.4.4 Association between rural/urban neighbourhood and the psychomotor development

The difference in mean PD index scores exists persistently across the yearly age groups by urban vs. rural neighbourhood (figure: 4.7). In addition, rural children have lower mean PD index scores as compared to urban children and the difference increases with age. However, SE quintiles show an increasing trend with PD index in figure 4.8, and rural areas have persistently lower scores compared to urban areas across all socio-economic levels. Finally, in order to provide further evidence about patterns of development between rural and urban areas, the lowest SE quintile is compared with the highest SE quintile as measure of socio-economic inequality in psychomotor development (table 4.8). The Lowest/Highest SES quintiles ratio ranges from 0.92:1 to 0.96:1. The results highlight the fact that the magnitude of difference between the lowest and highest socio-economic groups in terms of their childhood developmental status is not substantially different within urban or rural neighbourhoods of the study.

4.5 Discussion

4.5.1 Summary of key findings:

- The study suggests a strong inverse relationship between child psychomotor development and social-economic status.

- The major finding is that the area of residence as an important marker of neighbourhood has an independent effect on child development, even after social inequalities are controlled at the family level. The psychomotor developmental delay among children is substantially and significantly lower in rural areas than in urban areas.

- The mean psychomotor scores persistently decrease with increasing age which shows the cumulative effect of developmental delays in both rural and urban areas.

The general profile of families living in rural neighbourhoods is that parents are primarily illiterate or less educated, skilled work especially in agriculture is the common occupation. They are more religiously diverse with larger family size and a higher number of caregivers. The general profile of the urban families is that parents are relatively younger but more educated and professional, diverse in ethnicity, have greater access to safe water supply and have much higher per capita income as compared to their rural counter parts. In terms of commonalties, interestingly the majority of the families in both rural and urban neighbourhoods are extended in composition, mothers are mainly housewives and house ownership is a more common phenomenon than renting.

4.5.2 Differences in Psychomotor development by neighbourhood and socio-economic status

The study demonstrates that during the early childhood development phase, social inequality influences child development at family and neighbourhood level independently and simultaneously. At family level, socio-economic gradient represents the effect of relative poverty on childhood development. These differentials could effect through several pathways; non-availability of adequate care, nutrition, hygiene, and safe environment lead to ill health, faltering growth and developmental delays (146-149). In addition, cultural and psychological barriers in the form of child rearing practices may prevent especially the poor from the optimal usage of existing resources.

Among the socio-economic variables, maternal education and family income were the most significant contributing factors in the psychomotor development of the child. In fact, maternal education is the most frequently identified factor in child survival research from the developing countries (150-152). Maternal literacy is reflective of maternal ability and awareness to create a conducive home environment including all the aspects of care and nurture for child development (153-155). In general, the contribution of family income is also congruent with the vast array of research establishing a significant association between family income and child growth and development (156-161).

At neighbourhood level the study has shown the "epidemiological polarisation" of developmentally delayed children in rural areas (162, 163). Neighbourhoods' deprivation is a multidimensional concept that includes material and social forms such as poor educational and health services, environmental hygiene, recreation, work, social conditions, and so on.

Each neighbourhood has its own set of deprivations and even affluent neighbourhoods suffer from certain deprivations (164) which makes it a distinct concept as compared to poverty (165, 166). It is important to note that rural environment is not a causal factor in those deprivations; in fact it contributes as a conditioning factor for the deprivations to influence the child (167).

Additional explanation of child development differential between urban and rural children may be the result of selective migration due to urbanisation phenomenon in the developing countries.

4.5.3 Use of the SE index in the thesis

In epidemiological research one of the important premises to describe or understand any health phenomenon is by its socio-economic positioning. According to Krieger N, it refers to the prestige based measure determined by individual or family's relative economic and social ranking within a community (168). In my thesis socio-economic positioning is not only regarded as a determinant of child growth and development, but is also required for adjustment as a confounder for other associations considered.

In the literature the standard measures of socio-economic positioning are either single variables such as average family income, consumption/expenditure information or household assets based indices. The main assumption for these measures is that materialistic resources or living standards largely determine the general health and well being (169), therefore their content is more inclined towards the economic component of socio-economic status. While some may argue that they are interlinked the distinction between social and economic aspects and their simultaneous assessment is important from the child development perspective. For example parental education shapes up belief towards the

significance of child growth and development, and consequently determines the quality of parenting (170-172). On the other hand, the economic component directs the availability of necessary means and resources for the child's sustenance. In that aspect conventional measures are limited in their capacity to capture the construct of socio-economic positioning, for example the standard Asset Index based on Demographic and Health Survey (DHS) data, comprises housing characteristics, durable assets, and access to basic services. It is constructed using PCA technique and variance explained by it ranges from 11% to 27% as compared to 40% variance explained by the SE index in our study (173-175). Therefore we have decided to use the SE index as the socio-economic measure in the rest of the analysis owing to its conceptual comprehensiveness and better statistical properties.

4.5.4 Limitations:

- Being a cross-sectional study, there could be an element of reverse causality in the observed associations. However, due to the specific age group considered, the plausible direction of the association is from socio-economic status to child development status because children can not determine or influence their socio-economic status. Socio-economic status measured at one point of time doesn't account for duration of the exposure (176). But most of the variables considered in this study are more likely to be stable during the early childhood phase.

- In order to capture as much variation as possible and to minimise the residual confounding, we used as many categories as appropriate for each variable in the SE index construction and avoided simple dichotomy of any variable.

- However, we ordered these categories and fitted all the variables linear, test for departure from linearity has been tested against PD index for the variables

included in the PCA, (see appendix 4.3). All of them were insignificant except parental education and paternal occupation. The decision to retain linear terms in PCA was on the following basis.

a. Technically, construction of the SE index based on PCA is just a measurement of the socio-economic status construct at a household level and should be independent of any outcome or dependent variable.
b. Both maternal education and paternal occupation are categorical variables and are arranged in a logical increasing order.
c. The option of using variables as binary dummy verses ordinal variables for PCA is debateable in the literature. According to Kolenikov S and Angeles G, application of binary dummy variables in a PCA analysis introduces co-linearity that eventually affects the estimate of the index. The use of ordinal variables as an alternate method to use binary dummy variable, provided that the underlying logic for the order of the categories is very strong (177).

However, it is imperative to emphasize the general fact that there are always inherent challenges in quantifying the multifaceted dimensions of socio-economic status in any research.

- Our operational classification of locales into rural and urban is applicable to the majority of the scenarios in the developing countries. However, any differences in definition need caution in interpretation of cross country comparisons. Finally, the pattern of association with socio-economic status and neighbourhoods may also vary with the choice of indicators used to assess the child's development.

Figure 4.1 Conceptual framework of the relationship between socio-economic status, rural urban neighbourhood and psychomotor development

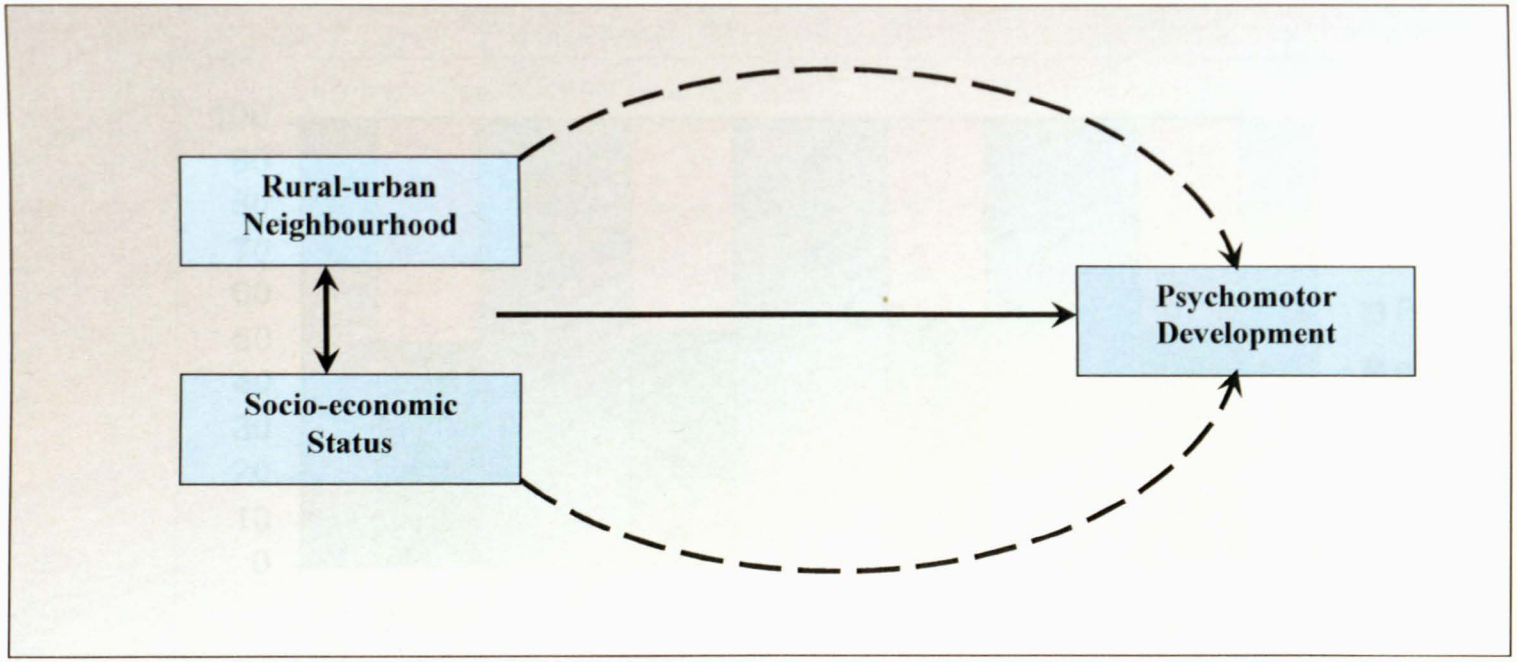


Figure 4.2: Gender of the child by yearly age group

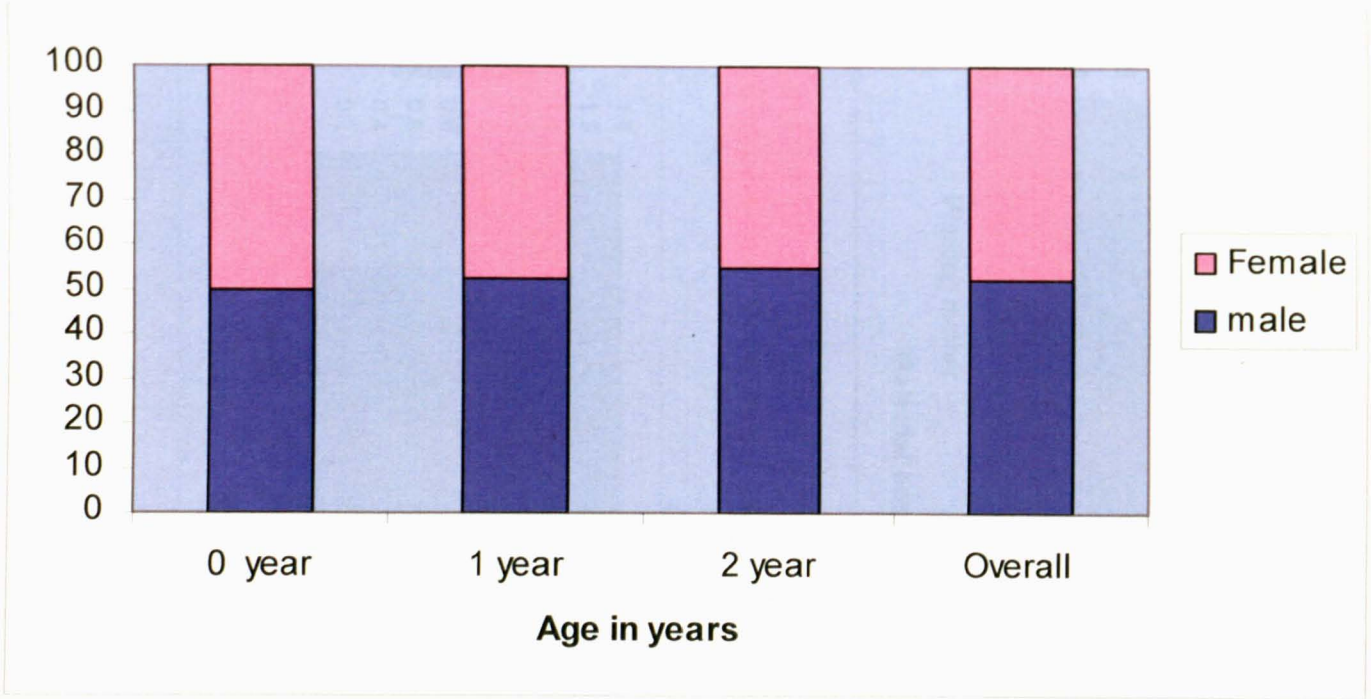


Figure 4.3: Comparison of maternal employment status by family income

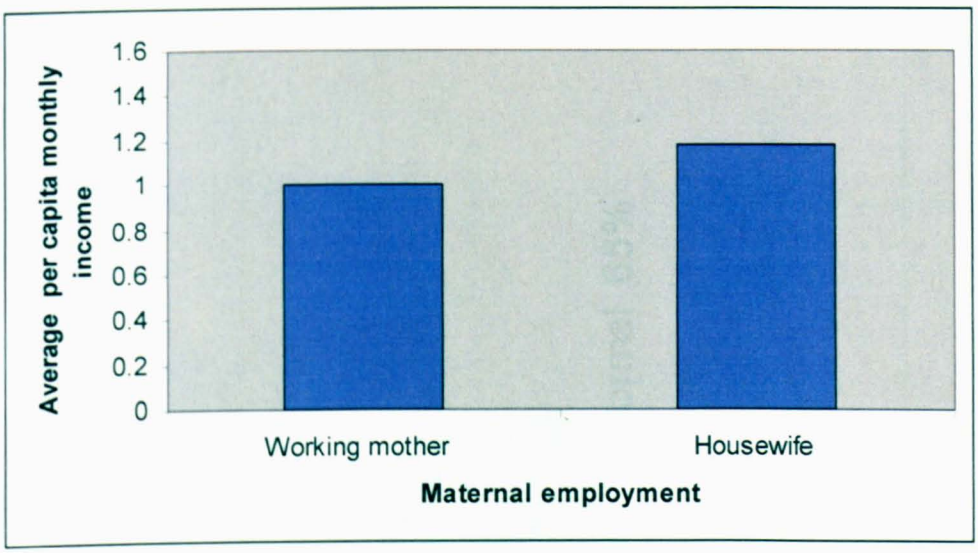


Figure 4.4: Comparison of House ownership by family income

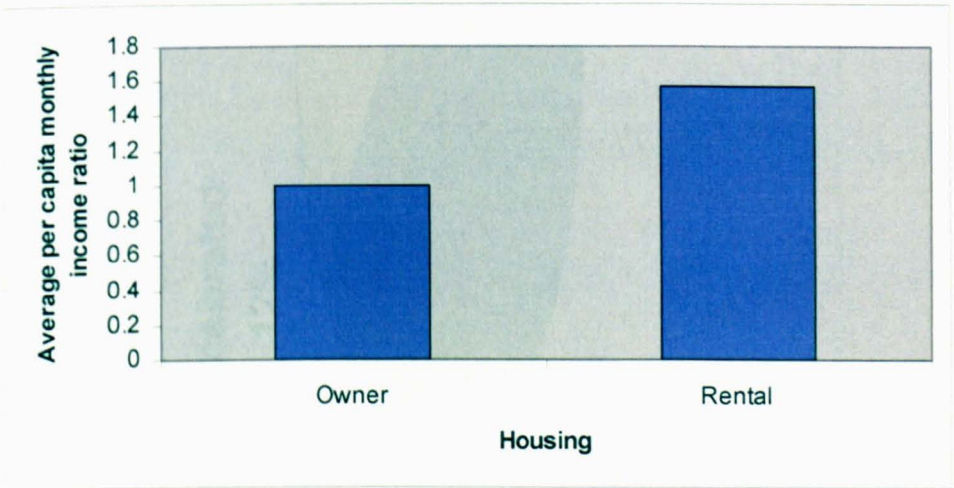


Figure 4.5: Psychomotor status of the study sample

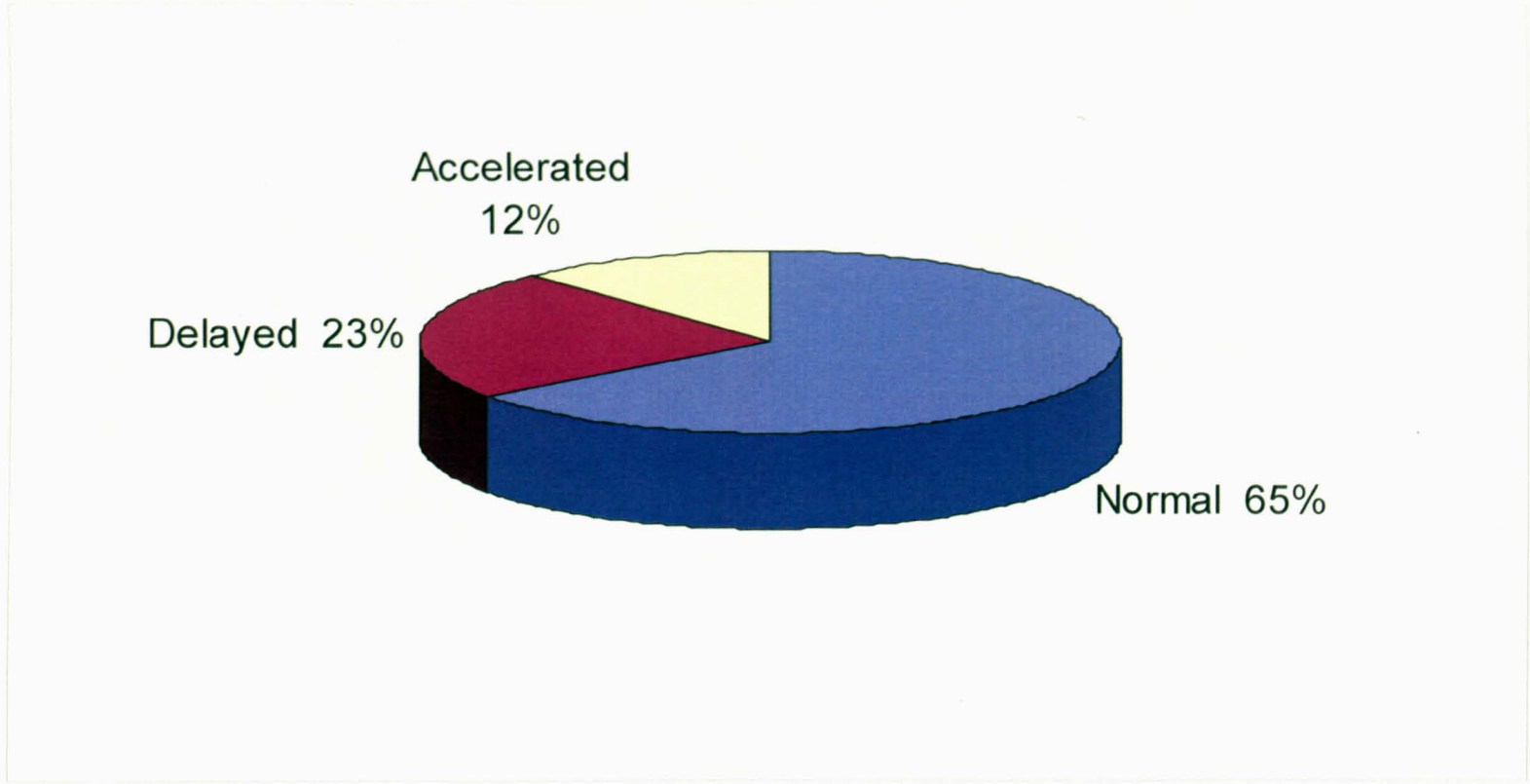


Figure 4.6: Delayed Psychomotor development by age groups.

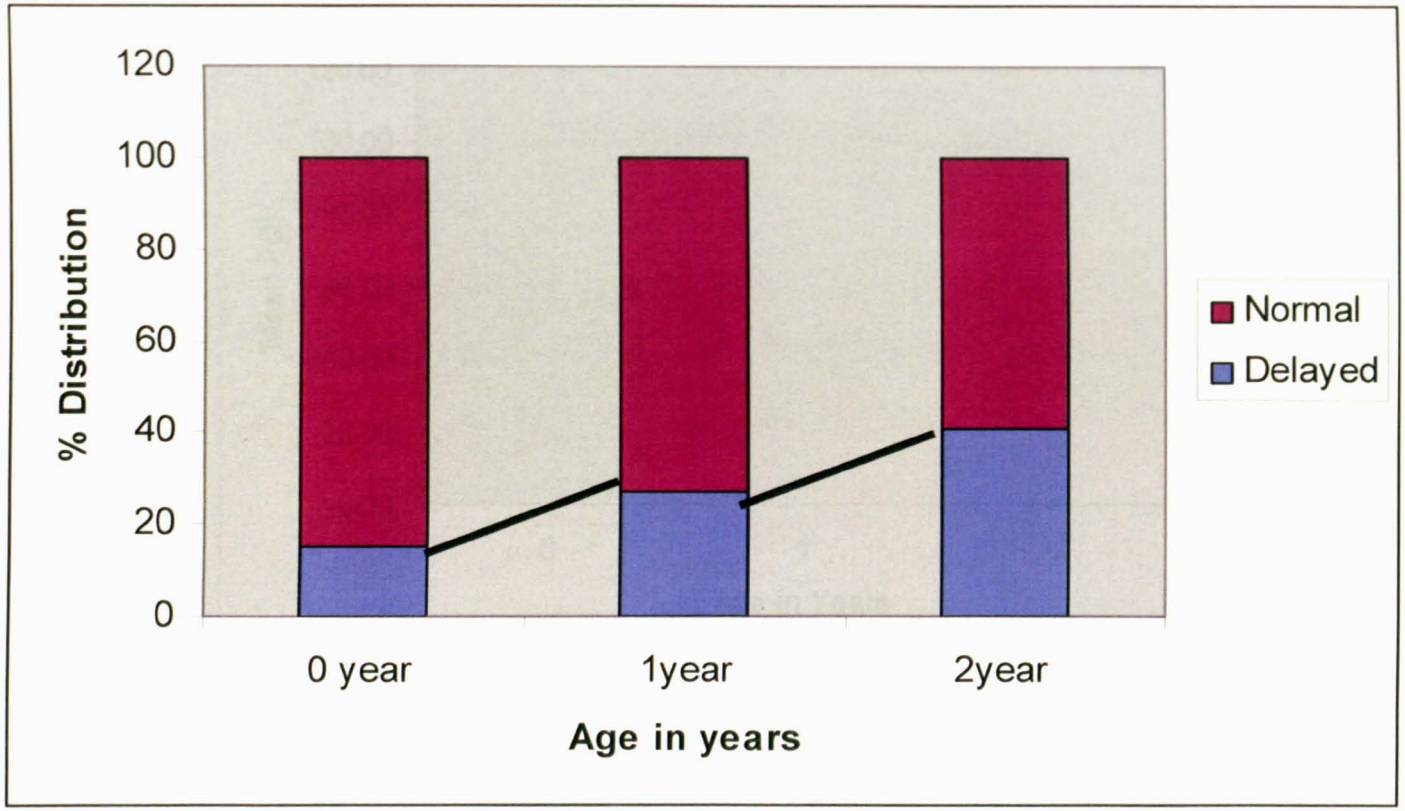


Figure 4.7: Rural urban difference in PD index by Age and rural urban neighbourhood

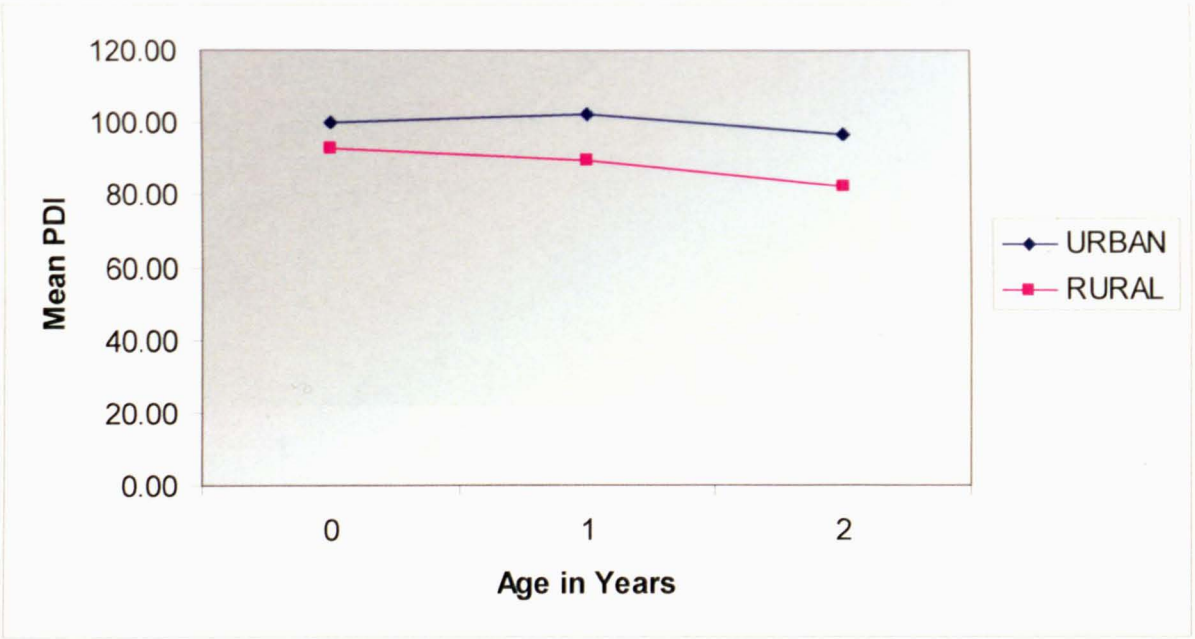


Figure 4.8: Rural urban difference in PD index by SE index

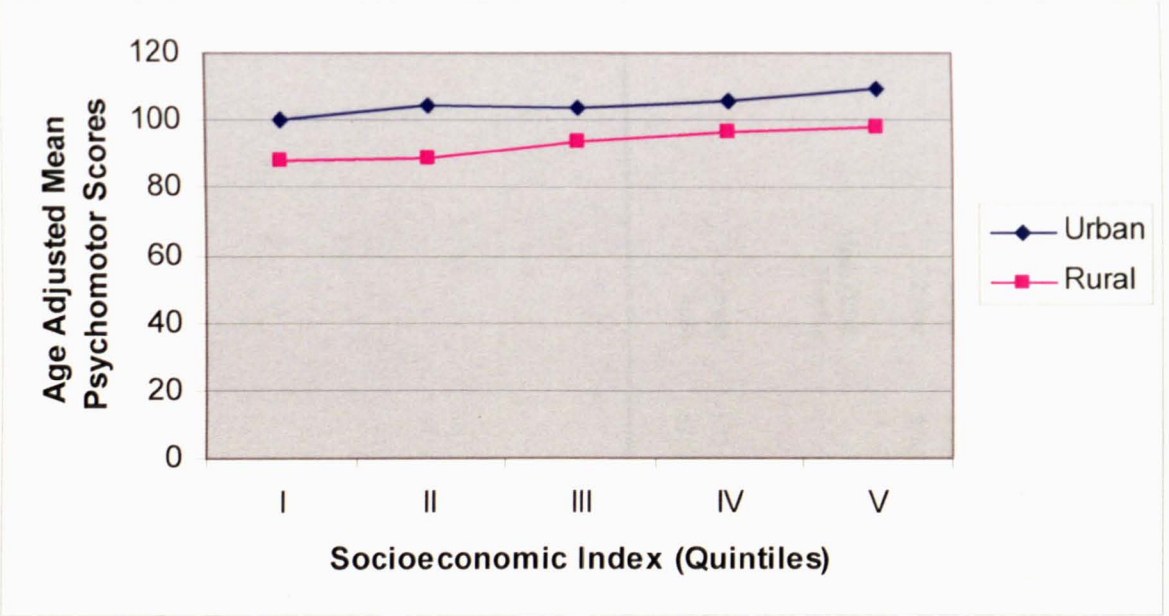


Table 4.1: Composition of study participants: age and gender by neighbourhood

			neighbourhood		
		Overall N (%)	**Rural n (%)**	**Urban n (%)**	**P value**
Age of the Child	0 year	454(36.5)	245 (40.0)	209 (33.1)	0.329
	1 year	454(36.5)	210 (34.3)	244 (38.7)	
	2 year	336(27.0)	158 (25.8)	178 (28.2)	
	Mean (SD): Months		15.94(9.89)	17.39(9.80)	
Gender	Female	593 (47.7)	280(45.7)	313(49.6)	0.166
	male	651 (52.3)	333(54.3)	318(50.4)	

Table 4.2: Parental characteristics by neighbourhood

			neighbourhood		
		Overall N (%)	Rural n (%)	Urban n (%)	p value
Mother					
Age (years)	Mean (SD)	29(6)	29(7)	28(5)	0.138
Education	Illiterate/read only	660(53.1)	445(72.6)	215(34.1)	0.000
	Primary	143(11.5)	61(10.0)	82(13.0)	
	Middle/Matric	203(16.3)	59(9.6)	144(22.8)	
	Intermediate & above	238(19.1)	48(7.8)	190(30.1)	
Occupation	Housewife	865(69.5)	367(59.9)	498(78.9)	0.000
	Unskilled Labour	70(5.6)	68(11.1)	2(0.3)	
	Skilled workers	149(12.0)	73(11.9)	76(12.0)	
	Agriculture	67(5.4)	67(10.9)	-	
	Professional	93(7.5)	38(6.2)	55(8.7)	
Father					
Age (years)	Mean (SD)	34(8)	35(9)	34(7)	0.010
Education	Illiterate/read only	395(31.9)	284(46.5)	111(17.7)	0.000
	Primary	160(12.9)	96(15.7)	64(10.2)	
	Middle/Matric	270(21.8)	100(16.4)	170(27.1)	
	Intermediate & above	414(33.4)	131(21.8)	283 (45.1)	
Occupation	Jobless	25(2.0)	15(2.5)	10(1.6)	0.000
	Unskilled Labour	190(15.3)	114(18.7)	78(12.4)	
	skilled Workers	192(15.5)	211(34.5)	360(57.3)	
	Agriculture	571(46.1)	174(28.5)	16(2.5)	
	Professional	261(21.1)	97(15.9)	164(26.1)	

Table 4.3: Family characteristics by neighbourhood

		Neighbourhood			
		Overall N (%)	**Rural n (%)**	**Urban n (%)**	**p value**
Religion	Muslim	1141(91.7)	541(88.3)	600 (95.1)	0.000
	Non Muslim	103(8.3)	72 (11.7)	31(4.9)	
Ethnicity	Sindhi	914(73.5)	547(89.2)	367(58.2)	0.000
	Non Sindhi	114(9.2)	35 (5.7)	79 (12.5)	
	Mohajir	216(17.4)	31(5.1)	185(29.3)	
Family type	Nuclear	544(43.7)	286(46.7)	258(40.9)	0.040
	Extended	700(56.3)	327 (53.3)	373 (59.1)	
Family size	Mean (SD)	8(4)	9(4)	8(4)	0.000
Number of Siblings	Mean (SD)	2.(2)	3 (3)	2 (2)	0.000
Number of caregivers	Mean (SD)	3(2)	3 (2)	2 (2)	0.000

Table 4.4: Economic characteristics by neighbourhood

		Neighbourhood			
		Overall N (%)	Rural n (%)	Urban n (%)	P value
House ownership	Rental	179(14.4)	(0.8)	174(27.6)	0.000
	family sharing	27(2.2)	11(1.8)	16(2.5)	
	Own	1038(83.4)	597(97.4)	441(69.9)	
Number of rooms in the house	Mean (SD)	2 (1)	1.6(0.9)	2.2(1.2)	0.000
Crowding	Mean (SD)	5(3)	5(3)	4(2)	0.000
Source of drinking water	Tap water	307 (25.6)	31(5.1)	276(43.7)	0.000
	Borehole	909 (73.1)	565(92.2)	344(54.5)	
	Well / canal	28 (2.3)	17(2.8)	11(1.7)	
Mode of transport	Private	150(12.1)	31(5.1)	119(18.9)	0.000
	Public	1064(85.5)	570(93.0)	494(78.3)	
	Walk/ animal	30(2.4)	12(2.0)	18(2.9)	
How many people work for house expenses	Mean (SD)	2(1)	2.2(1.6)	1.9(1.2)	0.000
Average Per capita income (rupees)	Mean (SD)	1065(1105)	706(580)	1413 (1354)	0.000
Average Per capita income (quintiles)	1.00	240(19.3)	183(30.4)	57(9.2)	0.000
	2.00	252(20.3)	167(27.7)	85(13.7)	
	3.00	238(19.1)	119(19.8)	119(19.2)	
	4.00	237(19.1)	80(13.3)	157(25.4)	
	5.00	254(20.4)	53(8.8)	201(32.5)	

Table 4.5: Mean PD index by Age and Gender

	Overall	Age in years 0 year	1 year	2 year	P value for trend
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Female	95.80 (16.56)	98.85 (13.10)	96.82 (17.24)	89.69 (18.62)	0.015
Male	95.82 (16.86)	95.82 (16.86)	98.13 (17.48)	92.13 (18.34)	0.000
p-value	0.977	0.061	0.424	0.230	
Overall	95.81(16.71)	97.65(13.75)	97.51(17.36)	91.04(18.48)	0.000

Table 4.6: Linear regression analyses of association between socio-economic factors and PD index:

	Univariate			Multivariate		
Factors	**Effect**	**95% CI**	**P-value**	**Effect**	**95% CI**	**P-value**
Social Factors						
Religion [1]	1.76	(-1.61,5.14)	0.305			
Type of family [2]	-0.09	(-1.97, 1.78)	0.925			
No of co residents [3]	-0.21	(-0.50, 0.08)	0.148			
Maternal education [4]	3.65	(2.91, 4.38)	0.000	1.97	(0.89, 3.04)	0.000
Paternal education [5]	2.91	(2.19, 3.63)	0.000	1.01	(-0.01, 2.02)	0.052
Maternal Occupation [6]	3.13	(2.13, 4.14)	0.000	0.50	(-0.64, 1.63)	0.391
Paternal Occupation [7]	3.13	(2.13, 4.14)	0.000	-0.39	(-2.72, 1.95)	0.746
Economic Factors						
Per capita income [8]	2.78	(2.15, 3.42)	0.000	1.17	(0.30, 2.04)	0.008
% of monthly income spent on food [9]	-0.08	(-0.62, 0.46)	0.779			
Number of rooms in the house [10]	1.52	(0.60, 2.44)	0.001	-0.05	(-1.03, 0.94)	0.925
Crowding [11]	-0.87	(-0.48, - 1.27)	0.000	-0.17	(-0.62, 0.29)	0.466
Tap water supply [12]	5.21	(3.18, 7.24)	0.000	1.37	(-0.82, 3.57)	0.221
Mode of transport [13]	5.59	(3.12, 8.07)	0.000	0.99	(-1.61, 3.59)	0.455
Age of the child				3.23	(2.10, 4.36)	0.000

1. Religion : Muslim, Non Muslim
2. Type of family: extended, nuclear
3. No of co residents: 0,1,2,3,4,5,6,7,8,9 & 10^{+}
4. Level of Maternal Education: illiterate/read only, primary, middle/matric, intermediate and above
5. Level of Paternal Education: illiterate/read only, primary, middle/matric, intermediate and above
6. Maternal Occupation: Agriculture worker, unskilled labourer, skilled worker, housewife, professional.
7. Paternal Occupation: Jobless, unskilled labourer, agriculture worker, skilled worker, professional.
8. Per capita income (quintiles): higher the income higher the quintile level.
9. Percentage of monthly income spent on food.
10. Number of rooms in the house: 1, 2,3,4 & 5^{+}
11. Crowding (no of people sharing room including the index child: 10 categories $1\text{-}10^{+}$
12. Tap water supply: Canal, Well/borehole, tap water.
13. Mode of transport: Walk/animal, Public transport and Private Vehicle.

Table 4.7: Principle component analysis (PCA) for the socio-economic factors

Factors	PCA Scoring Weight
Social Factors	
Maternal education [1]	0.819
Paternal education [2]	0.759
Maternal Occupation [3]	0.564
Paternal Occupation [4]	0.585
Economic Factors	
Per capita income [5]	0.785
Number of rooms in the house [6]	0.478
Crowding [7]	0.596
Tap water supply [8]	0.480
Mode of transport [9]	0.447

1. Level of Maternal Education: illiterate/read only, primary, middle/matric, intermediate and above

2. Level of Paternal Education: illiterate/read only, primary, middle/matric, intermediate and above

3. Maternal Occupation: Agriculture worker, unskilled labourer, skilled worker, housewife, professional.

4. Paternal Occupation: Jobless, unskilled labourer, agriculture worker, skilled worker, professional.

5. Per capita income (quintiles): higher the income higher the quintile level.

6. Number of rooms in the house: 1, 2, 3, 4 & 5^{+}

7. Crowding (no of people sharing room including the index child): 10 categories 1-10^{+}

8. Tap water supply: Canal, Well/borehole, tap water

9. Mode of transport: Walk/animal, Public transport and Private Vehicle.

Table 4.8: Poor to Rich Ratio for psychomotor development of children by rural - urban neighbourhoods

	Mean PD index		
Area of residence	**Lowest Quintile**	**Highest Quintile**	**Lowest /Highest SE quintile ratio**
Overall	91.66	99.44	0.92
Rural	89.46	96.10	0.93
Urban	96.98	101.28	0.96

Chapter Five

The relationship between growth and psychomotor development

5.1 Introduction

Physical growth during early childhood is fundamental for the future of individuals and nations. A child who is growing well is more likely to be alert, active, and interactive with the environment; this means better cognitive development and academic performance (24, 178). In addition, growth is also linked to a healthy immune system against infections (179). During adulthood, it results in enhanced work capacity and economic productivity (180-182). One of the most important consequences for female children of better growth during childhood is adequate maternal size, which leads to improved reproductive success, better birth weight, and maternal and infant survival (66, 129, 183, 184).

Unfortunately, there is a large burden of undernutrition among children worldwide. Furthermore, undernutrition is strongly associated with poor levels of child survival, 55% of under five mortality is attributable to it (185). According to the World Health Organisation about 25% of the world's children under five suffer from undernutrition, particularly in African and Asian regions (108). In addition, about 21 million babies are born with low birth weight (LBW) that is more than 16% of all births annually. The magnitude of the problem is grave in South Asia where at least every fourth newborn has a low birth weight (186). Low birth weight is primarily a consequence of undernutrition during the prenatal and antenatal period, and is a determinant of poor growth during early childhood period.

WHO estimates that:

- About 178 million children under five are *stunted*, that is their height is more than two standard deviations below the median height of children of the same age in the healthy reference population (refer to section 2.6.3 for details). Stunting is inadequate linear growth resulting from chronic insufficiency in nutrition or episodes of illness or both (108).

- 55 million children have a deficit in weight relative to height due to an acute shortfall in nutrition and are termed *wasted*, this is defined as weight-for-height z score < -2. About 19 million children have severe acute malnutrition (SAM), an extreme form of wasting defined as a weight-for-height z score < -3; many of them will not survive their fifth birthday due to this and will die from this preventable cause of child mortality (108, 187).

- About 110 million children under five (20% of all children) are *underweight* that is their weight for age is more than two standard deviations below the median weight of children of the same age of healthy reference population. The condition of being underweight is a result of undernutrition and can be either acute or chronic in nature.

There is strong evidence to suggest that a child's physical growth is principally determined by environmental factors rather than by their biology. Studies from India (188), Ghana (189), and Oman (190) have demonstrated that growth patterns of well fed preschool children of the affluent social classes and diverse ethnic

backgrounds from developing countries are comparable to those of children in the United States. WHO has developed new growth standards from samples of children from different countries raised in environments conducive to optimal growth, including such things as good breastfeeding and complementary dietary practices, absence of maternal smoking and better general socio-economic conditions. Currently WHO recommends these growth standards for the anthropometric assessment of children instead of previous WHO/NCHS references.

The environment in which a child grows is a multifaceted concept. In this study we examine three aspects: socio-economic status, the rural or urban status of their neighbourhood, and sensory stimulation in the home. This chapter focuses on the first two while the next chapter examines the role of sensory stimulation in the home.

Social and economic conditions are known to be associated with undernutrition. Some of the well established independent factors are poor parental education, parental occupation, low family income, crowding, unsafe water supplies, and poor hygiene and sanitation (191-197). For example a community based study in Pakistan by Shah et al. (198) found that illiterate mothers were 1.3 times more likely to have a stunted child when compared with educated mothers. In Mexico, a case control study demonstrated the negative effect of the lower status of father's occupation on the child's nutritional status. In particular it was found that in rural areas a farmer's child was 1.8 times more likely to be stunted compared to the child of a non-farmer, while in urban areas a father with an unstable job was 3.3 times likely to have a stunted child (145).

Furthermore, whether a child lives in a rural or urban neighbourhood has also been found to influence the risk of undernutrition. In general, Demographic and Health Surveys have shown that undernutrition is more prevalent in rural areas (199-201). In their analysis of the Multiple Indicator Cluster Surveys from the African member countries Kennedy G et al. (202) showed that on average the prevalence of stunting was 5% to 14% higher in rural areas compared to urban areas. They also found a strong relationship between poor socio-economic status and chronic undernutrition in both urban and rural areas.

In this chapter we also examine the association between nutritional status and PD index. In general, undernutrition during early childhood has been shown to have negative effects on child development, but the scientific evidence specifically establishing the relationship to psychomotor status lacks consistency (20, 24, 203). Cheung YB at al. (204) has found that growth status was positively able to predict the age of walking among Pakistani children. Similar findings were observed in research studies from Nepal, Guatemala, and Tanzania (205-208). On the contrary no relationship was found between height and motor development in Kenyan infants (209). Similarly, a recent study by the WHO Multicentre Growth Reference Study Group has shown a lack of evidence for an association in well nourished healthy children between growth and motor development (108). According to the Lancet Child Development Series published in early 2007, there are relatively limited studies assessing the relationship between undernutrition and child development during the very early years of life and motor development focussed studies are especially rare (20). In addition, the available literature is not comprehensive enough to cover all three anthropometric indicators (24, 210, 211). There is one study by Politt E et al which explores the association between the three anthropometric indicators and psychomotor development but unfortunately it didn't control for any confounding factors. The underlying mechanisms linking

the undernutrition with developmental delays are not clearly established such as social environment factors or past nutritional experiences like low birth weight.

In chapter 3 we discussed how socio-economic inequality and the rural or urban nature of their neighbourhood influence child development, here we will discuss the extent to which this may be mediated by their influence on undernutrition. We postulate that nutritional status is on the causal pathway between socio-economic status and psychomotor development (PD index), and between neighbourhood and PD index. This has been illustrated in the conceptual framework in fig 5.1. Finally, we examine whether birth weight influences the psychomotor development of children in addition to its influence through current growth status.

5.2 Objectives

The overall aim and objective of this chapter is:

- To evaluate the effect of socio-economic status and neighbourhood on undernutrition and its influence on child development.

The specific objectives are:

- To describe the levels of undernutrition of the study population compared to the WHO growth standards.
    - By age and gender
    - Compared to levels based on the previous NCHS growth standards.

- To assess whether these levels of undernutrition differ by socio-economic status and the rural or urban status of the child's neighbourhood.

- To explore whether the influences of socio-economic status and rural or urban neighbourhood on PD index are mediated partially or solely through growth.

- To examine whether low birth weight exerts influence on psychomotor development.

5.3 Methodology

The overall methodology of anthropometric assessment has been described in detail in section 3.7.3.

5.2.1 Statistical Analysis

The analysis was done in four stages:

I. The prevalence of undernutrition according to each indicator was calculated with respect to gender and age. The relative changes in the prevalence were also estimated to compare the NCHS reference with WHO standards.

   A Composite Index of Anthropometric Failure (CIAF) was formed with children categorized into 7 groups: stunted, wasted and underweight; stunted and underweight; wasted and underweight; stunted only; wasted only; underweight only; and normal. Note that the category of stunted and wasted is omitted as it is anthropometrically impossible, such a child would always also be underweight.

II. Logistic regression analysis was used to evaluate the association between anthropometric indicators and socio-economic status, and the rural or urban status of neighbourhoods. In addition, the associations were also presented graphically.

III. Multivariate linear regression was used to examine the relationship between PD index and the following factors: stunting, underweight, wasting, and CIAF; each was controlled for a) age and gender, and b) age, gender,

neighbourhood, and SE index. The P-value of trend was also calculated when considered necessary.

Then the association was examined between psychomotor development and growth status among well nourished children, defined as all anthropometric indices with z scores $\geq$ -2. Those who had scored less than -2 were excluded from this subgroup analysis.

IV. The impact of low birth weight on psychomotor development was examined using multivariate linear regression including adjustments for current nutritional status, age, gender, neighbourhood, and SE index.

5.4 Results

5.4.1 Levels of Undernutrition

Table 5.1 shows levels of undernutrition compared to WHO and NCHS reference standards. The prevalence of being underweight decreased when using WHO standards, while the prevalence for all other indicators increased. Stunting in the first three years of life increased from 34.4% using the NCHS reference to 39.8% with the WHO standards, a relative increase of 15.9%. The prevalence of being underweight was 30.9% based on WHO standards as compared to 35.5% estimated on the basis of NCHS reference, a relative decrease of 14.9%. The prevalence of wasting also increased when using the WHO standards, 18.1% compared to 15.2% a relative increase of about 19.1%. Similarly, the prevalence of severe acute malnutrition increased from 3.4% to 7.4%, a relative increase of 117.65%. Based on CIAF, 52.3% of the study children were overall undernourished using WHO standards compared to 48% using the NCHS reference.

The percentage distribution of combinations of different types of undernutrition based on CIAF is shown in figure 5.2. About 8% of the children were concurrently stunted, underweight, and wasted. The combination of stunting and wasting only was found in 15%, and wasting and underweight only in 6%, while 17% of children were stunted only.

Prevalences of undernutrition by age and gender are shown in table 5.2; girls have better growth indicators compared to boys, except for wasting. Overall undernutrition is 3.3% higher in male children compared to female children. The difference between male and female stunting is about 7% (p-value = 0.012).

Very different age patterns are seen for the different indicators (figure 5.3). In general, stunting rates increase with age (p-value < 0.001), as one would expect owing to the cumulative nature of the stunting phenomenon. No trend with respect to age is observed for being underweight (p-value= 0.553). In contrast rates of wasting (p-value < 0.001) and SAM decrease with age (p-value < 0.007).

5.4.2 Influence of SE index and Neighbourhood on Growth

Figure 5.4 shows age and gender adjusted prevalences of undernutrition by socio-economic quintiles and neighbourhood. There is an inverse relationship between socio-economic quintiles and undernutrition for each of the indicators; those with lower socio-economic status have higher levels of undernutrition (table 5.3). The trend is equally applicable to all the anthropometric indicators (p-value < 0.001).

Overall children living in rural areas have a considerably greater risk of being undernourished than those living in urban areas (table 5.4). This is true for all types of undernutrition. However these differences disappear after adjusting for socio-economic quintiles as can be seen in figure 5.4. It is interesting to note that in the richest SE quintile the proportion of undernourished children is higher for children living in urban areas compared to rural areas for all anthropometric indicators; however these are statistically insignificant. On the whole it is logical to conclude that the association between nutritional status and the rural or urban nature of a neighbourhood has been mediated by differences in socio-economic status.

5.4.3 Relationship between Undernutrition and Psychomotor Development

Table 5.5 shows that undernourished children on average have lower PD indices, and that age and gender adjusted PD scores are lower for undernourished children.

The difference is statistically significant for all anthropometric indicators e.g. age and gender adjusted mean psychomotor scores for stunted children are about 10 points lower than those of children with normal linear growth. Similarly underweight children have scores about 9 units lower than children with appropriate weight for age.

Except for wasting the differences remained significant after adjusting for socio-economic status and rural or urban neighbourhood. The magnitude of differences decreased for all indicators between undernourished and normal children as shown in table 5.5, for example on average the psychomotor status of stunted children is 7 points less when compared to non-stunted ones.

The separate and combined effect of stunting and being underweight are shown in table 5.6. As can be seen children who are simultaneously stunted and underweight have much worse psychomotor status compared those only stunted, only underweight, or neither.

Table 5.7 shows the link between PD index and CIAF (combination of three types of undernutrition). Psychomotor status is decreased by 10.5 PD index units when a child is undernourished on all three indicators as compared to a normal healthy child. It is important to note that only stunting containing undernutrition groups of CIAF is significantly associated with lower PD index scores.

5.4.4 Relationship between well nourished children and Psychomotor Development

Table 5.8 shows that the relationship between the physical growth and psychomotor development is further validated by limiting the analysis to the subgroup of 581 well nourished children. The association is statistically

significant for each index e.g. psychomotor status of children is increased by 2.07 points with every increase in a z score for height-for-age.

5.4.5 Relationship between Low Birth Weight and Psychomotor Development

Table 5.9 shows that, on average LBW children have 4 point lower mean psychomotor scores compared to normal birth weight children. This difference remains even after adjustment for neighbourhood and SE quintiles (p value = 0.051).

However, the difference is considerably reduced and becomes statistically insignificant when stunting, underweight, and wasting are added to the model (p value = 0.309). Thus it appears that the association between PD index and LBW has been largely mediated by postnatal growth status.

5.5 Discussion

5.5.1 Summary of Key Findings

- Overall 52.3% of children aged under three years are undernourished, with 39.8% stunted, 30.9% underweight, 18.1% wasted and 7.4% with SAM.

- Socio-economic inequalities in rates of undernutrition explained the higher overall rates observed in the rural compared to urban neighborhoods.

- Overall undernutrition in general and specifically stunted and underweight children are more likely to have lower psychomotor scores, irrespective of socio-economic status and whether they live in a rural or an urban neighborhood.

- Low birthweight children have lower PD index but it appears to be largely mediated through its impact on postnatal growth status.

5.5.2 Nutritional Status of the Children

Overall, in our study sample more than half of the children were undernourished. The undernutrition rates for specific anthropometric indicators ranged between 18% for wasting to 40% for stunting. These rates are comparable with Pakistan Demographic and Health Survey and other regional surveys, and add to the validity of the study findings e.g. according to recent UNICEF estimates among Pakistani under five children 37% were stunted, 38% underweight, and 13% wasted (212).

Estimation of undernutrition among children is primarily affected by selection of the specific age groups, growth indicators, and the reference population (213). The relative change in undernutrition rates is significant with a shift of the reference population from NCHS to WHO. NCHS reference standards represent the physiological growth pattern of bottle-fed infants from a homogenous population (214). While, WHO standards provide a better yardstick for growth because they are based on a sample of children who were either exclusively or predominantly breastfed, had a high quality of complementary diet and came from a high socio-economic group from heterogeneous populations (215, 216). With the new WHO growth standards the relative increase in the estimates of stunting, wasting, and SAM among children is inevitable because these standards are based on a sample of children which were taller and lighter compared to the NCHS growth reference(217).

The prevalence of chronic undernutrition is known to increase in the first three years of life especially in a developing country and our study finding is consistent with other studies (218). In our study the increase in the stunting rate every year might be a reflection of a cumulative effect of undernutrition for children living in deprived conditions over time (108).

Wasting and SAM are phenomena which are mainly related to seasonal variations in food or infections. Therefore it develops rapidly and can be reverted quickly by a favourable nutritional supply (219). The rates of wasting are known to improve with age especially from the second year onwards(220). In our study we observed the same phenomenon. It might be a reflection of the fact that as children grow older, they are better able to maintain their intake of food even during the state of seasonal food deficiency. Secondarily, with age, there is improvement in the body's immunity to infectious disease and consequently illness episodes are less severe so there are fewer acute fluctuations in growth status. Thirdly it may be a

reflection of survival bias in countries which have very high infant mortality rates (IMR), Pakistan's IMR is 79 (212). In such situations the most vulnerable children die very young primarily due to infections. Healthy infants survive and so we observe a decline in SAM and wasting rates with age.

In our study, female children have persistently lower rates of undernutrition than boys on all anthropometric indicators except wasting. Similarly, a large scale study conducted in Karachi has shown that female children were better off in terms of height for age at all levels of socio-economic status (221). Our findings are consistent with the existing literature about gender differences in nutritional status of children. Generally male children are marginally undernourished compared to female ones but usually this difference is not statistically significant (222-224). It could be both due to the fact that biologically female children are better off in terms of growth and immunity in early years, or the gender bias in terms of nutrition starts a bit later.

5.5.3 Determinants of Undernutrition

Our findings support the existing scientific evidence of the role of socio-economic inequality in the nutritional status of children (153, 225). Additional evidence is provided by the fact that a significant decline child undernutrition rates has been observed in China, primarily due to its rapid economic growth (226).

Interestingly, rural urban differences in the undernutrition status of children are explained by socio-economic status. Fotso JC has strongly argued, with the help of data from diverse countries, that the variation observed in the rural urban areas are primarily a function of differences in socio-economic status rather than the actual influence of the area of residence (199, 200). This is in contrast to the finding of the last chapter that both SE quintiles and rural urban neighbourhood

independently affect child development. This is a very interesting finding, that the socio-economic status is overarching factor which is shared by both growth and development phenomenon of the child. This finding has implications for policy makers. It suggests that ECD programmes to improve nutritional status should focus on the socio-economic inequalities while programmes targeting child development should also pay particular attention to the rural areas; this is further discussed in chapter 6.

5.5.4 Growth and Psychomotor Development

In general terms, although psychomotor development of a child is considered to be strongly influenced by the nutritional status of the child (208), this has never been systematically assessed (227). Our study has attempted to explore this association in three dimensions.

Firstly, significantly poorer psychomotor status was found among both stunted and underweight children, which shows that it is associated both by chronic and short term nutritional fluctuations The possible mechanism could be that the childhood undernutrition results in a decrease in work performance due to suboptimal development of muscle and neuronal coordination (228). Persistent stunting during childhood results in a significant reduction in adult size (229). This in turn has reduced economic efficiency via a decrease in work capacity (230). On a positive note, the association gives a hope that any improvement in child undernutrition could result in the upgrading of the overall socio-economic status of a nation.

Similarly, there is general consensus that undernutrition, especially being underweight, is associated with childhood morbidities, irrespective of the severity

of undernutrition (231-233). However scientific evidence of similar types of associations for developmental morbidities is very limited (234, 235).

The condition of being wasted was not associated with psychomotor performance in our study, suggesting that psychomotor development might be a relatively stable phenomenon and less influenced by short term nutritional fluctuations. However, this observation requires scrutiny through further research to develop an in-depth understanding of the relationship between wasting and psychomotor development before reaching any final conclusion.

Secondly, the impact of overall undernutrition on psychomotor development was assessed by using an aggregate measure of undernutrition because conventional solitary anthropometric indicators have an overlapping nature; a child is likely to have a growth deficit on more than one indicator in real life scenarios. The idea of a single measure of undernutrition was suggested by Peter Svedberg in his book "Poverty and undernutrition: theory, measurement and policy" (236). Conceptually it gives a more comprehensive picture of child undernutrition. This is an experimental indicator based on the number of anthropometric indicators present simultaneously in a child and the purpose is to identify the different groups of vulnerable children due to the undernutrition or in a state of "anthropometric failure". To the best of our knowledge this is the first attempt to assess the influence of CIAF on child development. However this concept has recently been used by Shailen Nandy et al. to demonstrate successfully the influence of undernutrition on diarrhoea and ARI in India (237).

In our study we found that children suffering from all the three anthropometric indicators simultaneously have the lowest mean PD index scores. Furthermore, stunting or its combination with any other anthropometric indicator was significantly associated with PD index. However, wasting, being underweight, or

a combination of both was not found to be a good predictor of PD index score in a child. It is important to note that the results of CIAF varies with the selection of outcomes (237). We recommend that these findings should be further assessed in diverse research settings before using this indicator for the policy and programme planning.

Thirdly, the association between nutritional status and psychomotor development among healthy children was assessed. Excluding all undernourished children from the analysis, the anthropometric > -2 z scores were highly associated with psychomotor development of the child. Our analysis shows that a child's risk of developmental delay as result of undernutrition is not only limited to those with severe levels of malnutrition. Persistent marginally insufficient food intake is known to reduce physical performance before there is a significant, observable deficit in growth. (238, 239)

Here it is important to note that gross motor milestones developed by the WHO have shown no relationship with the nutritional status of the child (240, 241). This might be linked to certain conceptual and analytical issues in the development of these milestones. For example psychomotor development is a continuous process comprising of both gross and fine motor outcomes. While in the WHO study it comprised 6 gross motor milestones only. Secondly, the method for generating the motor standards was based on "windows of achievement" defined as time of attainment of a specific milestone bounded by 1^{st} and 99^{th} percentile in months, rather than the conventional percentile curves. As a result, achievement of a specific milestone at a later month within a normal "window of achievement " has a limited predictive value for a successful or failed motor outcome, as demonstrated by the other child development studies in healthy populations (242).

5.5.5 Low Birth Weight and Psychomotor Development

In our analysis, low birth weight was associated with lower psychomotor scores when controlled for age, gender, neighbourhood, and socio-economic status. However, when current nutritional status was fitted into the model the association between low birth weight and psychomotor development disappeared.

Epidemiological literature on the influence of the birth weight on psychomotor status is limited. A recent review identified 7 eligible studies but was unable to draw any conclusions due to inconsistent definitions and assessment methodologies (211). A study conducted by Grantham-McGregor SM et al in Brazil demonstrated that low birthweight children have a PD index score 9.9 points lower at 12 months of age, $p<0.001$(20), while in our study children under three scored 4.3 points lower $p<0.001$. Both studies have same direction of association but the magnitude of the effect is different. It could be partially explained by the fact that in the Brazilian study the reference group was $\geq$ 3,000 grams, larger than the conventional cut off of 2,500 grams which we used; this might have resulted in the inflated magnitude of effect. However, current nutritional status of a child is an important factor which can influence the association between the LBW and psychomotor status. To the best of our knowledge there is no epidemiological study which has taken this into account while evaluating this association.

There is a strong body of evidence that prenatal (intrauterine growth) is a strong predicator of postnatal growth and consequently of an intergenerational vicious cycle of poor growth (186). This might provide partial explanation of the high rate of stunting in South Asia by its link with the high rate of low birth weight (19). Our findings highlight the importance of sound nutritional practices in the

postnatal period that can mitigate the harmful effect of the poor foetal growth, in addition to efforts to decrease the prevalence of low birth weights.

5.5.6 Limitations

- Information about birth weights was available for only 52% of the sample. Primarily it represented the group of children whose mother received antenatal care and delivered either in hospital or a maternity home. Moreover, overall they had better socio-economic status (see Appendix 4.1). This might have resulted in the underestimation of the association as we have excluded the most vulnerable group from the analysis due to unavailability of data.

- Anthropometric indicators represent protein energy malnutrition. While micronutrient deficiency is an important determinant of child survival, growth, and development (207, 243, 244), which can not be effectively assessed by the anthropometric indicators. This aspect of undernutrition assessment requires an enormous amount of resources and was beyond the scope of this study.

- Due to the cross-sectional nature of the study, concurrent assessment of physical growth and psychomotor status raises the issue of reverse casualty. However undernutrition is more likely to be a potent determinant of the physical growth and physical performance (motor development) as compared to the influence of physical performance on physical growth and undernutrition, which is theoretically possible in extreme cases of physical activity/stress when the routine nutritional intake is primarily used to maintain bodily functions at the expense of growth.

Figure 5.1 Conceptual framework of relationship between psychomotor status and undernutrition

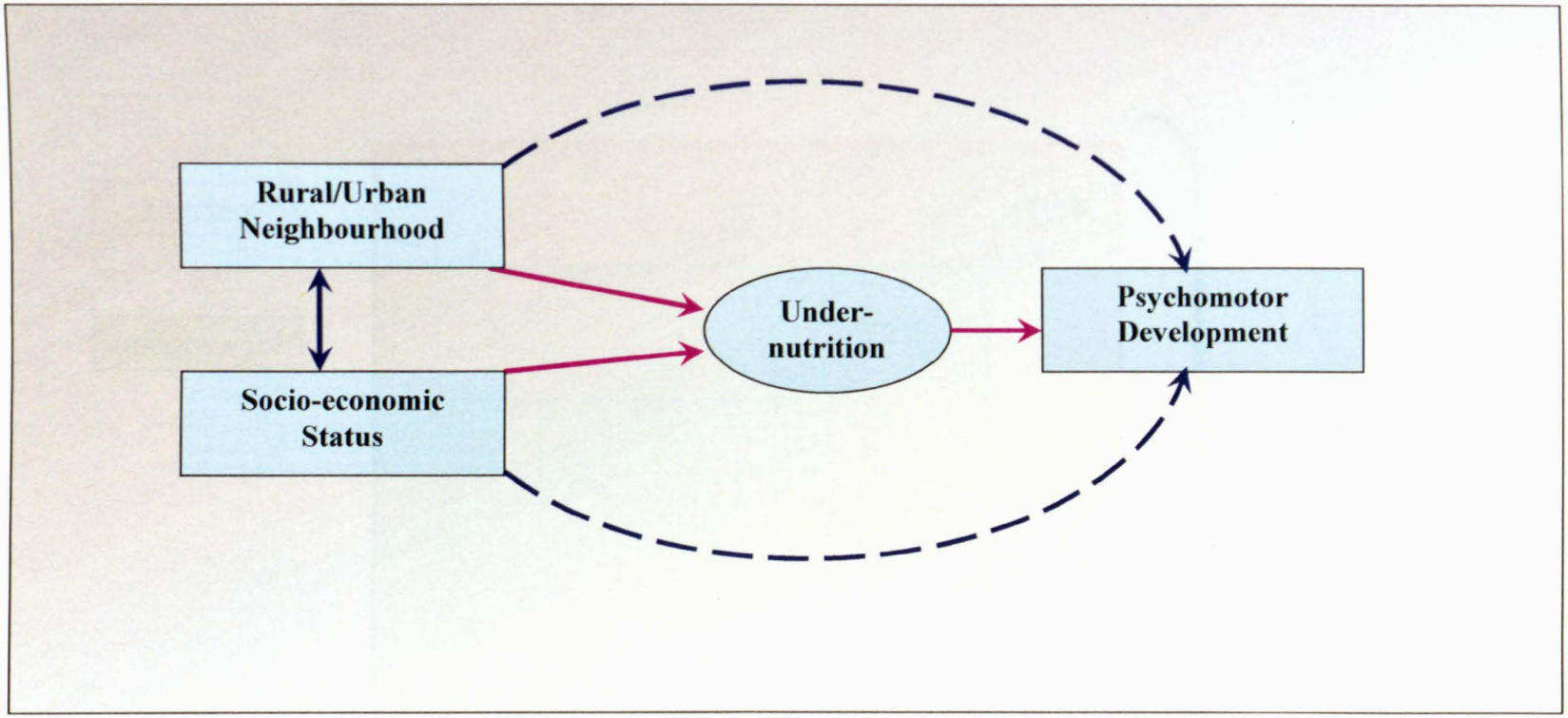


Figure 5.2: Combined Index of Anthropometric Failure (CIAF): Percentage distribution of combinations of different types of undernutrition

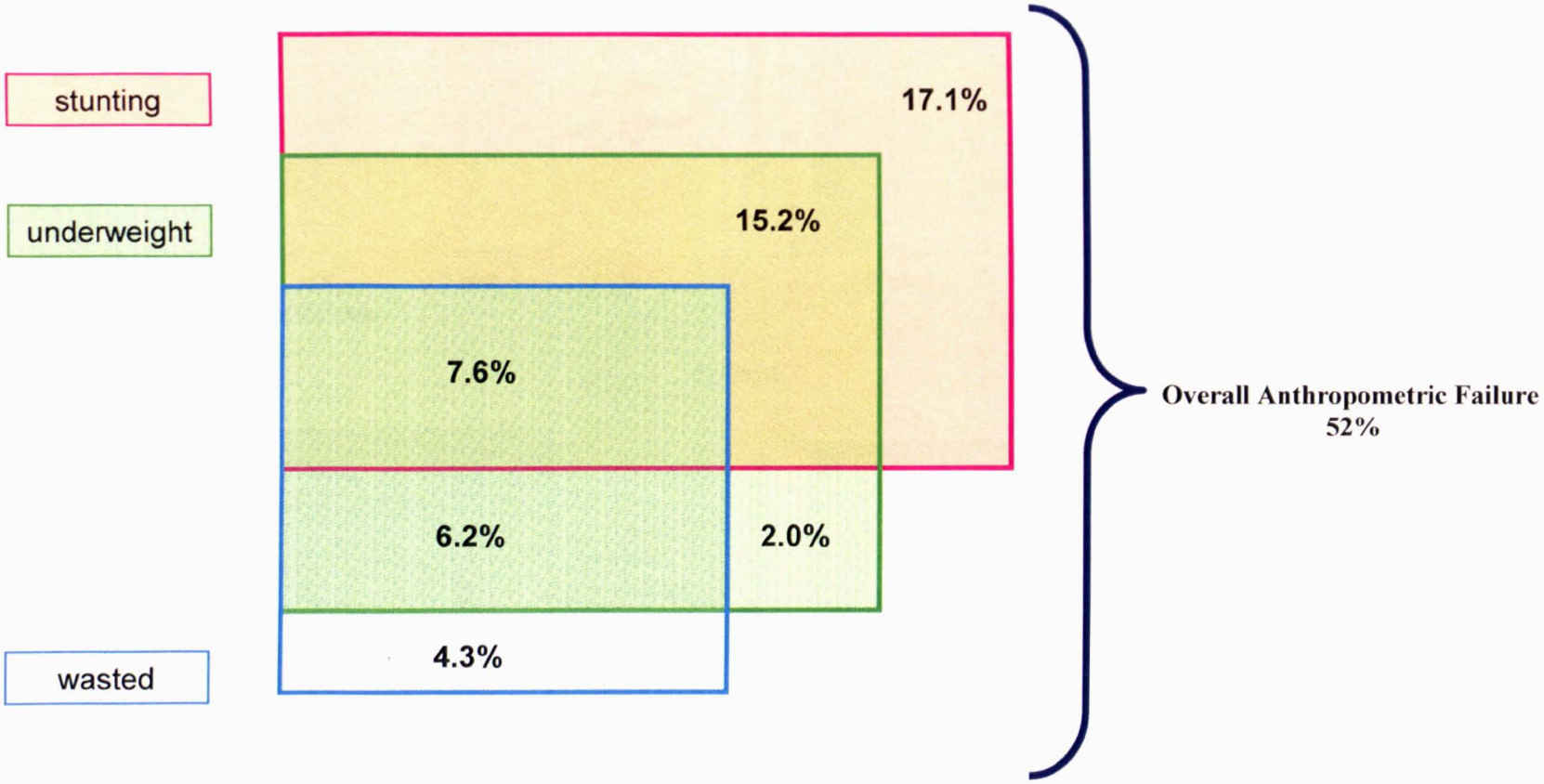
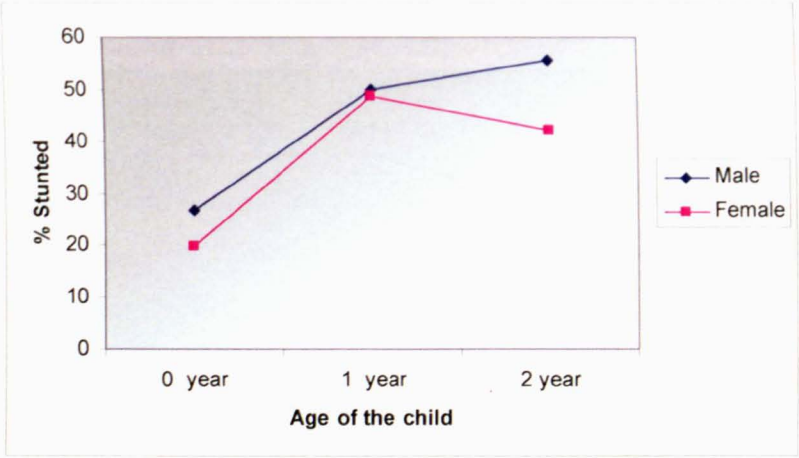
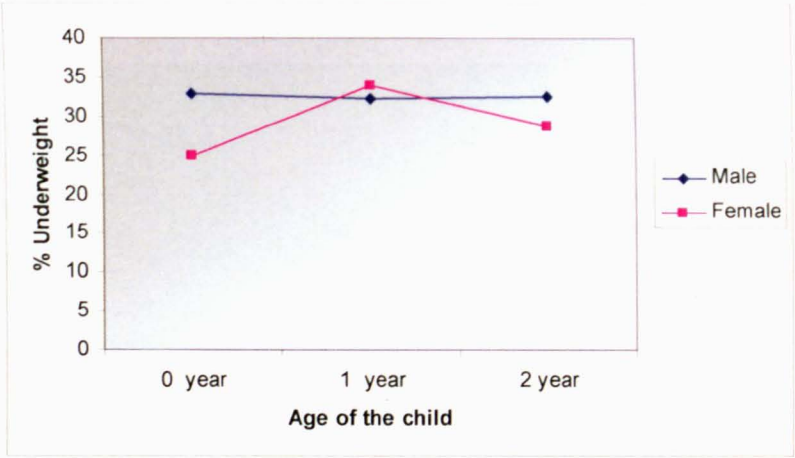


Figure 5.3: Nutritional status of children by age and gender

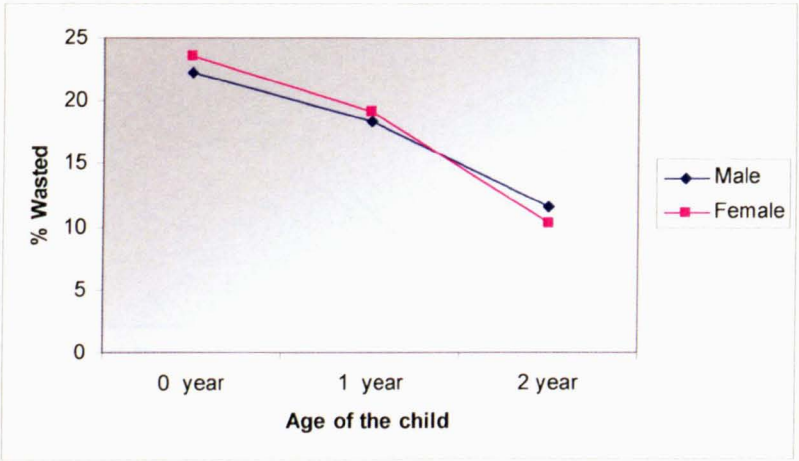
a) Stunting



b) Underweight



c) Wasting



d) SAM

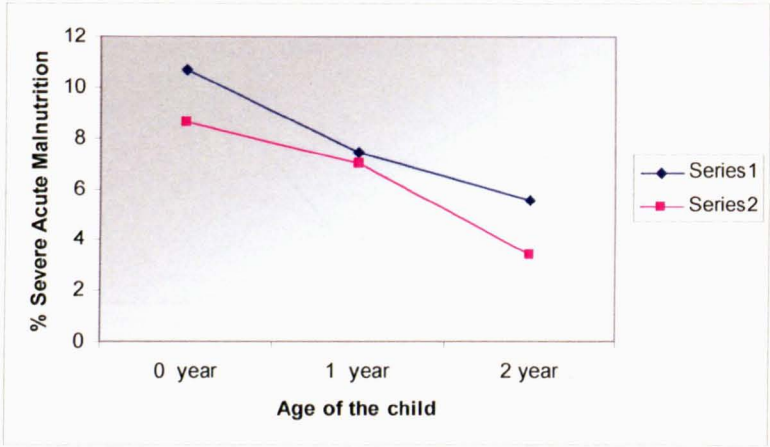
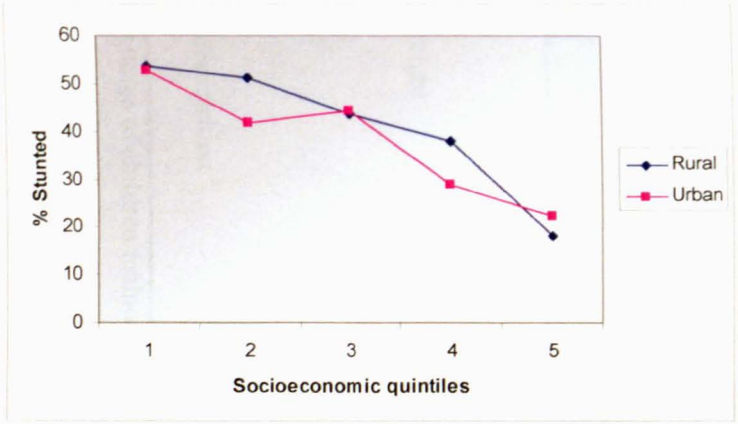
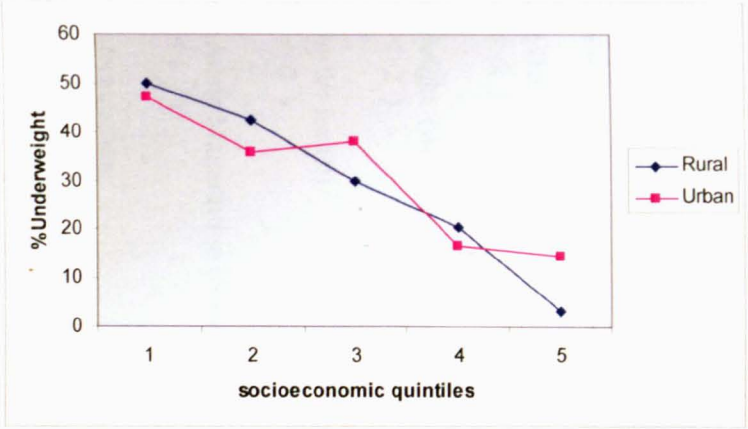


Figure 5.4: Prevalence of undernutrition by SE quintiles and rural or urban neighbourhood

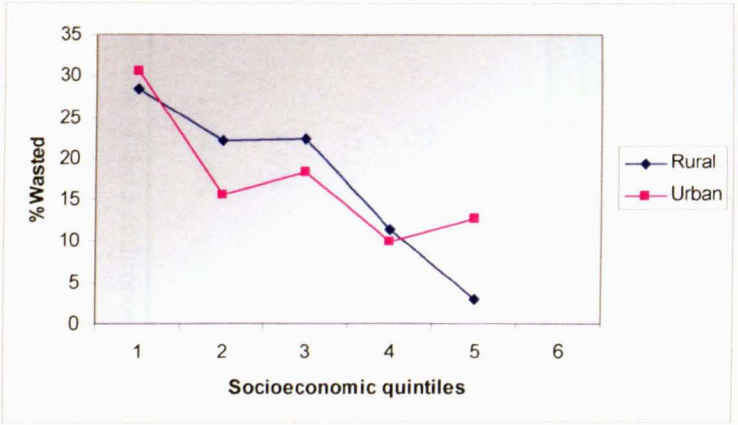
a) Stunting



b) Underweight



c) Wasted



d) SAM

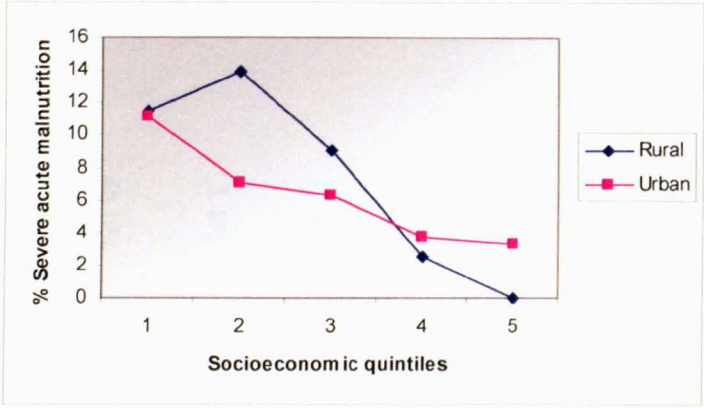


Table 5.1: Relative change in the undernutrition levels with WHO growth standards compared to NCHS growth reference

N=1219	Overall		Relative change
	WHO	NCHS	
Stunted (Ht for Age) (HAZ < -2)	39.8%	34.4%	15.7%
Underweight (wt for age) (WAZ < -2)	30.9%	35.5%	-14.9%
Wasted (Wt for Ht) (WHZ < -2)	18.1%	15.2%	19.1%
Severe Acute Malnutrition (SAM) (WHZ < - -3)	7.4%	3.4%	117.7%
Any undernutrition [1]	52.3%	48.0%	9.0%

1. Percentage of children malnourished on at least one of the 3 anthropometric indicators

Table 5.2 : Nutritional Status of the children by gender.

N=1219	Overall	Male	Female	P value
Stunted	39.8%	43.2%	36.2%	0.012
Underweight	30.9%	32.5%	29.2%	0.201
Wasted	18.1%	17.8%	18.5%	0.732
SAM	7.4%	8.0%	6.7%	0.375
Any undernutrition [1]	52.3%	54.4%	50.1%	0.132

1. Percentage of children malnourished on at least one of the 3 anthropometric indicators

Table 5.3: Prevalence of undernutrition children by SE quintiles

	Quintiles					
	I	II	III	IV	V	Adjusted p-value for trend [1]
n	n=244	n=242	n=247	n= 241	n= 245	
Stunted	131 (53.7%)	116 (47.9%)	109 (44.1%)	77 (32.0%)	53 (21.6%)	0.000
Underweight	12 (49.6%)	97 (40.1%)	84 (34.0%)	43 (17.8%)	32 (13.1%)	0.000
Severe Acute Malnutrition	28 (11.5%)	28 (11.6%)	19 (7.7%)	8 (3.3%)	7 (2.9%)	0.000
Any undernutrition	170(69.7%)	152(62.8%)	147(59.5%)	93(38.6%)	76(31.0%)	0.000

1. Adjusted for age and gender.

Table 5.4: Prevalence of undernutrition of the children by rural or urban neighbourhood

	Rural	Urban	OR(95%CI) [1]	P-value [1]	Adjusted p-value [2]
	n(%)	n(%)			
Stunted	282 (47.0)	204 (32.9)	1.99 (1.57, 2.54)	0.000	0.093
Underweight	224 (37.4)	153 (24.7)	1.83 (1.43, 2.34)	0.000	0.727
Wasted	131 (21.9)	90 (14.5)	1.60 (1.19, 2.16)	0.002	0.709
Severe Acute Malnutrition	59 (9.8)	31 (5.0)	2.00(1.27, 3.14)	0.003	0.456
Any undernutrition	368 (61.4%)	270 (43.5%)	2.12 (1.69, 2.68)	0.000	0.102

[1] Adjusted for age and gender
[2] Adjusted for age, gender, and SE Index

Table 5.5: Relationship between Undernutrition and PDI

		Mean PDI (SD)[1]	Adjusted Mean difference (95% CI)[1]	P-value [1]	Adjusted Mean difference (95% CI)[2]	P-value [2]
Stunted	*Yes*	90.63 (16.18)	-8.89 (-10.77, -7.01)	0.00	-6.89 (-8.77, -5.01)	0.00
	No	99.53 (16.11)				
Underweight	*Yes*	90.74 (16.77)	-8.65 (-10.59, -6.70)	0.00	-6.47 (-8.44, -4.50)	0.00
	No	98.80 (16.50)				
Wasted	*Yes*	93.07(16.52)	-3.55 (-5.96, -1.14)	0.04	-1.71 (-4.05, 0.64)	0.15
	No	96.62 (16.43)				
SAM	*Yes*	92.865 (16.50)	-3.36 (-6.91, 0.18)	0.06	-0.92 (-4.36, 2.51)	0.598
	No	96.229(16.46)				
Any undernutrition	*Yes*	92.18(16.92)	-7.66 (-9.47, -5.85	0.000	-5.39 (-7.23, -3.55)	0.000
	No	100.15(15.24)				

1. Adjusted for age and gender
2. Adjusted for age, gender, neighbourhood and SE index

Table 5.6: Relationship between combination of stunting and underweight, and PDI

	% (n)	Mean PDI (SD)[1]	Adjusted Mean difference (95% CI)[1]	P-value	Adjusted Mean difference (95% CI)[2]	P-value
Stunted & Underweight	22.8 (278)	87.71 (15.83)	-12.26 (-14.51, 1.15)	0.000	-9.69 (-11.99,-7.40)	0.000
Stunted but not Underweight	17.1 (208)	94.69 (15.99)	-5.29 (-7.81, -2.76)	0.000	-3.92 (-6.41,-1.44)	0.002
Not Stunted but Underweight	8.1 (99)	96.36 (15.85)	-3.62 (-6.96, -0.27)	0.057	-1.84 (-5.15,1.46)	0.273
Neither Stunted nor underweight	52.0 (634)	99.97 (15.86)	0			
p-value for trend				0.000		0.000

1. Adjusted for age and gender,
2. Adjusted for age, gender, neighbourhood, and SE index

Table 5.7: Mean PDI by various combined Index of anthropometric failure

	% (n)	Mean PDI (SD)	Mean difference (95% CI)1	P-value	Adjusted Mean difference (95% CI)[2]	P-value
Stunted + Underwt + Wasted	7.6 (93)	86.40 (17.68)	-13.49 (-16.95, -10.03)	0.000	-10.61 (-14.06, -7.15)	0.000
Stunted + Underwt	15.2 (185)	88.02 (17.61	-11.71 (-14.34, -9.08)	0.000	-9.14 (-11.79, -6.48)	0.000
Underwt only	2.0 (24)	93.92 (13.91)	-7.17 (-13.63, -0.71)	0.030	-4.91 (-11.24, 1.42)	0.128
Stunted only	17.1(208)	94.05 (15.36)	-5.31(-7.86, -2.77)	0.000	-3.85 (-6.36, -1.35)	0.003
Underwt + Wasted	6.2 (75)	97.89 (16.0)	-2.58 (-6.38, 1.22)	0.183	-0.78 (-4.52, 2.96)	0.682
Wasted only	4.3 (53)	100.62 (14.61)	2.29 (-5.25, 3.74)	0.740	0.80 (-3.59, 5.19)	0.721
Normal	47.7 (581)	100.15 (15.24)				

Adjusted for age and gender

1. Adjusted for age, gender, SE index, and neighbourhood

Table 5.8: Relationship between PDI and Nutritional status

	Adjusted Mean difference/increment in z scores	
	(95% CI)[1]	**P-value**
Height for Age z score > -2.01	2.07 (0.82, 3.32)	0.001
Weight for age z score > -2.01	3.15 (1.72, 4.58)	0.000
Weight for Height z score > -2.01	1.80 (0.52, 3.09)	0.006

[1] Adjusted for age, gender, and neighbourhood and SE index

Table 5.9: Relationship between PDI and birth weight

		n(%)	Mean PDI (SD)	Mean difference (95% CI)[1]	P-value	Adjusted mean difference (95% CI)[2]	P-value	Adjusted mean difference (95% CI)[3]	P-value
Low birth weight[4]	Yes	6.9 (86)	94.13 (18.13)	-4.21 (-7.88, -0.56)	.024	-3.41 (-6.83, 0.02)	0.051	-1.82 (-5.33,1.69,)	0.309
	No	45.7 (568)	98.39 (15.88)						

1. Adjusted for age and gender,
2. Adjusted for age, gender, SE index, and neighbourhood
3. Adjusted for age, gender, SE index, neighbourhood, stunted, underweight, and wasted
4. Sub sample 654 (52.6%)

Chapter Six

Role of Sensory Stimulation in the home environment on Growth and Psychomotor Development

6.1 Introduction

During first three years of life, brain development is a rapid process of interaction with the environment through sensory stimulation: arousing of the human bodily faculties by which the brain perceives outside stimuli i.e. audition, vision, olfactory, gustatory, tactile, or kinaesthetic. A normal infant starts its life with billions of neurons, and the quality and quantity of sensory stimulation affects their long-term development in 2 ways(227):

- With adequate sensory stimulation, neurons form quadrillions of inter-neuronal and neuromuscular synaptic connections, known as the "wiring of the brain" resulting in a more functional brain with optimal cognitive and psychomotor development.

- With insufficient sensory stimulation, unused neurons are discarded permanently. The process is known as the "sculpting of the brain" and over-pruning leads to compromised child development.

From an epidemiological perspective, sensory stimulation can be described as a systematic assessment of the physical, social, and emotional environments in which a child being cared for and nurtured. It is known to influence a wide range of developmental outcomes (245, 246). In this chapter, we focus on physical growth and psychomotor development as a consequence of sensory stimulation available at home.

Child growth and development occur in a context of interdependent influences of social environmental factors (247). The association between the socio-economic status of the family and sensory stimulation available in the home appears to be universal and cross-cultural (248-252). However, there is also strong evidence that every culture has its own specific set of expected competences from developing children (253, 254), consequently families create resources and opportunities to provide the sensory stimulation necessary for the achievement of these skills. Most of the cross-cultural literature on sensory stimulation is focussed on parental practices in developed countries with a special interest in either ethnic or on inner city vs. general urban differences in terms of child development (113, 118, 159, 255-258). On the other hand, for countries like Pakistan, exploration of rural/urban cultural differences is imperative; 67% of its population resides in rural neighbourhoods (259), which provide distinctively different community characteristics, expectations, and opportunities in terms of child development as compared to urban neighbourhoods (260).

In this chapter, we examine the concept of differential in quality and quantity of sensory stimulation by SE index and by rural urban neighbourhood. To the best of our knowledge, patterns of sensory stimulation in terms of rural urban differences have never been studied before.

Evidence on the role of sensory stimulation in the physical growth of children is inconsistent and limited (261, 262) mainly to few studies conducted on non-organic failure to thrive, a state of poor physical growth due to any non-specific cause other than illness or unavailability of food. It has been demonstrated that these children are less likely to be in an environment which has adequate psychosocial stimulation. In particular, their environment was characterized by a lack of organisation and predictability. Moreover, their caregivers were less

expressive in emotional and verbal response, and practised more restrictions and punishments (20, 263). However, most of these studies are marked by lack of generalizability mainly due to two limitations. Firstly, the condition under study represents only a small fraction of the undernourished children and secondly, they are usually facility based with very small sample sizes.

The International Child Development Steering Group has suggested in the Child Development Series of review articles recently published by The Lancet that inadequate sensory stimulation is the only established non-nutritional modifiable risk factor where the need for intervention is urgent especially in developing countries (24, 129). There is sufficient evidence to be conclusive that sensory stimulation affects cognitive development, but there is a scarcity of data as far as psychomotor development and its associated factors are concerned (20).

The role of sensory stimulation and nutrition on child development is of great interest among researchers. However, most of the research articles evaluate the major risk factors individually e.g. socio-economic status, sensory stimulation, nutrition, whereas in reality they act simultaneously in children most of the time and the risk is cumulative in nature (24, 264). The understanding is further complicated by scientific evidence that brain development is resistant to undernutrition provided the level of sensory stimulation of the child is adequate(265). However, it is difficult to isolate the effect of undernutrition from that of sensory stimulation, there are several attempts published, but still it is open to debate.

In general, epidemiological studies conducted in various parts of the world have shown that sensory stimulation and nutrition together positively influence cognitive development. A literature review conducted by Grantham-McGregor and Baker-Henningham found six studies demonstrating either concurrent or long-

term effects of sensory stimulation on successfully achieving better mental development among undernourished children (20). The association was significant across studies whether or not nutritional supplement was also given. Furthermore, the magnitude of the effect of sensory stimulation on cognitive development varied with the child's age.

However the role of sensory stimulation in motor development is inconsistent. A cluster randomized trial conducted in Jamaica found that enhancing parent's sensory stimulation skills for undernourished children improved on fine motor but not gross motor development. This trial included 139 children aged 9-30 months who were followed for 1 year and assessed on the Griffiths Mental Development Scales. This has two subscales relevant to motor development, assessing hand-eye coordination and loco-motor development, approximately indicative of fine and gross motor development respectively (266). The trial found that scores on fine motor development were on average 6.8 points (95% CI 2.4, 10.1) higher for the intervention group than the control group but no significant difference was observed in the gross motor development of the child (267). The assessment of the child's status was based on the general screening tool for child development and was not especially psychomotor focussed. In addition, the size of sample for this assessment was small. Therefore, it is important to be cautious in appraising the association between sensory stimulation and psychomotor development based on the relatively more specialized instrument such as BSID II. Also important is to evaluate how the nutritional status of the child affects this association.

6.2 Objectives

The conceptual framework of the thesis was given in figure 1.1, in chapter 4 we explored the role of socio-economic inequality and neighbourhood type on child development (blue arrows), and in chapter 5 we focussed on identifying the contribution of undernutrition in the pathways between these factors and psychomotor development (violet arrows). This chapter addresses the last element of our conceptual framework: the contribution of sensory stimulation in the home to early child growth and development, in the context of socio-economic differentials and rural urban differences (red arrows).

The specific objectives are:

V. To describe the levels of sensory stimulation in the home environment available to Pakistani children by age and gender.

VI. To assess whether the level of sensory stimulation in the home environment differs by socio-economic status and rural or urban neighbourhood type.

VII. To examine the contributions of Sensory stimulation in the home on
    a. Physical growth
    b. Psychomotor development

6.3 METHODOLOGY

The assessment of sensory stimulation available at home was based on Home Observation for Measurement of the Environment (HOME) inventory; its background, contents, psychometric properties, adaptation, and conduct details has been stated in section 3.7.4

Statistical analysis

First, reliability of the HOME scale is assessed using Cronbach's α, a coefficient of internal consistency for psychometric instruments. It measures the extent to which test items in a scale are measuring a single phenomenon or a latent construct. Cronbach's alpha is in the range zero to one, and increases when the correlations between the items increase; the higher the value, the better the reliability.

Then HOME scores (total and subscales) are presented by age and gender; differences were tested using multivariate linear regression and students t-test and ANOVA.

Fours sets of multiple linear regressions were carried out:

The first set assesses differences in mean HOME scores (total and subscales)

- By age and by gender
- Between rural and urban neighbourhoods
- Between socio-economic quintiles

In the second set the outcome was PD index scores with HOME (total and subscales) as an exposure and models fitted with adjustment for:

- Age and gender
- Age, gender, SE index, and neighbourhood

The third set assess the anthropometric indicators with HOME (total and subscales) as an exposure, the models were fitted with adjustment for:

- Age, gender, SE index, and neighbourhood

In the final set the outcome was PD index scores with HOME total scores grouped into quintiles and models fitted with adjustment for:

- Age, gender, SE index, neighbourhood, and undernutrition

6.4 Results

6.4.1 Mean HOME scores by age and gender, and their reliability

The average HOME inventory score was 26.90 in our study sample out of a possible total of 45 (table 6.1). Children were receiving on average about 60% of the ideal level of sensory stimulation. The achievement on HOME subscales was uneven; the highest percentage scores were attained in the Parental Responsitivity and Acceptance subscales both (77%), while the lowest score was obtained in the Learning Material subscale (34%).

Cronbach's α for total HOME inventory scores was 0.86, representing high internal consistency reliability of the measurements. The values for each subscale ranged from 0.5 to 0.85, as can also be seen in table 6.1.

The sensory stimulation available at home significantly increased with age i.e. the overall total HOME scores increased from an average of 24.9 in the first year to an average 28.8 in the third year of life, a relative change of 15.5% (p value for trend < 0.0001) as shown in table 6.2. Similar increasing trends were observed for each subscale (p value < 0.0001), except for the Acceptance subscale which assesses the extent to which parents accept less than optimal child behaviour; this decreased with advancing age of the child (p value for trend = 0.024).

Although the mean HOME total and subscale scores were persistently higher for female than for male children (table 6.3), these differences were not statistically significant.

6.4.2 Level of sensory stimulation in the home by socio-economic status and rural urban neighbourhood

In general, children of higher socio-economic status were more likely to have better sensory stimulation available at home (table 6.4) and this was true for both urban and

rural neighbourhoods (p value for trend < 0.0001). On average HOME scores were increased by 48% in rural areas and by 37% in urban areas in the highest socio-economic group as compared to the lowest one. In contrast, sensory stimulation was only marginally higher in urban areas for each SE index quintile, and the difference was not statistically significant. This is illustrated in figure 6.1 which also shows mean HOME scores by SE index and neighbourhood for each subscale.

There is a similar increasing trend with SE index irrespective of neighbourhood for all of the subscales, except for the Acceptance subscale. The latter shows a very small and non-significant decrease with SE index, p value = 0.715 (table 6.5). The highest differential with SE index was observed in Learning Materials i.e. availability of age appropriate play and learning materials; mean scores were about 500% higher for children from the highest socio-economic group as compared to the lowest one.

Overall mean HOME inventory scores were 19% higher for urban than for rural areas. The difference is largely due to differences in the Responsivity, Learning material and Parental involvement subscales (table 6.6). Mean subscales scores for Organization and Variety of experience were higher in urban areas but these differences were not significant after controlling for SE index. In contrast, parents in rural areas on average showed more Acceptance of the child behaviours than those in urban families. In order to provide an overview of the difference in actual practices within each sensory stimulation domain, Appendix 6.1 gives a detailed item by item comparison of the HOME inventory between urban and rural areas.

6.4.3 Impact of sensory stimulation in the home on psychomotor development

Variation in the levels of psychomotor status by sensory stimulation has been depicted in scatter diagrams with regression lines in figure 6.2. PD index shows a significant positive trend with increase in HOME and subscales scores, except for the Acceptance subscales (p value = 0.94).

Table 6.7 shows that overall age and gender adjusted PD index is increased by 0.73 units with every unit increase in HOME inventory score. This was reduced to 0.47 units after additionally adjustment for SE index and neighbourhood. A similar pattern was observed for all the HOME subscales for example the PD index is increased by 1.02 with every increase in Responsitivity irrespective of SE index and neighbourhood. However, no association was observed between the Acceptance subscale and PD index.

After adjusting HOME subscales for each other as well as age, gender, SE index, and neighbourhood the only subscales significantly associated with psychomotor development remaining were Parental responsivity and Organisation of the environment. PD index is increased by 0.83 units with every unit increase in Parental involvement after controlling for other HOME subscales, SE index and neighbourhood.

6.4.4 Relationship between sensory stimulation in the home and growth

Overall HOME scores were significantly associated with stunting and underweight (table 6.8) e.g. mean total HOME scores were 1.30 units lower among stunted children (p value<0.001). Among its subscales, Responsivity, Organization, Learning material, Parental involvement, and Variety of experience were significantly associated with stunting, while Organization and Learning material were associated with being underweight. Neither HOME total scores nor its subscales were significantly associated with wasting.

The association of the Combine Index of Anthropometric Failure (CIAF) with sensory stimulation has been summarised in table 6.9. As compared to a well-nourished child, HOME scores decreases by 1.76 units provided the child is stunted, underweight and wasted concurrently. While it decreases to 1.68 units provided the child is both stunted and underweight simultaneously. The rest of the anthropometric indicators and their combinations were not significantly associated with HOME total scores. Table 6.9 shows that there is a subgroup of children who are both stunted and underweight that is in

homes with less sensory stimulation. It is this subgroup that contributes the bulk of the overall lower mean HOME scores of stunted children in table 6.8.

6.4.5 Nutrition as a mediator between HOME and PD index

The association of sensory stimulation with psychomotor development of the child even after controlling for the other strong predictors has been summarized in table 6.10. HOME scores (0–45) are categorized into quintiles in this analysis. The mean psychomotor scores of the child decrease with decreases in the availability of sensory stimulation at home (p value for trend <0.001). The association between PD index and sensory stimulation status becomes attenuated but remains significant even after controlling for SE index and neighbourhood. The mean difference of psychomotor score is 8.2 units between highest and lowest HOME quintiles. In addition, the association remained significant even when anthropometric indicators were introduced into the model (p value for trend <0.001), the mean PD index difference between highest and lowest HOME quintiles is 7.15 units. This highlights the fact that HOME is a significant predictor of PD index even after controlling for neighbourhood type, socio-economic status, and nutrition.

6.5 Discussion

6.5.1 Summary of Key Findings:

- On average, our study households provided 60% of the ideal sensory stimulation on the HOME inventory.

- No statistically significant difference was found in the provision of a sensory stimulating environment between male and female children. However, a relative increase of 15.5% was observed in the mean total HOME scores from the first to the third year of life (p value < 0.001).

- The amount of sensory stimulation available at home significantly increased with the socio-economic status of the child (p value < 0.001). Rural homes were significantly devoid of sensory stimulation, compared to their urban counterparts but this was largely due to differences in socio-economic status between them.

- The amount of sensory stimulation is a significant associated factor with stunting and being underweight, even after controlling for age, gender, neighbourhood, and socio-economic factors.

- The amount of sensory stimulation was significantly associated with the psychomotor development of children over and above the combined contribution of age, gender, neighbourhood, socio-economic, and growth status. Primarily sensory stimulation influenced psychomotor development directly and it mediated marginally via growth status.

6.5.2 Sensory Stimulation Status of the Children

Overall, the mean HOME score was 26.90 or 60%, which changed significantly with age, socio-economic status, and neighbourhood type. It increased from 55% in the first year of life to 64% in the third year of life, 50% in the lowest SE status to 74% in the highest SE status, and 55% in rural to 65% among urban dwellers.

Most of the HOME estimates from developing countries are based on small-scale studies. For example Ahoud (268) reported a mean HOME score of 63% based on 159 children from rural Bangladesh. Similarly, 64% sensory stimulation was observed among young rural Thai children (269). Apart from the studies from developing countries, estimates from North America are of particular interest; because the HOME inventory was originally developed there, it is more likely to represent child-rearing indicators that closely match their cultural practices. Therefore, sometimes estimates from this population are informally considered as a reference for comparison with studies from the other cultures. In a cross-cultural study from North America, HOME estimates ranged from 81% for Seattle (Washington), 78% Hamilton Ontario Canada, to 62% for Chapel Hill, North Carolina (105).

HOME has been used throughout the world and some adaptive modifications are always assumed to accommodate local cultural differences. However, despite the variation in HOME estimates the correlations between HOME and child competences are universally found. Our study estimates are similar to estimates from the developing and developed countries and unlikely to be attributable to modifications made as we have kept the original inventory items intact and only extra hints were added for the data collectors to make them culturally relevant.

According to John U Oghu (270), child rearing practices in resource scarce societies are more survival oriented. In order to achieve basic child sustenance their primary focus is to shift the child from distress to a state of contentment. As a result, caregivers are physically more responsive, showing abundant warmth and affection to the extent that sometime it could even result in inconsistent demands in child discipline and obedience. On the other hand well resourced societies are relatively more oriented towards optimal child development. Their main purpose is to shift the child from the state of contentment to a state of happiness and thriving well. As a result, caregivers are more inclined towards the provision of age appropriate stimuli, play and independence (271). For example, as compared to developed countries, there is a prevalent tradition in developing countries to physically carry the baby and share the bed with the mother for an extended phase in infancy. In general, the patterns of HOME inventory subscales in our study are very much congruent to the survival model of resource scarce societies. In our study, maximum sensory stimulation was observed in the Responsivity and Acceptance subscales and minimum in the provision of age appropriate toys and other learning materials.

Research about child rearing often reports differential parental practices with male and female children. However, it is not fully established whether that gender differential results in gender bias in child development. Bradley & Caldwell have shown that HOME scores are not different for male and female children, and subsequently there is no significant contribution of gender in terms of relationship between HOME and IQ of the child (272). Garrett et al. have further concluded that gender differences do not manifest during early childhood and possibly may manifest when children are relatively grown up (273). Our study findings point in the same direction, as no statistically significant differences were found in HOME and its subscales with respect to gender.

6.5.3 Determinants of Sensory Stimulation available at home

Evan has pointed out in a literature review on the role of poverty on early childhood development that socio-economic status is not a single variable entity, rather it is combination of multiple precarious conditions in the child's environment, which have a detrimental effect on the child's health and subsequently on their developmental outcomes (12). Garret et al. have explored the relationship between socio-economic status and HOME (246); their analysis was carried out on the National Longitudinal Survey of Youth data (NLSY _USA) on a sample consisting of 1,887 children. They tried various combinations of socio-economic variables statistically modelled to predict HOME scores. It was concluded that that no single variable alone can predominantly predict HOME scores, rather it is always a combination of different socio-economic variables that is able to better predict the variability in the sensory stimulation available at HOME. Under the same premise use of SE index seems a valid option in our study as it contains most of the important socio-economic factors relevant for the child's home environment. We found that socio-economic status and HOME are strongly linked and furthermore that HOME is strongly associated with child development across all socio-economic strata. Our findings correspond with the Kohn hypothesis about parenting behaviour that the higher the parents socio-economic status, the more likely they value child development, and provide stimulation and freedom to explore (274). To the best of our understanding, HOME inventory has been used only once in a research study in Pakistan. Masud et al. used it on fifty 4 to 6 six year old children from urban families; they also found a strong association of socio-economic characteristics with HOME scores (275).

Our study is the first attempt to delineate the differences between rural and urban neighbourhoods. In the child development discipline, understanding of the context

is always emphasized, especially it is postulated that the relationship between sensory stimulation and child competencies might be mediated by the contextual effects of the neighbourhood. In our study setting rural urban neighbourhood is an important context. It has been found that overall rural households have less sensory stimulation available for child development than in urban areas e.g. caregivers lack encouragement on child's developmental achievements, avoid disciplinary constrains, create less expectations for mature behaviours and fail to provide age appropriate learning materials. It is important to highlight differences in various sensory stimulation domains between rural and urban neighbourhoods are small but significant, and are independent of the socio-economic status of the child. It certainly highlights the distinct life styles, beliefs, and cultural practices of rural and urban dwellers.

6.5.4 Sensory Stimulation and Physical Growth

HOME is known to be associated with the malnutrition status of children (276). In our study we have also found that undernutrition specifically stunting and being underweight are significantly associated with HOME irrespective of socio-economic status. Similarly, a study conducted among two Indonesian tribes found that in the tribe which had the relatively lower prevalence of undernutrition, HOME scores were significantly associated with stunting and being underweight, whereas in the other tribe which had relatively higher prevalence of undernutrition, HOME scores were associated with all three anthropometric indicators (262). This shows that association between sensory stimulation and growth status might be affected by population characteristics and levels of undernutrition.

It is important to mention here that attempts to influence physical growth by enhancing sensory stimulation have been somewhat successful in clinical settings but no successful results exist at community level. A randomized controlled trial

conducted under the Bangladesh Integrated Nutrition Program included nutrition supplement and sensory stimulation through weekly home visits for a year for undernourished children. At the end, there was no significant improvement in the nutritional status of the malnourished children (261). These results raise several issues including better conceptualisation of the psychosocial contents for the interventions and identification of the best possible mode of delivery of such interventions at community/household level.

Furthermore, it requires more detailed understanding of the exact domains of sensory stimulation relevant to the type of undernutrition. Our study expanded this understanding by identifying the pathways of sensory stimulation which can be helpful in ameliorating the undernutrition status of the child. Being underweight is significantly associated with the Responsivity, Organization, and Learning materials subscales. In addition to these, stunting is also associated with the Variety subscale. Such understanding would be helpful in designing the interventions to precisely target the psychosocial needs of undernourished children.

6.5.5 Sensory Stimulation and Psychomotor Development

We have already established in chapter 4 that SE index is strongly related to the PD index and in chapter 5 we discussed the mediatory role of nutritional status. In this chapter we conceptualized and examined the role of sensory stimulation by considering two pathways for their effects on PD index. First sensory stimulation directly influencing the PD index and second it indirectly intervenes through its effect on nutritional interventions.

We have found that psychomotor development increases with the increase in sensory stimulation at home, irrespective of socio-economic status and

neighbourhood. The specific pathways which are associated with the psychomotor development include the Responsivity, Acceptance, Learning material, and Parental Involvement subscales while the Variety subscale was marginally significant. A similar association is supported by the literature. For example, a study conducted in Temuco, Chile found that HOME scores were a strong predictor of the psychomotor development of preschool children even after adjustment for socio-economic status (277).

The studies ascertaining the association between sensory stimulation and growth, and psychomotor development are relatively limited and our finding is congruent with the evidence provided from these studies that HOME influence on the PD index is also mediated by the undernutrition status of the child. The intervention studies conducted in different regions of the world have found that sensory stimulation is an important component in the improvement of the developmental status of undernourished children. Eickmann et al. have demonstrated in a field trial that provision of sensory stimulation through home visits for 5 months on average improves the PD index among young children by 8 points in an urban Brazil setting (278). The effect of sensory stimulation is not just limited to the psychomotor development of children. Plenty of literature is available establishing the relationship between sensory stimulation and various child development outcomes. Primarily these studies have demonstrated that psychosocial stimulation can prevent the delay in cognitive development in diverse settings (208, 279-283). The scientific evidence also suggests that sensory stimulation during early childhood has long term effects on nearly all domains of human development. For example, Walker et al. have conducted a clinical intervention by providing sensory stimulation and nutritional supplement for 2 years to stunted vs. non-stunted children identified at the age of 9-24 months. Although no link was observed between nutritional supplement and child developmental outcomes during adolescence, strong associations have been found

between sensory stimulation and numerous positive emotional outcomes at late adolescence including higher self-esteem, fewer attention problems, less anxiety and depression (284). In addition, they had no cognitive or educational deficits during early and late adolescence, which otherwise would have been expected among stunted children (8). There is also some evidence that impact of micronutrient intake on child development is enhanced by simultaneous provision of sensory stimulation to the malnourished children (24).

6.5.6 Strengths and Limitations

- In general, reliability estimates of the psychometric measurements are assessed in three ways; test-retest reliability, inter-rater reliability and internal consistency reliability. In our study, internal consistency of HOME measurements was estimated using Cronbach's Alpha coefficient. According to the Elardo, the internal consistency of HOME total scores at the time of its validation was 0.89 and for the individual subscales it ranged from 0.44 – 0.89 (114). In our study, Cronbach's Alpha values are quite close to the original test values demonstrating a high quality of study observations.

- As part of quality control measures, test-retest and inter-rater variability was repeatedly assessed among trainees during the training. Workers were declared eligible for data collection provided they achieved a reliability of at least 0.8. During data collection, measurements were carried out at home, and any prolonged assessment or multiple visits were ruled out to avoid inconvenience for the family. However, to ensure the quality of the assessment, HOME measurements were carried out by a team of two field workers and team members were reshuffled regularly. One hour of refresher training was scheduled on a weekly basis in which mock assessments were carried out and challenges faced during data collection were discussed with the

principle investigators. Furthermore, field supervisor directly observed at least 20% of assessments on a regular basis. At the end of the assessment the supervisor shared her feedback with the examiners.

- The Isolation Hypothesis is one of the important alternative explanations to our findings. Undernourished children due to their physical frailty and younger physical stature are less likely to generate age appropriate expectations and opportunities of sensory stimulation from their caregivers (231, 285). In addition, they are considered less active, clingy, and more dependent on their caregivers, and therefore less likely to explore their surroundings (286). In other words, it is hypothesized that poor physical growth leads to a fall in the availability of sensory stimulation in these children. Our study certainly is not able to tease out the direction of this association between undernutrition, sensory stimulation, and psychomotor development. The best possible way to test the social isolation hypothesis is through a longitudinal study design.

- Another important aspect could be variation in capacity for processing the available sensory stimulation at the brain level of a malnourished child. This information is vital to understand the mechanism and to determine the level of sensory stimulation required to achieve optimal child development. Nevertheless, this aspect of child development research falls into the domain of neuroscience research rather than epidemiological research.

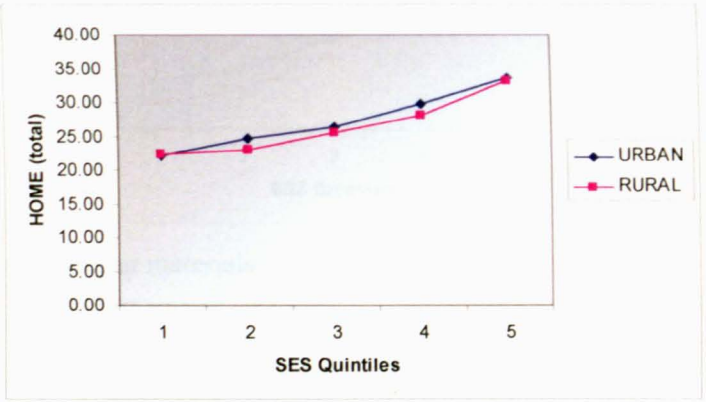
- Maternal mental health is known to influence HOME scores (287), apart from its established association with the growth and development of the child. The control of this confounder was beyond the scope of our study.

- Social desirability bias in the HOME assessment cannot be ruled out as it is possible that caregivers might have tried to seek some level of social acceptance in their responses during the interview. It could have resulted in some degree of distortion in the attitude and practise observation, but on a positive note it would show that the caregiver had the knowledge of what was appropriate care giving.

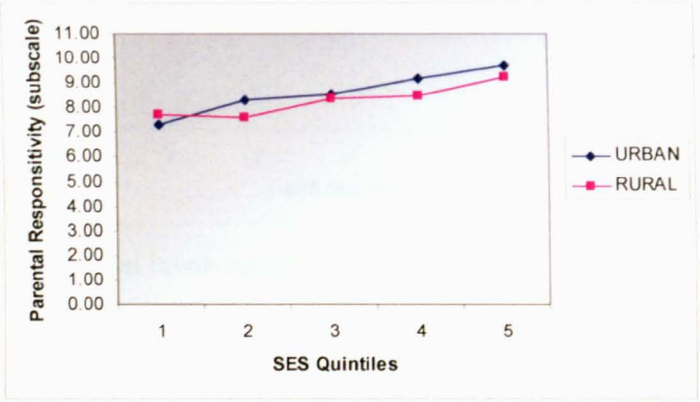
- There are certain limitations, which are inherent to the HOME inventory:

  - Individual items are assessed on a binary scale and it is therefore impossible to capture the extent of the specific phenomenon, for example severity of physical punishment.
  - The Acceptance subscale is known to act differently in certain contexts. Therefore, sometime it is advised not to interpret it separately but only as part of the complete HOME inventory.
  - HOME is also criticized for being based on western child rearing ideologies and theories, and is an expression of the standards of white middle class families. Therefore, it is possible that in every new context, HOME will have a different distribution of psychometric values, and has a different spectrum of its subscales related to a specific child competency. However, its successful cross-cultural use and association with child outcomes worldwide is a reflection of the universal appeal of the HOME inventory. In addition, local adaptive changes and quality control measures are always recommended in every setting (288).

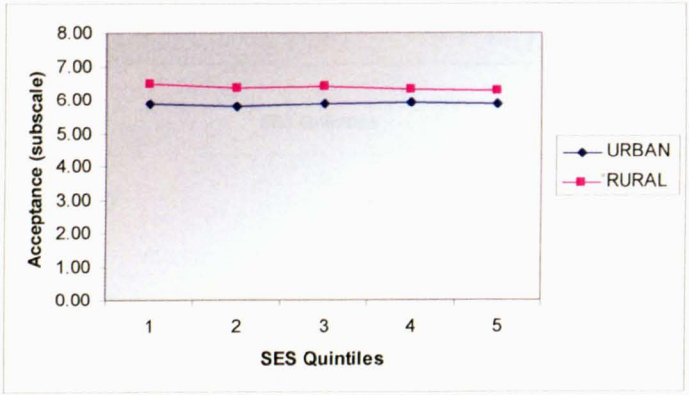
Figure 6.1: Variation in HOME and its subscales according to SE index by neighbourhood



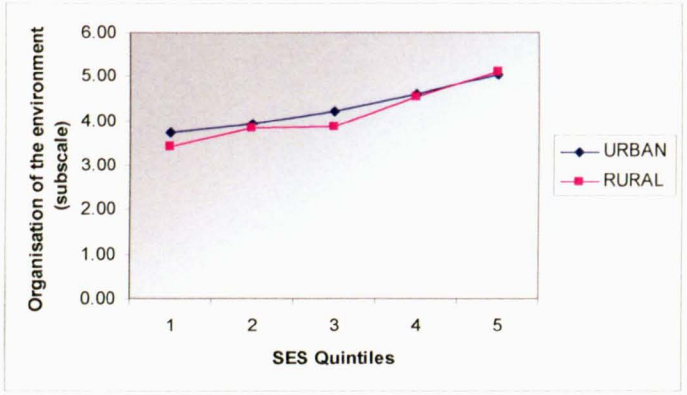
a) HOME



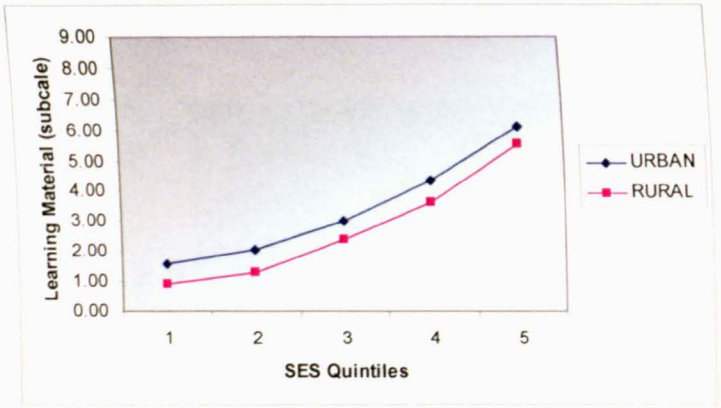
b) Responsivity



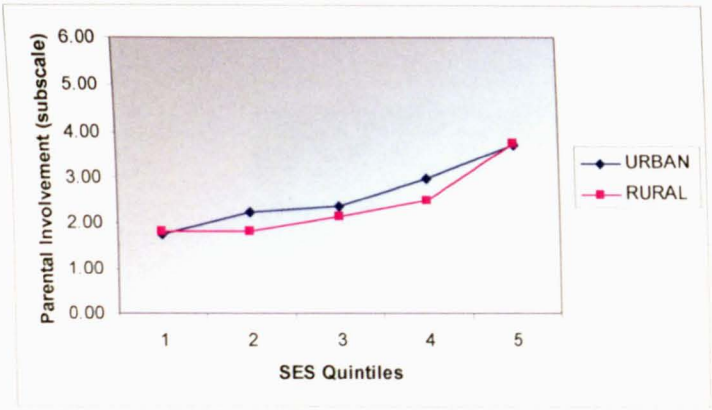
c) Acceptance



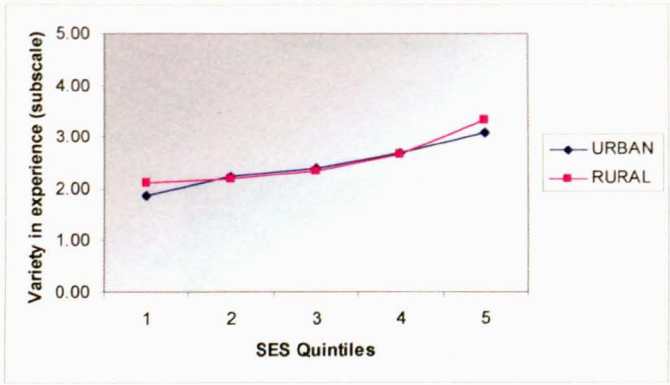
d) Organization



e) Learning materials

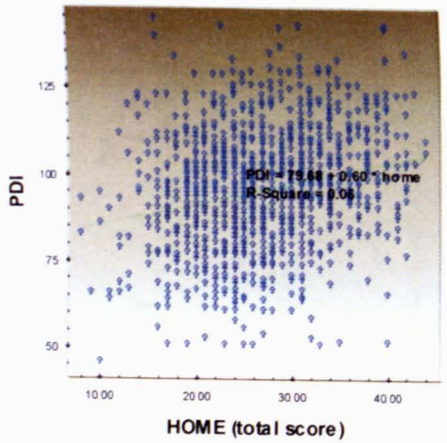


f) Parental involvement

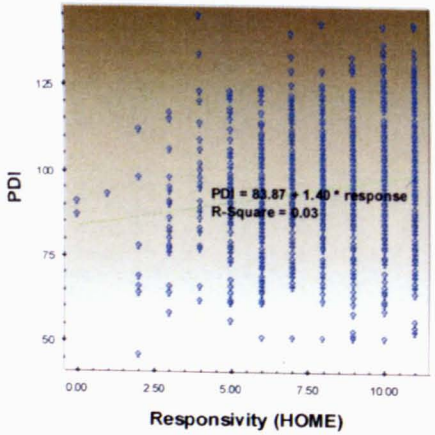


g) Variety

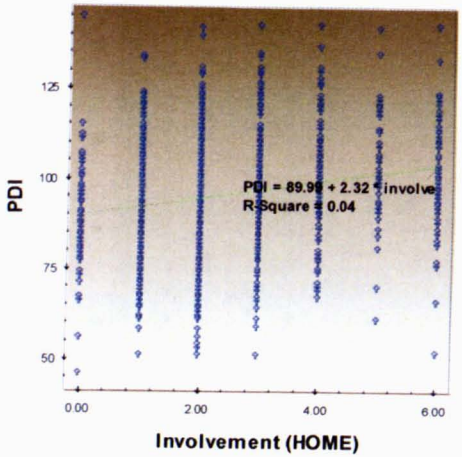
Figure 6.2: Scatter diagrams of HOME inventory and its subscales by PDI



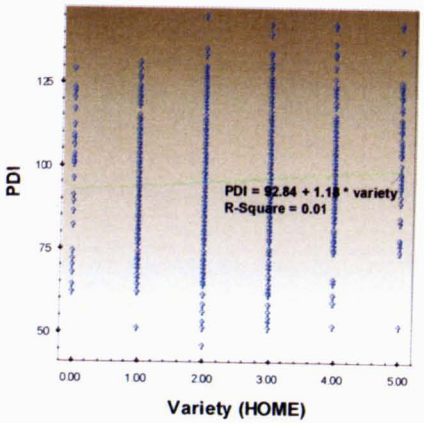
a)



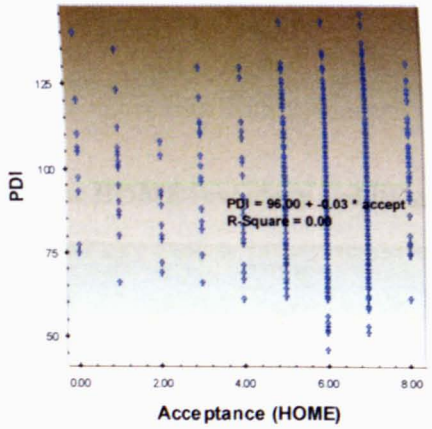
b)



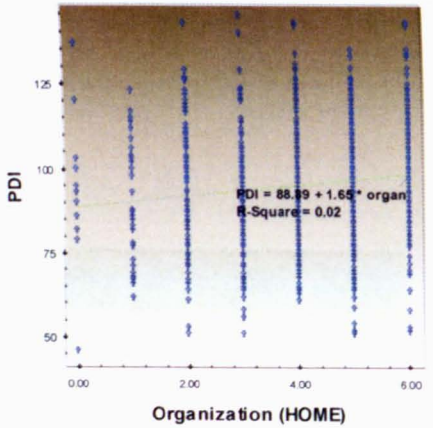
c)



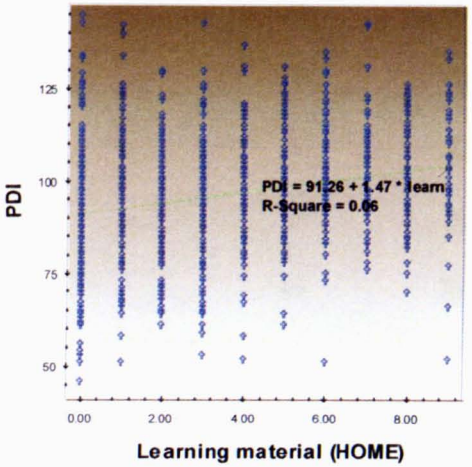
d)


PDI
125
100
75
50
PDI = 96.00 + -0.03 * accept
R-Square = 0.00
0.00
2.00
4.00
6.00
8.00
Acceptance (HOME)

e)


PDI
125
100
75
50
PDI = 88.89 + 1.65 * organ
R-Square = 0.02
0.00
2.00
4.00
6.00
Organization (HOME)

f)


PDI
125
100
75
50
PDI = 91.26 + 1.47 * learn
R-Square = 0.06
0.00
2.00
4.00
6.00
8.00
Learning material (HOME)

g)

Table 6.1: Reliability of the HOME inventory and its subscales

HOME inventory	No of Items	Mean (SD)	% score	Cronbach's α	Cronbach's α Standardized
Responsivity	11	8.51 (2.16)	77.36	0.71	0.73
Acceptance	8	6.13 (1.25)	76.63	0.47	0.70
Organization	6	4.20 (1.33)	70.0	0.47	0.50
Learning material	9	3.08 (2.77)	34.22	0.85	0.85
Parental Involvement	6	2.50 (1.51)	41.67	0.71	0.71
Variety	5	2.49 (1.10)	49.80	0.47	0.47
HOME (total score)	45	26.90 (6.75)	59.78	0.86	0.86

Table 6.2: Mean (SD) of sensory stimulation by child's age in Years

HOME inventory	1st year	2nd Year	3rd Year	P-value for trend
	Mean (SD)	Mean (SD)	Mean (SD)	
Responsivity	7.99 (2.14)	8.66 (2.12)	9.00 (2.09)	0.000
Acceptance	6.25 (1.29)	6.06 (1.19)	6.05 (1.26	0.024
Organization	3.82 (1.44)	4.28 (1.26)	4.60 (1.12)	0.000
Learning material	2.62 (2.63)	3.32 (2.77)	3.40 (2.86)	0.000
Parental Involvement	2.19 (1.40)	2.61 (1.50)	2.77 (1.60)	0.000
Variety	2.04 (0.93)	2.61 (1.03)	2.93 (1.20)	0.000
HOME (total score)	24.90 (6.46)	27.54 (6.49)	28.75 (6.82)	0.000

Table 6.3: Mean (SD) of sensory stimulation by gender of the child

HOME inventory	Female	Male	P-value
	Mean (SD)	Mean (SD)	
Responsivity	8.59 (2.14)	8.44 (2.18)	0.242
Acceptance	6.17 (1.27)	6.09 (1.23)	0.236
Organization	4.25 (1.33)	4.16 (1.34)	0.247
Learning material	3.10 (2.85)	3.08 (2.69)	0.920
Parental Involvement	2.57 (1.57)	2.44 (1.46)	0.133
Variety	2.51 (1.17)	2.47 (1.04)	0.434
HOME (total score)	27.17 (6.94)	26.66 (6.57)	0.180

Table 6.4: Mean (SD) of sensory stimulation by socioeconomic status and rural urban neighbourhood

	Quintile I	Quintile II	Quintile III	Quintile IV	Quintile V	P-value [1]
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Rural	22.44 (4.50)	23.04 (5.12)	25.52 (6.13)	28.11 (5.41)	33.21 (5.98)	0.00
Urban	24.54 (5.93)	24.59 (5.02)	26.42 (6.08)	29.71 (5.78)	33.51 (5.65)	0.00
P-value [1]	0.19	0.07	0.79	0.10	0.58	0.03 [2]

1. Adjusted for age and gender
2. P value for overall rural urban difference, adjusted for age, gender and SE index

Table 6.5: Mean (SD) of sensory stimulation by socioeconomic status

HOME inventory	Quintile I	Quintile II	Quintile III	Quintile IV	Quintile V	P-value [1]	P-value [2]
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
Responsivity	7.64 (2.28)	7.85 (2.36)	8.47 (2.20)	8.96 (1.83)	9.63 (1.48)	0.000	0.000
Acceptance	6.36 (0.98)	6.15 (1.18)	6.12 (1.31)	6.05 (1.24)	5.94 (1.47)	0.000	0.715
Organization	3.47 (1.29)	3.87 (1.26)	4.05 (1.39)	4.58 (1.09)	5.04 (0.99)	0.000	0.000
Learning material	1.02 (1.33)	1.56 (1.68)	2.72 (2.43)	4.11 (2.56)	6.05 (2.19)	0.000	0.000
Parental Involvement	1.81 (1.05)	1.96 (1.11)	2.24 (1.37)	2.80 (1.49)	3.70 (1.64)	0.000	0.000
Variety	2.08 (0.97)	2.20 (0.93)	2.37 (1.14)	2.68 (1.04)	3.12 (1.11)	0.000	0.000
HOME (total score)	22.38 (4.46)	23.57 (5.13)	25.98 (6.11)	29.19 (5.70)	33.47 (5.65)	0.000	0.000

1. Adjusted for age and gender
2. Adjusted for age, gender and neighbourhood

Table 6.6: Mean (SD) of sensory stimulation by rural urban neighbourhood

HOME inventory	Urban	Rural	P value[1]	P value [2]
	Mean (SD)	Mean (SD)		
Responsivity	9.00 (1.98)	8.00 (2.23)	0.000	0.015
Acceptance	5.88 (1.39)	6.38 (1.03)	0.000	0.000
Organization	4.53 (1.22)	3.86 (1.36)	0.000	0.108
Learning material	4.21 (2.76)	1.93 (2.25)	0.000	0.000
Parental Involvement	2.92 (1.62)	2.07 (1.25)	0.000	0.007
Variety	2.66 (1.11)	2.31 (1.07)	0.000	0.238
HOME (total score)	29.20 (6.71)	24.54 (5.93)	0.000	0.030

1. Adjusted for age and gender
2. Adjusted for age, gender and SE index

Table 6.7: Increase in PDI score associated with each unit increase of the HOME scores (total and subscales) as measured by linear regression

	Model A[1]		Model B[2]		Model C[3]	
Factors	**Regression coefficient (95% CI)**	**P-value**	**Regression coefficient (95% CI)**	**P-value**	**Regression coefficient (95% CI)**	**P-value**
Responsivity	1.69(1.26, 2.11)	0.000	1.02 (0.58, 1.46)	0.000	0.64(0.14, 1.13)	0.012
Acceptance	-0.16(-0.90, 0.58)	0.665	0.52 (-0.20, 1.24)	0.154	0.33(-0.39, 1.05)	0.366
Organization	2.20 (1.50, 2.91)	0.000	0.81(0.06, 1.56)	0.033	0.13(-0.66, 0.93)	0.743
Learning material	1.60(1.27, 1.92)	0.000	0.80 (0.38, 1.22)	0.000	0.41(-0.05, 0.88)	0.083
Parental Involvement	2.65(2.05, 3.25)	0.000	1.54 (0.89, 2.19)	0.000	0.83(0.05, 1.60)	0.037
Variety	2.17(1.29, 3.04)	0.000	0.84 (-0.06, 1.73)	0.067	0.02(-0.93, 0.97)	0.966
HOME (total score)	0.73(0.59, 0.86)	0.000	0.47(0.30, 0.63)	0.000		

1. Adjusted for age and gender
2. Adjusted for age, gender, SE index and neighbourhood
3. Adjusted for age, gender, SE index, neighbourhood and other HOME subscales

Table 6.8: Relationship of HOME and undernutrition

Factors	Stunted		Underweight		Wasted	
	Mean HOME difference [1] (95% CI)	P-value	Mean HOME difference [1] (95% CI)	P-value	Mean HOME difference [1] (95% CI)	P-value
Responsivity	-0.24 (-0.49, -0.01)	0.049	-0.171(-0.43, 0.08)	0.185	-0.08(-0.38, 0.22)	0.602
Acceptance	-0.013 (-0.16, 0.14)	0.864	0.04(-0.12, 0.19)	0.642	0.128(-0.05, 0.31)	0.165
Organization	-0.228(-0.37, -0.09)	0.002	-0.24 (-0.39, -0.09)	0.002	-0.06(-0.24, 0.12)	0.506
Learning material	-0.460(-0.71, -0.21)	0.000	-0.53(-0.79, -0.26)	0.000	-0.23(-0.54, 0.09)	0.154
Parental Involvement	-0.184 (-0.35, -0.02)	0.027	-0.08(-0.25, 0.09)	0.374	-0.154(-0.35, 0.05)	0.130
Variety	-0.169(-0.29, -0.05)	0.005	-0.06(-0.19, 0.06)	0.316	0.06(-0.08, 0.21)	0.393
HOME (total score)	-1.30 (-1.93, -0.66)	0.000	-1.04(-1.71, -0.38)	0.002	-0.33(-1.11, 0.46)	0.414

1. Adjusted for age, gender, SE index and neighborhood

Table 6.9: Mean HOME by Combined Index of Anthropometric Failure

	% (n)	Mean HOME (SD)	Mean HOME difference [1] (95% CI)	P-value	Adjusted Mean difference (95% CI) [2]	P-value
Stunted + underweight + wasted	7.6 (93)	23.88(6.21)	-4.68 (-6.17, -3.18)	0.000	-1.76 (-2.99, -0.52)	0.005
Stunted + underweight	15.2 (185)	24.54(5.54)	-4.02 (-5.12, -2.93)	0.000	-1.68 (-2.61, -0.76)	0.000
Underweight only	2.0 (24)	23.08 (7.44)	-5.48 (-8.31, -2.64)	0.000	-1.42 (-3.62,0.77)	0.204
Stunted only	17.1(208)	27.12(6.39)	-1.44 (-2.51, -0.36)	0.009	-0.76 (-1.62, 0.10)	0.084
Underweight + wasted	6.2 (75)	26.28(6.28)	-2.28 (-3.93, -0.63)	0.007	0.36 (-0.92, 1.64)	0.582
Wasted only	4.3 (53)	25.08(5.53)	-3.48 (-5.40, -1.56)	0.000	-0.47 (-1.98, 1.04)	0.541
Normal	47.7 (579)	28.56(6.92)				

1. Adjusted for age and gender
2. Adjusted for age, gender, SE index and neighbourhood

Table 6.10: Multivariate analysis of relationship between PDI, Undernutrition and HOME *(quintiles)*

HOME			Adjusted [1]		Adjusted [2]		Adjusted [2]	
(Quintiles)	No. (range of HOME scores)	Mean PDI (SD)	Mean PDI difference (95% CI)	P-value	Mean PDI difference (95% CI)	P-value	Mean PDI difference (95% CI)	P-value
I	285(8, 21)	91.04 (16.14)	-13.35(-16.20, -10.51)	0.000	-8.20 (-11.59, -4.82)	0.000	-7.68 (-11.07, -4.29)	0.000
II	258(22, 25)	93.21 (17.48)	-10.47 (-13.35, -7.59)	0.000	-6.23 (-9.55, -2.92)	0.000	-5.75 (-9.06, -2.44)	0.001
III	206(26, 28)	94.28 (16.66)	-8.82 (-11.84, -5.80)	0.000	-5.53 (-8.76, -2.30)	0.001	-5.34 (-8.56, -2.11)	0.001
IV	272(29, 33)	99.14 (15.70)	-3.49 (-6.32, -0.67)	0.015	-1.42 (-4.30, 1.47)	0.335	-1.42 (-4.29, 1.46)	0.334
V	221(34, 44)	102.15 (14.89)						
P-value for trend				0.000		0.000		0.000
Adjusted R^2			9.9%		12.7%		13.9%	

1. Adjusted for age and gender
2. Adjusted for age, gender, SE index and neighbourhood
3. Adjusted for age, gender, SE index, neighbourhood, stunted, underweight and wasted

Chapter Seven

Summary, Conclusions and Recommendations

7.1 Summary of the main findings:

- ***Age-gender patterns:*** The decrease in mean psychomotor development score with age together with increases in prevalence of undernutrition highlight the cumulative nature of growth and developmental delays. No overall gender differences were seen, except for stunting with boys having a higher overall level of stunting than girls.

- ***Determinants of psychomotor development:*** Socio-economic status, rural-urban environment, nutritional status, and sensory stimulation available at home were all strongly and independently associated with psychomotor development. Their relative contributions are explored in tables 7.1 to 7.5. Table 7.1 shows the percentage of variation in psychomotor development score attributed to each factor, considered separately, over and above the amount of variation explained by age and gender. Maximum variability is explained by HOME (8.2%) followed by Undernutrition (8.0%), SE index (7.4%) and Neighbourhood (5.9%). Stunting on its own explains more than three quarters of the variation explained by undernutrition: 6.3% of the 8.0%.

In Tables 7.2 to 7.5 factors are added to the basic model in the order determined by the conceptual framework, and relative contributions of other factors examined. Thus in Table 7.2, SE index has been added to the basic model. The variation attributable to rural urban neighbourhood decreased from

5.9% to 1.5 %, with SE index explaining 4.4% of the variation attributed to neighbourhood in Table 7.1; this is still strongly statistically significant. Percentage variations attributable to HOME and undernutrition were approximately halved.

Neighbourhood is added next to the basic model in Table 7.3 and 7.4, the combination explaining 10.9% variability in the PD index. The % variation attributable to undernutrition (Table 7.3) or to HOME (Table 7.4) is little changed; 3.7% compared to 3.9%, and 2.1% compared to 2.3% respectively, suggesting that the majority of the neighbourhood influence on psychomotor development is not through an effect on growth or on sensory stimulation in the home, when considering children of the same age, gender, and SE index.

Table 7.4 also examines the contributions from the individual subscales of the HOME score; maximum variability is explained by the responsivity, parental involvement (both 1.4%), and learning material (0.9%) subscales, while the acceptance subscale didn't contribute significantly to the PD index over and above the basic model .

Finally Table 7.5 examines the contribution of HOME over and above SE index, neighbourhood and undernutrition; this remained significant, accounting for 1.7% of the variability in the PD index.

- ***Determinants of undernutrition:*** SE index was strongly associated with all three indicators of undernutrition: stunting, being underweight and wasting. This is congruent with the scientific literature where malnutrition among children is termed as a social and economic phenomenon.

The combined contribution of SE index, age and gender to the variability of stunting is 10.8%, underweight 8.6%, and wasting 4.0%; in contrast to PD index, addition of neighbourhood doesn't make any difference to this contribution (Table 7.7).

Sensory stimulation available in the HOME was also strongly negatively associated with the risks of stunting and being underweight, but not of wasting - an acute condition exacerbated by illness episodes and lack of food.

- ***Growth and development status:*** These findings reaffirm the fact that growth status is strongly linked with the developmental status of the child. This link varies with the type and number of anthropometric indicators of undernutrition. Stunting and underweight, but not wasting, are strongly negatively associated with PD index with stunting having a larger negative effect than being underweight, and the simultaneous presence of both having a greater negative effect than either alone.

- ***Neighbourhood:*** Children in rural neighbourhoods have poorer psychomotor development than their counterparts in urban areas and this is not explained by socio-economic differences between them. In contrast higher rates of undernutrition observed among rural children are completely explained by these socio-economic differences. We can confidently conclude therefore that certain aspects of rural urban disparity go beyond differences in the socio-economic profiles of the two types of neighbourhoods with community characteristics and cultural aspects also contributing significantly to the variability of psychomotor development of young children.

- ***HOME:*** We can draw some noteworthy conclusions about sensory stimulation from our study. First, as only partial variability in HOME is explained by demographic and socio-economic factors, it establishes it as an independent entity influencing child development. Secondly, sensory stimulation influences psychomotor development in two ways; primarily it affects psychomotor development directly over and above the combined contribution of socio-economic status and rural or urban neighbourhood type. In addition, this effect is only marginally mediated via the nutritional status of the child.

7.2 Implications of study findings

7.2.1 Rural urban differences matter

- In our study, rural or urban neighbourhood type has been identified as a strong predictor of the child development status. The fact is that mean age-gender adjusted psychomotor scores are 4.0 to 4.5 points lower among rural children compared to their urban counterparts. This association is very robust with a 4 point difference in PD index maintained even when all the variables within the conceptual framework are included in the model (p value = 0.000).

- Another way of appreciating the rural urban contextual differential is to consider what it means in terms of developmental delays, as shown in Table 7.7. PD index has been grouped into normal, mild, severe and overall delayed psychomotor developed categories, on the basis of the normative standards of the BSID II (104). Overall 23.2% of the children in the study have delayed psychomotor development for their age with 6.9% severely delayed. These rates are higher among rural than urban children; the odds ratio (OR) for mild

delayed development adjusted for age, gender, and SE index is 1.66 and for severely delayed development 1.95, with an average OR of 1.74 overall. Furthermore, to assess the impact of neighbourhood on child development, Population Attributable Fractions (PAF %) have been calculated on the basis of adjusted Odds Ratio (OR) and the distribution of exposure among developmentally delayed children (289). On average, it is estimated that 21% of the overall delay in psychomotor status of child can be attributed to rural residential exposure (table 7.7). This means that the status of a significant portion of the developmentally delayed children residing in rural areas can be reverted to normal development, by providing them with an environment comparable to urban neighbourhoods, irrespective of their socio-economic inequalities. Note that influence of rural urban neighbourhood on PD index is in marked contrast to the pattern seen with growth where neighbourhood influence is not independent and is mediated by socio-economic status.

- To the best of our knowledge this is the first study which highlights the contextual effect of rural neighbourhood on child development. It has imperative policy, programmatic, and research ramifications.

- Important research questions are:
  - To explore whether such contextual differences exist in other settings so as to determine the universality of the phenomenon.
  - To estimate the burden of delayed development attributable to rural neighbourhoods.
  - To identify the specific processes which distinguish rural neighbourhoods from urban beyond socio-economic differences is imperative. Especially what is the nature of the community cohesion and social capital differences

with respect to neighbourhood during the early childhood phase? What are the existing recreational facilities and educational practises, and are they detrimental or promotive enough to create growth and developmental differences among rural verses urban children. Finally is there a differential in expectations of age appropriate growth developmental milestones by the caregivers, and how does it influence the availability of the essential resources, opportunities and sensory stimulation to the child. Answers to these questions would be essential to develop relevant policy and programme agendas.

- To conduct intervention research to test new strategies to promote child development that tackle the underlying differences inherent in the rural or urban neighbourhood.

- From a policy standpoint, the challenge of enhancing developmental outcomes among children is accentuated by the dynamics of the neighbourhoods (118, 290, 291). Within the same region or country, interventions of such nature require an adjustment for its rural-urban neighbourhoods. The neighbourhood represents a factor that is capable of modifying the susceptibility to environmental influences on child development. It is important for child focussed research and community developmental programmes to identify the magnitude and pattern of deprivations in rural areas.

- Child development research and initiatives require a much broader comprehensive approach which includes all the components of society and of lifestyle (292). Empirical evidence on child development with respect to geographic context would be valuable for formulating relevant health policies and implementing specific interventions on target populations. This will

eventually help to prevent the errors that occur in child survival strategies which results in widening the rural urban gap (134).

- For a developing country like Pakistan where the majority of the population are rural dwellers its research and public health agenda requires a strong reorientation towards the specific needs of the rural areas.

- In addition, emphasis on the progress of rural areas to improve child development and consequently human development would be vital from a policy and pragmatic point of view.

7.2.2 Addressing socio-economic challenges

- Socio-economic inequalities were found to be an overarching phenomenon, effecting early child growth and development. The difference between the lowest and highest SE quintiles were enormous; children from lower socio-economic status performed poorly.

- Age, gender, and neighbourhood adjusted mean PD index were 13 points lower for the lowest SE quintiles compared to the highest SE quintile, while mean adjusted HOME was 10 points lower. Similarly, the prevalence of stunting inflated from 13% in highest SE quintiles to 50% in lowest SE quintiles.

- These estimates lead to the fact that child growth and development initiative can be successful with overall uplifting of the community's social and economic status. Community development certainly leads to child

development and creates a virtuous cycle of human development. However such endeavours require simultaneous action on short and long term strategies: pro-poor intervention providing social, financial, and health safety nets is an immediate need for underdeveloped countries to prevent further damage to vulnerable children. However, economic reforms aimed to protect and provide support for poor countries can only ensure sustainable success if implemented on a long term basis.

7.2.3 Growth and Development are intertwined

- The study highlights that nutritional status is one of the key factors for child development, and delineates several fundamental conclusions. Our findings substantiate the existing scientific literature that socio-economic inequalities are strong determinants of the undernutrition of the child and the rural urban differentials in undernutrition are actually mediated through it. Similarly, it also validates the popular scientific belief that growth and development during the early childhood phase are linked; therefore it is important to characterize the nutritional status of children in order to assess their development status. Furthermore, any assessment of nutritional status based on a single anthropometric indicator will underestimate the undernutrition status of children; therefore, it is important to consider multiple indicators simultaneously to describe growth status adequately.

- The practical implication of a lack of association between low birth weight and psychomotor development due to mediation of its influence by postnatal growth status, suggests efforts to enhance child growth status can potentially

ameliorate any harmful influences of antenatal growth on psychomotor development.

- From a program and policy perspective, the study emphasizes the fact that undernutrition is a facet of poverty. Due to the strong association with socio-economic status, the level of child's growth and development can potentially be good indicators of the quality of life in a community. Any change in them can reflect on the progress or deterioration of the socio-economic status of the communities.

- Anthropometric assessment is a well recognized and widely practised strategy at population level to estimate child undernutrition and to identify the needs of undernourished groups (293). In practice, such needs are limited to provision of nutrients and treatment for infectious ailments. However, its association with psychomotor development is suggestive of the fact that among undernourished children there is likely to be a developmentally delayed group. Therefore, it is important to consider the developmental needs of undernourished children in public health programmes that targets improved child survival.

- In general, undernutrition is still alarmingly high and is a major public health challenge in most of the developing countries especially as it also impedes child development. With the existing public health programmatic initiatives, decreases in the rates of child undernutrition are remarkably slow in most of the countries (294). Furthermore the burden of undernutrition is leading to considerable increase in developmental delay. It is understandable that the

proportion of developmental delay is bound to rise in the near future, if preventive and promotive measures are not in place.

- With the new WHO growth standards, the relative increase in the estimates of stunting, wasting, and SAM among children is inevitable. This change has many potential consequences in terms of public health policy and resource management of nutrition programmes in a developing country setting. Internationally such concerns are raised and require immediate attention (295), for example SAM is an emergency situation which require immediate admission to therapeutic care programmes (187, 278). Despite the significant burden of SAM in developing countries, no relevant planning or growth monitoring programme is in place in these regions (296). The new WHO standards have resulted in an increase in SAM rates in excess of 100%. The challenge therein lies in providing additional resources while simultaneously implementing the new standards.

- Our study raises an important challenge for future research due to the lack of any observable association between birth weight and psychomotor development. Birth weight is known to be a proxy indicator of the intrauterine milieu of the foetus. However, it does not cover the comprehensive maternal experiences during pregnancy which might influence the development of child in later life. It is important to develop and validate foetal indicators, other than birth weight, which can be useful to identify comprehensive intrauterine nutritional and other foetal experiences with a potential to influence later growth and development.

- The association between child's growth and development is very significant but it is likely to be dependent on specific context. Apart from socio-economic conditions, it would be vital to conduct research upon the association in other contexts such as HIV epidemic, child labour, and children in difficult circumstances etc.

- Anthropometric indices measure health and nutritional status of children and predict their survival. Several analyses are available indicating that undernutrition significantly contributes towards child mortality and morbidities. However, the impact of nutrition on child development is a relatively less studied area as compared to child growth and survival. Concrete research efforts are required to further understand the underlying mechanisms and to assess the contributions of undernutrition in child development morbidities, in order to provide more comprehensive evidence for corrective public health initiatives for children.

7.2.4 Promoting Sensory Stimulation

- We believe that one of the major highlight of our study is the identification of the specific pathways (domains) of sensory stimulation which can affect child's growth and development. The summary is illustrated in figure 7.1 based on the analysis in chapter 6. It is imperative to state that sensory stimulation pathways are child outcome and context specific. This provides a reasonable framework and impetus to guide policy makers and ECD programmers of the type of sensory stimulation which would be relevant for their initiatives. It is also equally applicable for ECD researchers to expand on these finding and to explore the long term consequences.

- Overall, some important conclusions extracted from our findings are: Socio-economic stress negatively affects the quality of home environment possibly by limiting the physical resources and changing the family interactions. While, rural-urban neighbourhood provide different opportunities for being stimulated during early childhood, more likely due to differences in lifestyle, cultural values, beliefs, and practices. Above all it also proves the point that the quality of home environment cannot simply be reduced to socio-economic and neighbourhood characteristics only.

- Furthermore, there is convincing evidence that children raised in sensory enriched home environments have lower rates of undernutrition and psychomotor deficiencies. In addition, sensory stimulation has a significant effect on psychomotor development independent of the undernutrition status of the child.

- The lower levels of sensory stimulation to some extent highlights the lack of necessary information for child rearing at household and community level and has significant and urgent implications for ECD policy makers in developing countries.

- Despite the evidence that sensory stimulation is a significant determinant of growth and development; still its integration into child survival and developmental initiatives has a long way to go. Apart from the challenge of socio-political awareness and commitment, specific research related issues are:
  - Sensory stimulation is a collective term comprising various coherent conceptual domains. The usual trend of child development research for

developing countries is to enhance sensory stimulation through maternal responsivity or interactions primarily targeting the cognitive outcome; they are important components of sensory stimulation and interventions based on this approach certainly make sense in terms of practicality and logistics. However, our study shows that other conceptual domains of sensory stimulation also act as pathways in various combinations to achieve specific growth and development outcomes. In addition, these combinations are also context specific. Therefore, any generalization of the limited approach to achieve holistic child development would not be realistic; development and validation of comprehensive contents for sensory stimulation applicable to most of the development and growth indicators is the need of the time.

- Most of the research on sensory stimulation in developing countries is also limited from methodological perspective; either studies are small scale or focused on selective high risk groups such as low birth weight babies, ethnic minorities or hospital visiting or admitted children. Still, evidence of successful interventions to achieve optimal growth and development potentials for general underprivileged children for these countries does not exist and requires extensive further research.

- From a programmatic point of view, some interventions have been designed to assess modes of delivery of sensory stimulation as a means to enhance the status of caregiving such as training of the caregivers, counselling sessions during hospital visits or home visits by paraprofessionals. All of the strategies have shown some success but interestingly, numbers of home visits have also shown a dose response relationship with increase in HOME scores, which is a reflection of the fact that personal supervision and monitoring could be the key in enhancing

child caring practices. However the issue of planned exposure for these interventions is yet to be fully explored. This includes what would be the ideal professional profile of a home visitor, what is the optimal level of frequency of home visits and how much rigour required within each visit to achieve minimum effective threshold of sensory support needed to attain a desirable level of child development. Last but not the least, identification of the culturally appropriate child rearing practices which can successfully provide the maximum amount of sensory stimulation to the child and promotion of these practices through home visits.

Figure 7.1: Summary of HOME and its subscales associations

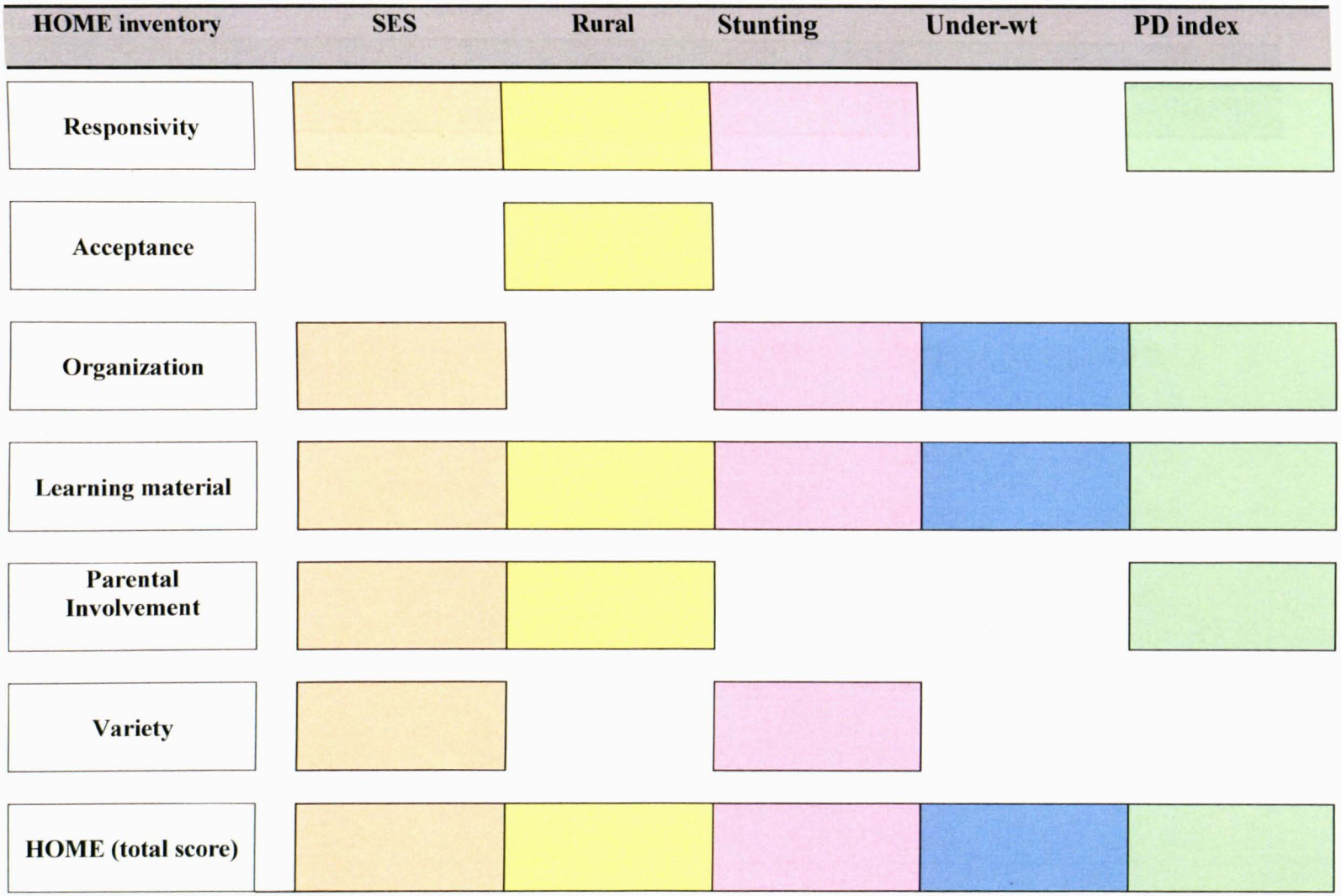


Table 7.1: Variation in PD index explained by neighbourhood, HOME and Undernutrition, over and above age, gender SE index

Factors	P value	Variation explained	Additional variation explained
Age + Gender	0.000	2.0%	
Age + Gender + **SE index**	0.000	9.4%	7.4%
Age + Gender + **Neighbourhood**	0.000	7.9%	5.9 %
Age + Gender + **HOME**	0.000	10.2%	8.2 %
Age + Gender + **Stunted**	0.000	8.3%	6.3 %
Age + Gender + **Under weight**	0.000	7.5%	5.5%
Age + Gender + **Stunted + Underweight + Wasted**	0.000	10.0%	8.0%

Table 7.2: Variation in PD index explained by factors over and above age, gender, and SE index

Factors	P value	Variation explained	Additional variation explained
Age + Gender + SE index	0.000	9.4%	
Age + Gender + SE index + **Neighbourhood**	0.000	10.9%	1.5 %
Age + Gender + SE index + **HOME**	0.000	11.7%	2.3 %
Age + Gender + SE index + **Stunted**	0.000	12.5%	3.1 %
Age + Gender + SE index + **Under weight**	0.000	11.6%	2.2%
Age + Gender + SE index + **Stunted + Underweight + Wasted**	0.000	13.3%	3.9%

Table 7.3: Variation in PD index explained by Undernutrition, over and above age, gender, SE index, and neighbourhood

Factors	P value	Variation explained	Additional Variation explained
Age + Gender + Neighbourhood + SE Index		10.9%	
Age + Gender + Neighbourhood + SE Index + **Stunted**	0.000	13.7%	2.8%
Age + Gender + Neighbourhood + SE Index + **Underweight**	0.000	13.0%	2.1%
Age + Gender + Neighbourhood + SE Index + **Stunted** + **Underweight** + **Wasted**	0.000	14.6%	3.7%

Table 7.4: Variation in PD index explained by HOME and its subscales

Factors	P value	Variation explained	Additional variation explained
Age + Gender + Neighbourhood + SE Index		10.9%	
Age + Gender + Neighbourhood + SE Index + **HOME**	0.00	13.0%	2.1%
Age + Gender + Neighbourhood + SE Index + **Responsivity**	0.00	12.3%	1.4%
Age + Gender + Neighbourhood + SE Index + **Acceptance**	0.16	11.0%	0.1%
Age + Gender + Neighbourhood + SE Index + **Organization**	0.04	11.2%	0.2%
Age+ Gender + Neighbourhood + SE Index + **Learning material**	0.00	11.8%	0.9%
Age+ Gender + Neighbourhood + SE Index + **Involvement**	0.07	12.3%	1.4%
Age+ Gender + Neighbourhood + SE Index + **Variety**	0.00	11.1%	0.1%

Table 7.5: Variation in PD index explained by HOME over and above all other factors

	P value	R^2	Additional variation explained
Age + Gender + Neighbourhood + SE Index + **stunted + underweight + wasted**		14.6%	
Age + Gender + Neighbourhood + SE Index + **stunted + underweight + wasted** + **HOME**	0.000	16.0%	1.7 %

Table 7.6: Variation in undernutrition contributed by the age, gender, rural urban neighbourhood, and SE index

Factors	Stunting		Underweight		Wasting	
	Variation explained	Additional variation explained	Variation explained	Additional variation explained	Variation explained	Additional variation explained
Age + Gender	5.3%		2.0%		1.5%	
Age + Gender + SE Index	10.8%	5.5%	8.6%	6.6%	4.0%	2.5%
Age + Gender + SE Index +Neighbourhood	10.8%	5.5 %	8.6%	6.6%	4.0%	2.5%

Table 7.7: Population attributable fraction (PAF) of rural neighbourhood exposure for delayed psychomotor development

Psychomotor status	Adjusted OR (95%CI)[1]	PAF % (95%CI)
Normal development	1	
Mild delayed	1.66 (1.16, 2.38)	18.93 (6.57,27.60)
Severely delayed	1.95 (1.1, 3.46)	22.80 (4.26, 33.27)
Overall delayed	1.74 (1.26, 2.4)	20.97 (10.17, 28.76)

1. Adjusted for age, gender, and SE index

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APPENDICES

Appendix 2.1: Description of Social Environment

Theory of Human Development (Urie Bronfenbrenner)

The five levels of social environment can be further categorised into primary and secondary on the basis of these determinants.

Primary Determinants comprise those classes of factors which directly interact with the child:

- **Micro-System:** the first level of factors is the caregiver's relationships, roles, and activities. Essential physical and psychological needs for healthy survival, growth, and development of the child are met by one or more people who understand what infants need in general. They are mothers, fathers, siblings, relatives, and childcare service providers e.g. education and health personnel. The dyadic relations with a child are very much influenced by the knowledge and skills of the caregivers.

- **Meso-System**: the second level of factors refers to the physical setting such as the home, health, and educational facilities. The direct interaction with a resource rich physical environment is more likely to engage and influence a child.

Secondary Determinants comprise those classes of factors which indirectly interact with child.

- **Exo-System:** the third level is community based factors such as family, friends, relatives, neighbourhood, media, and community social services. They provide the social support to carry out the primary interactions with ease.

- **Macro-system:** which comprises cultural factors and refers to the overarching ideology of belief, value, and customs of a particular population. Each culture

has its own priority structure for child rearing and gives different emphasis to different child needs.

- **Chrono-system:** the fifth level consists of time related factors. Environment is not a static force which affects people in a uniform way, it is ever changing. This has a significant role to play as each time from its significant events creates specific opportunities and challenges for child nurture.

Appendix 3.1: Field Sites of the Study

S.no	Area	Type
	The Aga Khan Health Service, Pakistan (AKHS,P)	
1	Sultanabad Karachi	Urban
2	Jan Mohammad	Urban
3	Rehmani Garden	Urban
4	Al-Noor Colony	Urban
5	Saleemabad	Urban
6	Sultanabad No.1(Mirpurkhas)	Rural
7	Sultanabad No 2	Rural
8	Sultanabad No. 3	Rural
9	Shah Ali	Rural
10	Khyber	Rural
11	Mohd Abad	Rural
12	Hussain Abad	Rural
13	Tar Khawaja	Rural
	Health and Nutrition Development Society (HANDS)	
14	Amin Fahim Colony	Urban
15	Gulshan-e-Fahim	Urban
16	Ward Two U/C I	Urban
17	Pir Maula Bux Colony	Urban
18	Talibul Maula colony	Urban
19	Pir Pini Ladho Colony	Urban
20	Kod Bhanoja	Rural
21	Pahar Jamali Goth	Rural
22	Mari Mohammad Khan	Rural
23	Pir Fazal Haq Shah	Rural
24	Jamal Dahri	Rural
25	Qasim Bucho	Rural
26	Bheel Mori	Rural

Appendix 3.2: Data Collection from the AKHSP field sites

Total Study Population = 33934 Total study Sample = 1244

Urban

s.no	Area name	Total Population	Forms filled
1	Sultanabad	3700	160
2	Jan Mohammad	2850	62
3	Rehmani Garden	1970	38
4	Al-Noor Colony	850	28
5	Salimabad	2100	41
	Total	**11470**	**329**

Rural

s.no	Area name	Total Population	Forms filled
1	Sultanabad No 3 (Mirpur Khas)	400	15
2	Sultanabad no 2	400	14
3	Sultanabad no 1	1500	47
4	Shah Ali	781	37
5	Khyber	630	52
6	Mohammad Abad	1626	42
7	Hussainabad	700	27
8	Tur Khowaja	1104	56
	Total	**7141**	**290**

Appendix 3.3: Data Collection from the HANDS field sites

Urban

s.no	Area name	Total Population	Forms filled
1	Makhdom Amin Fahim colony (ward 3/ Bagri Ghitti)	1646	88
2	Gulshan-e- Fahim	800	29
3	Ward 2 UC1	1131	30
4	Pir Mola Bux Colony Ward 3	1935	75
5	Talib-ul- Mola Colony	745	33
6	Pir Ladho Colony Ward 12	1850	47
	Total	**8107**	**302**

Rural

s.no	Area name	Total Population	Forms filled
1	Kod Bhanoga	660	19
2	Pahar Khan Jamali	1042	33
3	Mari Muhammad Khan	960	43
4	Ootaque Pir Fazul Haq Shah	1285	50
5	Jamal Dahri	1251	72
6	Qasim Bughio	1168	57
7	Bheel Mori	850	49
	Total	**7216**	**323**

Appendix 3.4: Study Questionnaire

ID Code: -----/-----/-----

Early Childhood Development: Social environment, growth and psychomotor development of children aged less than three years.

Completion Checklist:

Interviewer Name	Signature	Questionnaire	Anthropometry	BSID II	HOME

Q 1 NGO: 1. AKHSP 2. HANDS:

Q 2 Field Site name:

Q 3 Neighborhood type 1 Urban 2. Rural

Q 3 Address (home) _____

_____

Q 5 Date of interview

Visit #	Date	Status
1	____ / ____ / ____	1 - complete 2 - incomplete 3 - refusal 4 - not at home
2	____ / ____ / ____	1 - complete 2 - incomplete 3 - refusal 4 - not at home
3	____ / ____ / ____	1 - complete 2 - incomplete 3 - refusal 4 - not at home

General information		
This section queries are to assess the general characteristics of child and family.		
Q 6	What is the name of the child?	_____
Q 7	Child's gender	_____
Q 8	What is the date of birth of child? (if possible check the birth record card)	_____
Q 9	What is your name (child's mother)?	_____
Q 10	What is the name of the child's father?	_____
Q 11	What is your ethnicity?	_____
Q 12	Mother tongue	_____
Q 13	What is your religion?	_____

#	Questions	Coding categories	Skip to	Answers
Family structure				
This section queries are to assess the effect of family configuration, on the child's growth and development.				
Q14	Specify the number of your household members?			
Q15	How many family members are actively involved in the caretaking of this child?			
Q16	Do family members apart from the index child's parents and siblings live with you?	1. Yes 2. No	=Q17 =Q18	
Q17	If 'Yes', please specify	S# Age / Sex / Relation 1. a.M b. F 2. a.M b. F 3. a.M b. F 4 a.M b. F a.M b. F		

#	Questions	Coding categories	Skip to	Answers
Q18	How many siblings index child have? *(specify the number)*			
Q19	Specify other siblings Name	S# Age 1. 2. 3. 4 5. 6. 7. 8. 9	Sex a.M b. F a.M b. F a.M b. F a.M b. F a.M b. F a.M b. F a.M b. F a.M b. F a.M b. F a.M b. F	
Q20	What is the rank of the index child among living siblings? (specify the exact number)			

Family back ground				
This section queries are to assess the effect of socio-economic status on the child's growth and development.				
Q21	Are you educated? (mother)	1. Yes 2. No	= Q22 = Q23	
Q22	If 'Yes', what is the level of your education?	1. Read only 2. Primary 3. Middle 4. Matric 5. More (specify)		
Q23	Are you a working woman?	1. Yes 2. No	= Q24 = Q25	
Q24	If 'Yes', what is your occupation? (specify)			
Q25	Is the child's father educated?	1 Yes 2 No	= Q26 = Q27	
Q26	If 'Yes', what is level of his education?	1. Read only 2. Primary 3. Middle 4. Matric 5. More (specify)		

#	Questions	Coding categories	Skip to	Answers
Q27	What is his occupation? (specify)			
Q28	Do you own a house?	1. Rented 2. Good will. 3. Owner 4. Other (specify)_____		
Q29	How many rooms do you have in your house? (excluding store, bathrooms and kitchen) (specify the number)			
Q30	How many persons share the room with the index child?			
Q31	What is the most common mode of transport your family use daily?	1 Bus 2 Rickshaw 3 Taxi 4 Your own motor cycle 5 Your own car		
Q32	How many family members are bread earners?			
Q33	What is your average family monthly income? (specify)			
Q34	What proportion of your monthly income is spent on food (for the family)?			

#	Questions	Coding categories	Skip to	Answers
Anthropometry (current)				
This is to assess the effect of physical status on the child's development.				
Q35	Child height (cm)			
Q36	Child weight (kg)			
Q37	Any visible physical abnormality observed?	1. Yes 2. No	=Q38 =Q39	
Q38	If 'Yes', please specify			
Q39	Child birth weight (kg) (if possible check the birth record card)			

Psychomotor development				
This is to assess the developmental status of the child.				
Q40	Raw scores			
Q41	Psychomotor Development Index			
Q42	Any comments			

Appendix 3.5: Bayley Scale of Infant Motor Development II (BSID-II)

Child's Name _____ Child's Gender _____

Caregiver's Name _____

Daycare/ School Program _____

Place of Testing _____

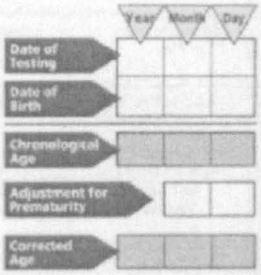
Teacher _____

Examiner _____

Reason for Referral _____

Bayley Scales of Infant Development Second Edition

Motor Scale Record Form



Scale	Factor	Raw Score	MDI	PDI	Confidence Interval (____%)	Percentile	Classification
Mental							
Motor							
Behavior Rating	Attention/ Arousal						
	Orientation/ Engagement						
	Emotional Regulation						
	Motor Quality						
	Additional Items						
	Total Raw Score						

Observations and General Comments _____

6 9 10 11 12 A B C D E

015-402804-I

Begin 1, 2 & 3 months

Age Group	Item	Position	Materials	Next Item: Scored	Next Item: Admin.	Previous Item in Series	Comments/ Scoring Criteria/ Trial & Counted Information	Score C, NC, RF, RPT, O
1 month	1. Thrusts Arms in Play	Supine						
	2. Thrusts Legs in Play	Supine						
	3. Lifts Head When Held at Shoulder	Supine		4, 5, 7	15			
	4. Holds Head Erect for 3 Seconds (Vertical Position)	Upright at Shoulder		5, 7		3		
	5. Adjusts Posture When Held at Shoulder	Upright at Shoulder		7		4		
	6. Hands are Fisted							
2 months	7. Holds Head Erect and Steady for 15 Seconds	Upright at Shoulder				5		
	8. Lifts Head (Dorsal Suspension)	Upright						
	9. Holds Legs Up for 2 Seconds	Supine						
	10. Makes Crawling Movements	Prone						
3 months	11. Turns from Side to Back	Supine						
	12. Attempts to Bring Hand to Mouth							
	13. Retains Ring	Supine	Ring with String					
	14. Adjusts Head to Ventral Suspension	Prone				8		
	15. Holds Head Steady While Being Moved	Upright at Shoulder				7		
	16. Displays Symmetric Movements	Supine						

Incidental Observation

Number of Items Child Received Credit (C) for This Page

Begin 4, 5 & 6 months

End 1, 2 & 3 months

Age Group	Item	Position	Materials	Next Item: Scored	Next Item: Admin.	Previous Item in Series	Comments/ Scoring Criteria/ Trial & Counted Information	Score C, NC, RF, RPT, O
4 months	17. Holds Head in Midline Position	Supine						
1 month	18. Elevates Self by Arms	Prone						
	19. Balances Head	Upright				15		
	20. Maintains Head at 45° and Lowers with Control	Prone		24				
2 months	21. Sits with Support	Seated		22, 28, 34				
	22. Sits with Slight Support for 10 Seconds	Seated		28, 34, 36		21		
	23. Keeps Hands Open					6		
	24. Maintains Head at 90° and Lowers with Control	Prone				20		
5 months	25. Shifts Weight on Arms	Prone				18		
	26. Turns from Back to Side	Supine	Bell or Rattle	38		11		
	27. Rotates Wrist		Cube, Rattle, Bell or Other Small Toy					
6 months	28. Sits Alone Momentarily	Seated		34, 36		22		
3 months	29. Uses Whole Hand to Grasp Rod	Seated	Rod				Type of Grasp:	
	30. Reaches Unilaterally						Hand ____	
	31. Uses Partial Thumb Opposition to Grasp Cube	Seated	Cube	37				
	32. Attempts to Secure Pellet	Seated	Sugar Pellet	41				

Incidental Observation

Number of Items Child Received Credit (C) for This Page

Begin 7 & 8 months

End 4, 5 & 6 months

Age Group	Item	Position	Materials	Next Item: Scored	Next Item: Admin.	Previous Item in Series	Comments/ Scoring Criteria/ Trial & Counted Information	Score C, NC, RF, RPT, O
	33. Pulls to Sitting Position	Supine		45				
	34. Sits Alone for 30 Seconds	Seated		36		28		
7 months	**35.** Sits Alone While Playing with Toy	Seated	Rabbit, Bell, Rattle or Other Small Toy			34		
4 months	**36.** Sits Alone Steadily	Seated				35		
	37. Uses Pads of Fingertips to Grasp Cube	Seated	Cube			31		
	38. Turns from Back to Stomach	Supine	Bell or Rattle			26		
	39. Grasps Foot with Hands	Supine	Facial Tissue					
	40. Makes Early Stepping Movements	Standing			44			
5 months	**41.** Uses Whole Hand to Grasp Pellet	Seated	Sugar Pellet	49, 56		32		
8 months	**42.** Attempts to Raise Self to Sit	Supine	Bell or Rattle					
	43. Moves Forward, Using Prewalking Methods	Seated	Bell or Rattle			25		
	44. Supports Weight Momentarily	Standing		46, 53		40		
	45. Pulls to Standing Position	Supine				33		
	46. Shifts Weight While Standing	Standing		53		44		
	47. Raises Self to Sitting Position	Supine	Bell or Rattle			42		
6 months	**48.** Brings Spoons or Cubes to Midline	Seated	2 Spoons or Cubes					

Number of Items Child Received Credit (C) for This Page

Begin 9, 10, 11, 12, 13 & 14–16 months

End 7, 8, 9 & 10 months

Age Group	Item	Position	Materials	Next Item: Scored	Next Item: Admin.	Previous Item in Series	Comments/ Scoring Criteria/ Trial & Counted Information	Score C, NC, RF, RPT, O
9 months	**49.** Uses Partial Thumb Opposition to Grasp Pellet	Seated	Sugar Pellet	56		41		
	50. Rotates Trunk While Sitting Alone	Seated	Bell			36	**Scoring Criterion:** 1 of 2 Trial 1____ 2____	
10 months	**51.** Moves from Sitting to Creeping Position	Seated	Bell			50		
7 months	**52.** Raises Self to Standing Position	Supine	Bell or Rattle			47		
	53. Attempts to Walk	Standing		60, 61		46		
11 months	**54.** Walks Sideways While Holding on to Furniture	Standing				53		
	55. Sits Down	Standing						
	56. Uses Pads of Fingertips to Grasp Pellet	Seated	Sugar Pellet			49		
	57. Uses Partial Thumb Opposition to Grasp Rod	Seated	Rod			29		
12 months	**58.** Grasps Pencil at Farthest End	Seated	Pencil & Paper	70				
	59. Stand Up I	Seated		68		52		
8 months	**60.** Walks with Help	Standing		61, 62 63		54		
13 months	**61.** Stands Alone	Standing		62, 63		60		
9 months	**62.** Walks Alone	Standing		63		61	Number of Steps _____	
14–16 months	**63.** Walks Alone with Good Coordination	Standing	Any toy that interests child			62	Number of Steps _____	
10 months	**64.** Throws Ball	Standing	Ball					

Incidental Observation

Number of Items Child Received Credit (C) for This Page

Begin 17–19, 20–22, 23–25 & 26–28 months

End 11, 12, 13 & 14–16 months

Age Group	Item	Position	Materials	Next Item: Scored	Next Item: Admin.	Previous Item in Series	Comments/ Scoring Criteria/ Trial & Counted Information	Score C, NC, RPT, O
	65. Squats Briefly	Standing				55		
17–19 months	66. Walks Up Stairs with Help	Standing	Stairs & any toy that interests child	79	69			
	67. Walks Backward	Standing	Pull Toy			63	Number of Steps _____	
	68. Stands Up II	Standing				59		
11 months	69. Walks Down Stairs with Help	Standing	Stairs & any toy that interests child	80		66		
20–22 months	70. Grasps Pencil at Middle	Seated	Pencil & Paper	74, 75, 90		58		
	71. Walks Sideways	Standing	Pull Toy			67		
12 months	72. Stands on Right Foot with Help	Standing			82			
	73. Stands on Left Foot with Help	Standing			83	72		
	74. Uses Pads of Fingertips to Grasp Pencil	Seated	Pencil & Paper	75, 90		70		
23–25 months	75. Uses Hand to Hold Paper in Place	Seated	Pencil & Paper	90				
13 months	76. Places 10 Pellets in Bottle in 60 Seconds	Seated	12 Sugar Pellets, Bottle &			56	Number of Pellets _____	
	77. Runs with Coordination	Standing	Ball			71		
26–28 months	78. Jumps off Floor (Both Feet)	Standing	Jumping Rope					
14–16 months	79. Walks Up Stairs Alone, Placing Both Feet on Each Step	Standing	Stairs & any toy that interests child	95	80	69		
	80. Walks Down Stairs Alone, Placing Both Feet on Each Step	Standing	Stairs & any toy that interests child		81	79		

Incidental Observation

Number of Items Child Received Credit (C) for This Page

Begin 29–31, 32–34, 35–37 & 38–42 months

End 17–19, 20–22, 23–25 & 26–28 months

Age Group	Item	Position	Materials	Next Item: Scored	Next Item: Admin.	Previous Item in Series	Comments/ Scoring Criteria/ Trial & Counted Information	Score C, NC, RF, RPT, O
	81. Jumps from Bottom Step	Standing	Stairs			78		
17–19 months	**82.** Stands Alone on Right Foot	Standing				73		
	83. Stands Alone on Left Foot	Standing				82		
29–31 months	**84.** Walks Forward on Line	Standing	Tape Measure		85	77		
	85. Walks Backward Close to Line	Standing	Tape Measure			84		
20–22 months	**86.** Swings Leg to Kick Ball	Standing	Ball			83		
	87. Jumps Distance of 4 Inches	Standing	Tape Measure			78	**Scoring Criterion:** 1 of 3 Trials ≥ 4" Trial 1____ 2____ 3____	
32–34 months	**88.** Laces Three Beads	Seated	2 Shoe Strings & 8 Square Beads				Number of Beads _____	
	89. Walks on Tiptoe for Four Steps	Standing	Tape Measure	99		85	**Scoring Criterion:** 4 Steps Number of Steps _____	
	90. Grasps Pencil at Nearest End	Seated	Pencil & Paper	93		74		
35–37 months	**91.** Imitates Hand Movements	Seated			98		**Scoring Criterion:** 2 of 3 Trial 1____ 2____ 3____	
	92. Tactilely Discriminates Shapes	Seated	2 Pegs, 2 Cubes, 2 Square Pieces (from Blue Block Set) & Shield				**Scoring Criterion:** 2 of 3 Peg____ Cube____ Square____	
23–25 months	**93.** Manipulates Pencil in Hand	Seated	Pencil & Paper			90		
	94. Stands Up III	Standing				68		
	95. Walks Up Stairs, Alternating Feet	Standing	Stairs & any toy that interests child		108	80		
38–42 months	**96.** Copies Circle	Seated	Pencil & Paper		104			
26–28 months	**97.** Uses Eye-Hand Coordination in Tossing Ring	Standing	Rod, Pegboard & Ring (without String)					

Number of Items Child Received Credit (C) for This Page

End 29-31, 32-34, 35-37 & 38-42 months

Age Group	Item	Position	Materials	Next Item: Scored	Next Item: Admin.	Previous Item in Series	Comments/ Scoring Criteria/ Trial & Counted Information	Score C, NC, R RPT, O
	98. Imitates Postures	Standing				91	**Scoring Criterion:** 2 of 3 Trial 1____ 2____ 3____	
	99. Walks on Tiptoe for 9 Feet	Standing	Tape Measure			89		
	100. Stops from a Full Run	Standing	Tape Measure				**Scoring Criterion:** 2 of 3 ≤ 2 Steps Steps needed to stop Trial 1____ 2____ 3____	
29-31 months	**101.** Buttons One Button	Seated	Button Sleeve					
	102. Stands Alone on Left Foot for 4 Seconds	Standing			103	83		
	103. Stands Alone on Right Foot for 4 Seconds	Standing				102		
	104. Copies Plus Sign	Seated	Pencil & Paper		111	96		
	105. Traces Designs	Seated	Tracing Sheet & Pencil			104	**Scoring Criterion:** 2 of 3 Square____ Circle____ Diamond____	
	106. Jumps Over Rope	Standing	Jumping Rope			87	**Scoring Criterion:** 8 inches 2 inches : Trial 1____ 2____ 4 inches : Trial 1____ 2____ 6 inches : Trial 1____ 2____ 8 inches : Trial 1____ 2____	
32-34 months	**107.** Hops Twice on One Foot	Standing	Tape Measure	110		103	Number of Hops _____	
	108. Walks Down Stairs, Alternating Feet	Standing	Stairs & any toy that interests child			95		
	109. Jumps Distance of 24 Inches	Standing	Tape Measure			106	**Scoring Criterion:** 1 of 3 ≥ 24" Inches: _____ Trial 1____ 2____ 3____	
	110. Hops Five Feet	Standing	Tape Measure			107	Distance: _____	
35-37 & 38-42 months	**111.** Copies Square	Seated	Pencil & Paper			105		

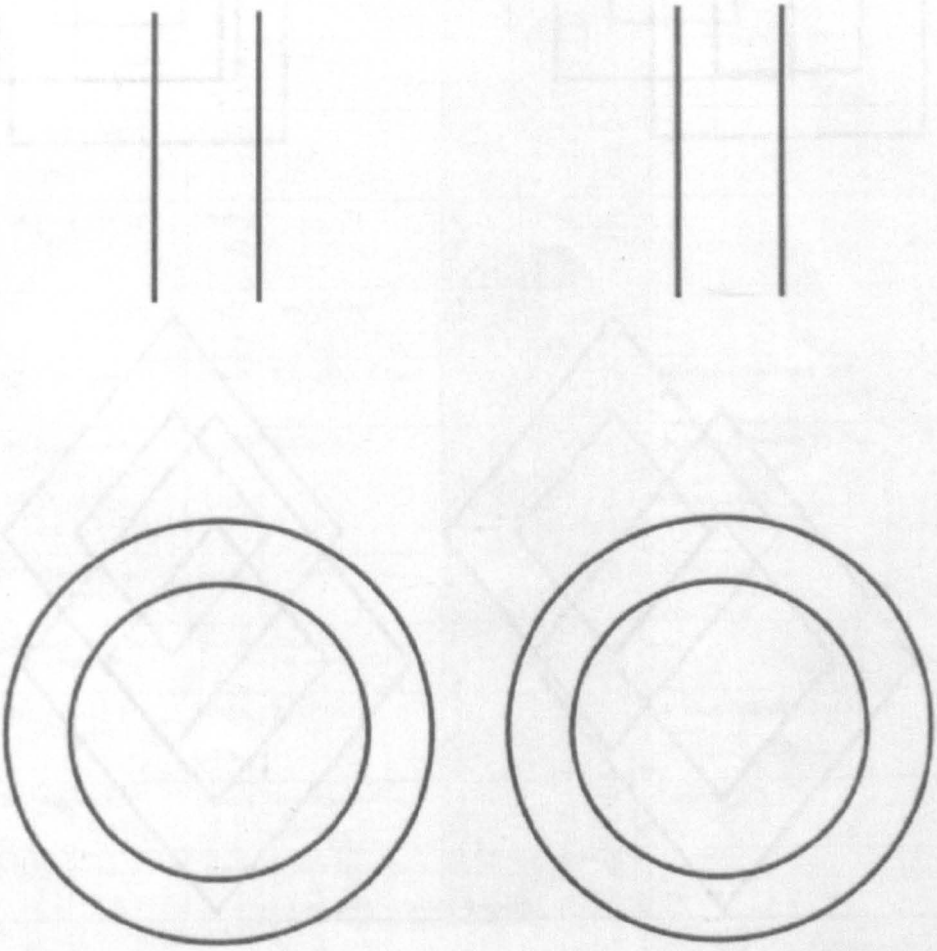
ISBN 015-4028-04-5

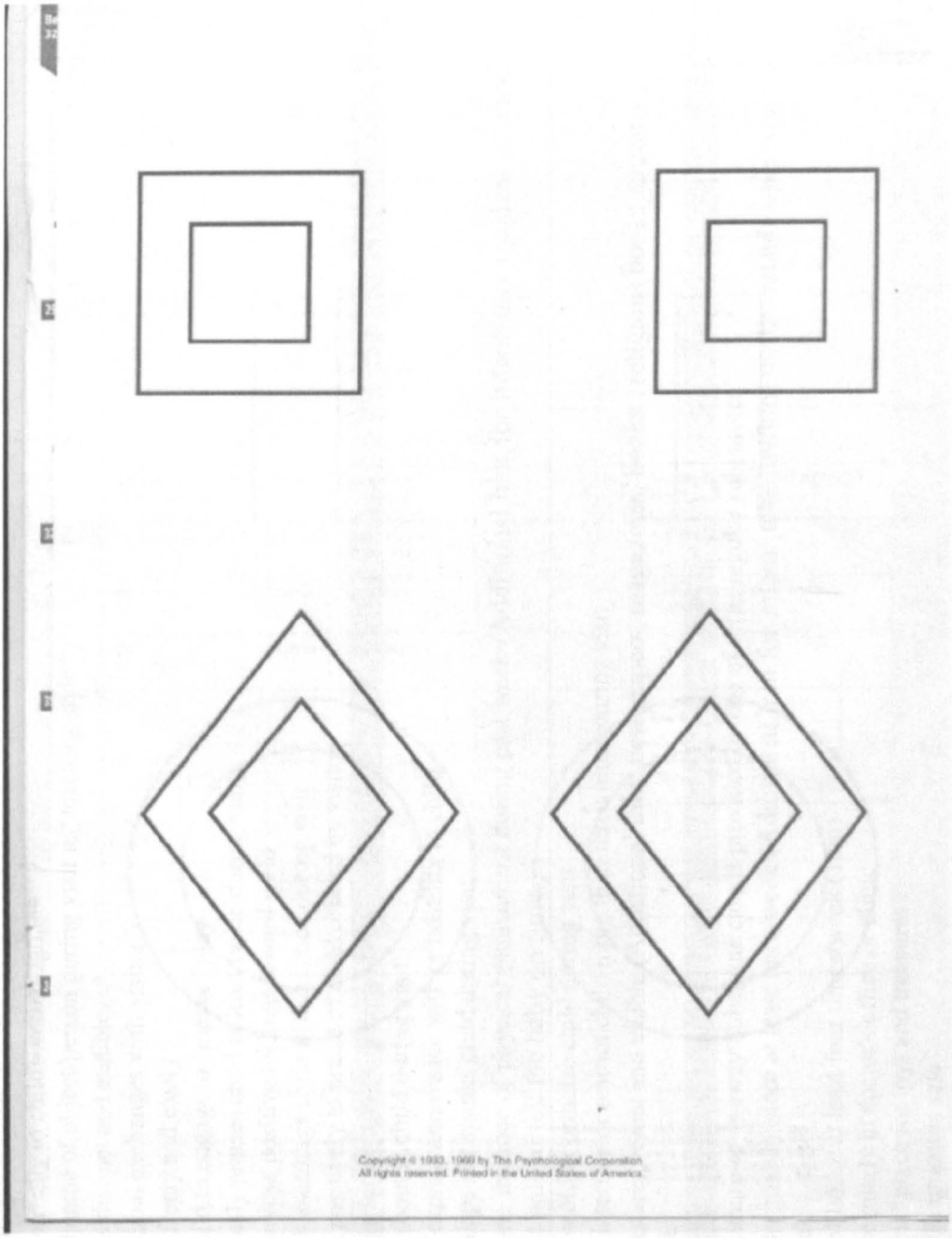
Number of Items Child Received Credit (C) for This Page

Bayley Scales of Infant Development Second Edition

Traces Designs
Item 105

Child's Name: _____ Examiner's Name _____





Appendix 3.6: HOME subscales, individual items and modifications

i. Emotional and verbal responsivity	Yes/ No
1. Parent spontaneously vocalizes to child twice	
2. Parent responds verbally to child's verbalizations	
3. Parent tells child name of object/person during visit in "teaching style"	
4. Parent's speech is distinct and audible	
5. Parent initiates verbal exchanges with visitor	
6. Parent converses freely and easily	
7. Parent permits child to engage in "messy" play	
8. Parent spontaneously praises child at least twice during visit	
9. Parent's voice conveys positive feelings toward child	
10. Parent caresses/kisses/hugs child at least once during visit	
11. Parent responds positively to praise of child offered by visitor	
ii. Avoidance of restriction and punishment	
12. Parent does not shout at child during visit	
13. Parent does not express annoyance with or hostility to child	
14. Parent neither slaps nor spanks child during visit	
15. No more than one instance of physical punishment during past week (Additional hint for infant: any incident of child neglect such as not bale to fell the baby on time.)	
16. Parent does not scold or criticize child during visit	
17. Parent does not interfere or restrict child more than three times during visit	
18. At least 10 books are present and visible (Additional hint: newspapers, magazines, books , religious books_Quran)	
19. Family has a pet	
iii. Organization of physical and temporal environment	
20. When primary caregiver is away Substitute care is provided by one of three regular substitutes	
21. Child is taken to grocery store at least once/week (Additional hint for infant: take her/him to the outside open spaces at least once a week	
22. Child gets out of house at least four times/week (12m)	
23. Child is taken regularly to doctor's office or clinic	
24. Child has a special place for toys and treasures	
25. Child's play environment is safe	

iv. Provision of appropriate play materials	Yes/ No
26. Muscle activity toys or equipment available (Additional hint for infant: rattle)	
27. Push or pull toy available	
28. Stroller or walker, kiddie car, scooter, or tricycle available	
29. Parent provides toys for child during visit	
30. Learning equipment appropriate to age (cuddly or role-playing toys)	
31. Learning facilitators—mobile table and chairs, high chair, play pen	
32. Simple eye-hand coordination toys (Additional hint for infant: ball, doll)	
33. Complex eye-hand coordination toys (those permitting combination)	
34. Toys for music and education (Additional hint: buildings blocks, color /alphabet naming toys)	
Parental involvement with child	
35. Parent keeps child in visual range, looks at often	
36. Parent talks to child while doing household work	
37. Parent consciously encourages developmental advance	
38. Parent invests maturing toys with value via personal attention	
39. Parent structures child's play periods	
40. Parent provides toys that challenge child to develop new skills	
Opportunities for variety in daily stimulation	
41. Father provides some care daily	
42. Parent reads stories to child at least three times weekly	
43. Child eats at least one meal per day with mother and father	
44. Family visits with relatives or friends once a month or so	
45. Child has three or more books of his or her own	

Appendix 3.7: Training Schedule

(24 June-6th July 2002)

Day -Date	Time	Content	Resource Persons
June24,2002	9.30-10.30 a.m.	Introduction Review of study objectives	Dr. Bilal Iqbal
	10.30-11.00a.m.	Tea Break	
	11.00-1.00 p.m.	Communication Skills	Tazeen Saeed
	1.00-2.00p.m	Lunch	
	2.00-4.00p.m	Observational methodology	Sanober M.
June25,2002	9.30-10.30 a.m.	Normal growth and development	Suzan Saghir
	10.30-11.00a.m.	Tea break	
	11.00-1.00 p.m.	Interviewing skills	Jacqueline Dais
	1.00-2.00p.m	Lunch	
	2.00-4.00p.m	Child Assessment	Dr. Naushaba Mobeen
June26,2002	9.30-10.30 a.m.	Anthropometry	Dr. Saima
	10.30-11.00a.m.	Tea break	
	11.00-1.00 p.m.	Anthropometry	Dr. Saima
	1.00-2.00p.m	Lunch	
	2.00-4.00p.m	AKU-HDP scale	Jacqueline Dais & Suzan Saghir
June27,2002	9.30-12.00 a.m.	Practice in Day care center (Interviewing Skills, Anthropometry) Lunch	Jacqueline Dais & Suzan Saghir
	12.00-1.00 p.m.	Practice	
	1.00-4.00p.m		Dr. Saima
June28,2002	9.30-12.00 a.m.	Practice in Day care center (Interviewing Skills, Anthropometry)	Jacqueline Dais &Suzan Saghir, Dr. Saima
	12.00-1.00p.m	Lunch	
	2.00- 4.00 p.m	HOME Scale	Sanober Mubeen
June29,2002	9.30-1.00 p.m	Questionnaire (Urdu)	Dr. Bilal Iqbal
	10.30-11.00a.m.	Tea Break	
	11.00-1.00 p.m.	Questionnaire Continue	
	1.00-2.00p.m	Lunch	
	2.00-4.00	Practice	Sanober Mubeen, Jacqueline Dais

Day -Date	Time	Content	Resource Persons
July1,2002	9.30-1.00 p.m	Questionnaire (Sindhi version)	Dr. Tanweer
	10.30-11.00a.m.	Tea Break	Dr. Saima
	11.00-1.00 p.m	Questionnaire continue	
	1.00-2.00p.m	Lunch	
	2.00- 4.00 p.m	Practice	Jacqueline Dais
July2,2002	9.30-1.00 p.m	BSID II (PD index)	Sanober Mubeen
	10.30-11.00a.m.	Tea Break	Suzan Saghir,
	11.00-1.00 p.m	Bayley Continue	
	1.00-2.00p.m	Lunch	
	2.00- 4.00 p.m	Practice	Jacqueline Dais
July3,2002	9.30-1.00 p.m	BSID II (PD index)	Sanober Mubeen
	10.30-11.00a.m	Tea Break	Suzan Saghir,
	11.00-1.00 p.m	Bayley Continue	
	2.00-3.00 p.m	Lunch	
	2.00- 4.00 p.m	Practice	
July 4,2002	9.30-1.00 p.m	BSID II (PD index)	Sanober Mubeen
	10.30-11.00a.m.	Tea Break	Suzan Saghir,
	11.00-1.00 p.m.	Bayley Continue	
	2.00-3.00 p.m	Lunch	
	2.00- 4.00 p.m	Practice	
July5,2002	9.30-1.00 p.m	Over view on Sindhi Urban/Rural	Dr. Altaf Khalid Deno
	2.00-3.00 p.m	Communities	Sanober & Dr. Saima
	2.00- 4.00 p.m	Lunch	
		Practice (PD index & HOME)	
July6,2002	9.30- 1.00 p.m	Practice (PD index & HOME)	Sanober Mubeen, Suzan
	2.00-3.00 p.m	Lunch	Saghir, Dr. Saima
	2.00-4.00 p.m	Practice (PD index & HOME)	

Appendix 3.8: Consent Form

Title of the project

Study of factors in the social environment that affect growth and development children aged less than three years

Principal Investigator
Dr. Bilal Iqbal, Senior Research Fellow
Department of Community Health Sciences, the Aga Khan University, Karachi, Pakistan.

Sponsors

a) The Aga Khan University, Karachi, Pakistan.
b) Fogarty Fellowship 2002 by University of Alabama at Birmingham (UAB) - Fogarty International Center (FIC), International Maternal and Child Health Research and Training (IMCHRT), USA

Introduction

We belong to the Aga Khan University and are conducting a study of social environment of children. We invite you to participate in this research study the purpose of which is to study factors in the social environment that affect growth and development of children aged less than three years. Before you can decide whether or not to volunteer to answer the questions for this study, you must understand its purpose and how it may affect you. This consent form gives you information about the study, which will be discussed with you. Once you understand the purpose and if you agree to participate, you will be asked to sign this informed consent form.

Purpose

The purpose of this research is to identify the association between factors of social environment and physical growth, social behaviour and learning ability. Social environment broadly refers to factors that influence learning during early childhood with particular interest in sensory stimulation, economics as well as health.

Procedure

An interview using a questionnaire will be conducted taking approximately 90-120 minutes of your time. Questions will be asked about your knowledge and practices as

regards to child rearing and assessment of the child developmental status (Anthropometry, Bayley's infant developmental scale and HOME inventory) will be done. No treatment or laboratory investigations are required. There is no *risk* involved to your physical and mental health. All information gathered in this study would be kept in the strictest confidence. Data collectors will be rigorously directed and monitored to keep the confidentiality of the study participants. All records will be identified by code numbers and stored in locked file cabinet. It will be the responsibility of the principal investigator in keeping information about study participants confidential.

Your participation is voluntary and there will be no cost to you to participate in this study other than the time you spend with the interviewer. You will not receive any money or compensation or other reward for your participation. However, the collaborating service providers (AKHS,P and HANDS) will provide the service support for intervention/treatment identified during the course of study.

Potential benefits

The findings of the study will help the government authorities, community health workers and community service providers to take steps to improve the current state of children at the community level and will also help them to design programs/strategies to enhance the child development.

If you have any questions about the study, the Principal investigator, Dr. Bilal Iqbal will be glad to answer them.

Your participation is voluntary. You are free to stop participating in the research at any time or decline to answer any specific questions without penalty.

Are you willing to give this interview? Yes ☐ No ☐

I agree to participate in this study. I understand the information given to me, and I have received the answers to any questions I may have had about the research procedure. I understand and agree to the conditions of this study as described.

SIGNATURE OF THE PARENT
OR LEGALLY AUTHORIZED REPRESENTATIVE Date

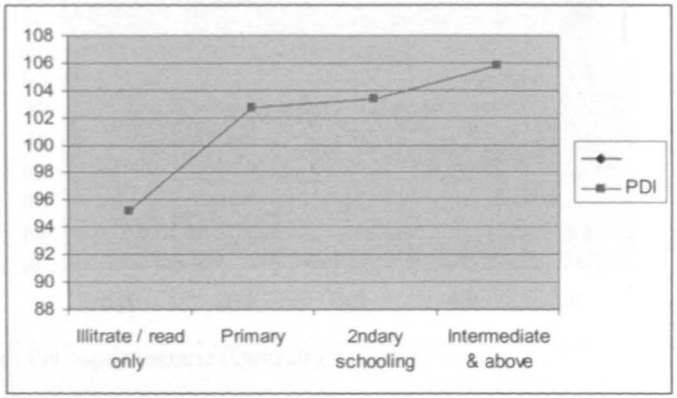
SIGNATURE OF THE INVESTIGATOR Date

SIGNATURE OF THE WITNESS Date

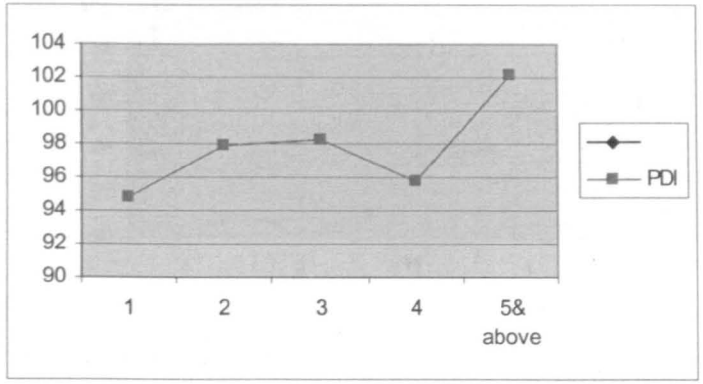
Appendix 4.1: Characteristics of jobless fathers by neighbourhood

		Overall N (%)	Neighbourhood Rural n (%)	Urban n (%)	P value
Maternal employment	No	13 (52)	7(47)	6(60)	0.513
	Yes	12 (48)	8(53)	4(40)	
Family type	Nuclear	12 (48)	8(53)	4(40)	0.513
	Extended	13 (52)	7(475)	6(60)	
Family size	Mean (SD)	8(2)	9(3)	8(3)	0.728
No. of sibling of the index child	Mean (SD)	3(3)	4(3)	3(2)	0.369
No. of people work for house expenses	Mean (SD)	2(1)	2(2)	1(1)	0.139
No. of care givers	Mean (SD)	3(2)	3(2)	2 (2)	0.358
Average per capita income (rupees)	Mean (SD)	618(527)	391(283)	936 (633)	0.009

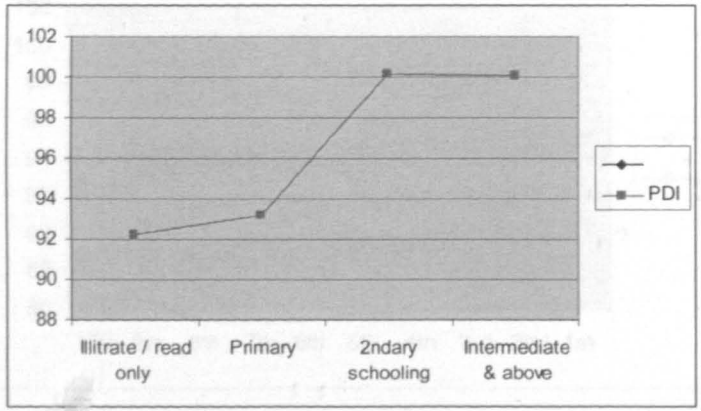
Appendix 4.2: Illustrations of significant relationship between PD index and socio-economic variables



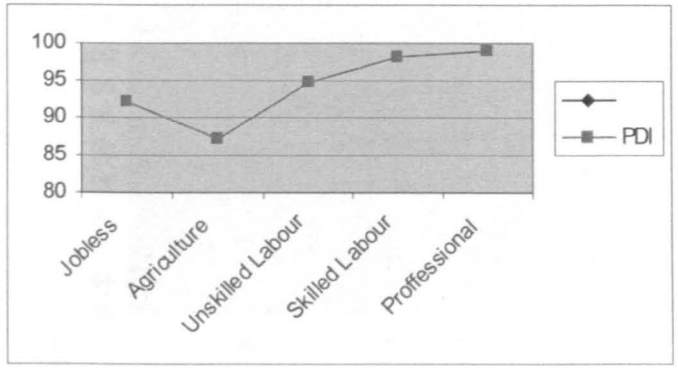
a) Maternal Education



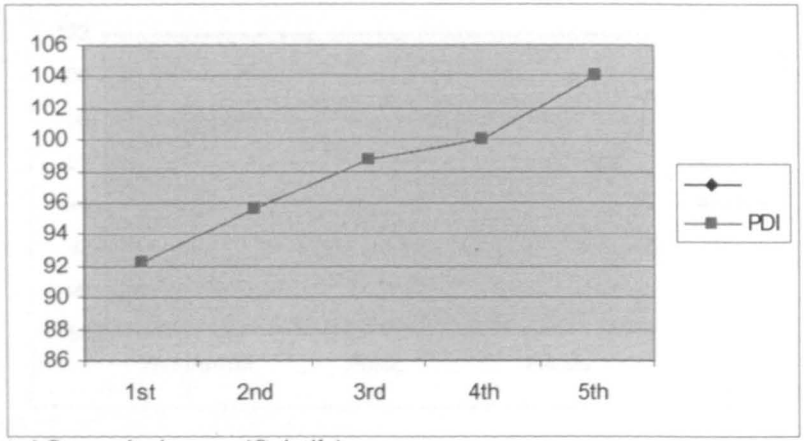
b) Maternal Occupation



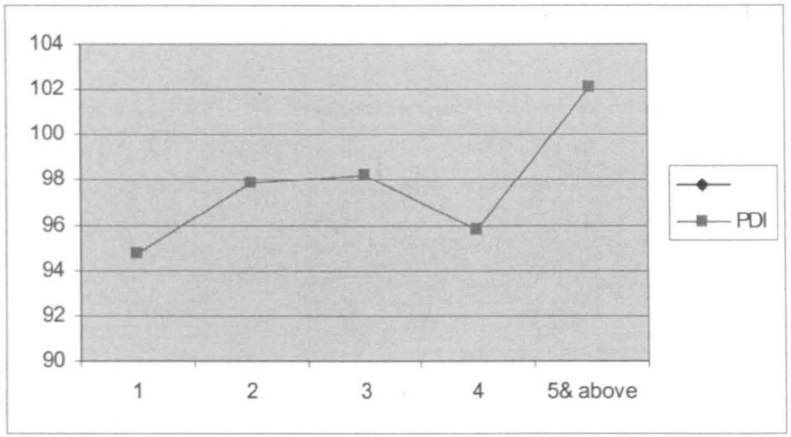
c) Paternal Education



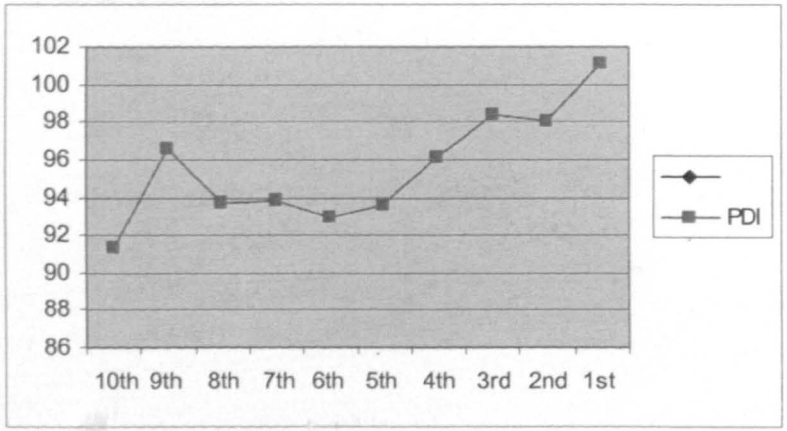
d) Paternal Occupation



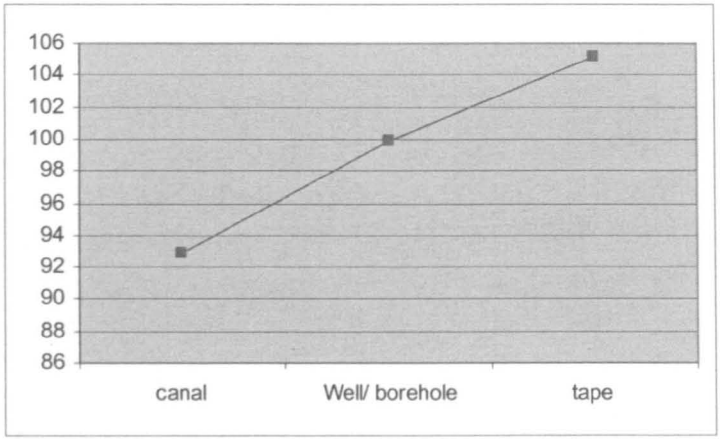
e) Per capita income (Quintile)



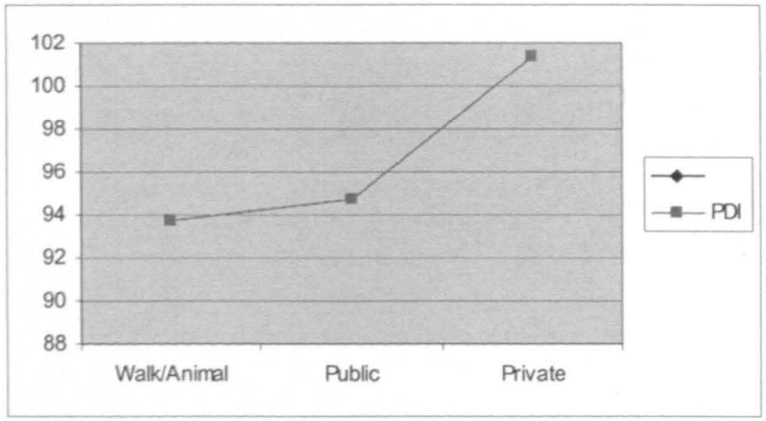
f) No. of rooms in the house



g) Crowding



h) Water supply



i) Mode of Transport

APPENDIX 6.1: Relationship HOME individual items with rural urban neighbourhood

	Overall n= (%)	Urban n(%)	Rural n(%)	OR (% CI)	P value
Emotional and verbal responsivity of mother					
1. Parent spontaneously vocalizes to child twice	829 (66.7)	458 (72.6)	371 (60.6)	1.72(1.36, 2.18)	0.000
2. Parent responds verbally to child's verbalizations	1010 (81.3)	548 (86.8)	462 (75.5)	2.14 (1.60, 2.88)	0.000
3. Parent tells child name of object/person during visit in "teaching style"	513 (41.3)	434 (68.8)	296 (48.4)	2.35 (1.87, 2.96)	0.000
4. Parent's speech is distinct and audible	1196 (96.2)	618 (97.9)	578 (94.4)	2.80 (1.46, 5.35)	0.001
5. Parent initiates verbal exchanges with visitor	1155 (92.9)	604 (95.7)	551 (90.0)	2.48 (1.55, 3.95)	0.000
6. Parent converses freely and easily	1151 (92.6)	604 (95.7)	547 (89.4)	2.66 (1.67, 4.23)	0.000
7. Parent permits child to engage in "messy" play	727 (58.5)	371 (58.8)	356 (58.2)	1.03 (0.82, 1.29)	0.823
8. Parent spontaneously praises child at least twice during visit	594 (47.8)	374 (59.3)	220 (35.9)	2.59 (2.06, 3.26)	0.000
9. Parent's voice conveys positive feelings toward child	1151 (92.6)	585 (92.7)	566 (92.5)	1.03 (0.68, 1.58)	0.879
10. Parent caresses/kisses/hugs child at least once during visit	993 (79.9)	515 (81.6)	478 (78.1)	1.25 (0.94, 1.64)	0.123
11. Parent responds positively to praise of child offered by visitor	1040 (83.7)	569 (90.2)	471 (77.0	2.75 (1.99, 3.79)	0.000
Avoidance of restriction and punishment					
12. Parent does not shout at child during visit	1177 (94.7)	587 (93.0)	590 (96.4)	0.50 (0.29, 0.84))	0.008
13. Parent does not express annoyance with or hostility to child	1172 (94.3)	586 (92.9)	586 (95.8)	0.58 (0.35, 0.95)	0.029
14. Parent neither slaps nor spanks child during visit	1197 (96.3)	594 (94.1)	603 (98.5)	0.24 (0.12, 0.50)	0.000
15. No more than one instance of physical punishment during past week	841 (67.7)	435 (68.9)	406 (66.3)	1.13 (0.89, 1.43)	0.33
16. Parent does not scold or criticize child during visit	1166 (93.8)	577 (91.4)	589 (96.2)	0.42 (0.25, 0.69)	0.000
17. Parent does not interfere or restrict child more than three times during visit	1158 (93.2)	578 (91.6)	580 (94.8)	0.60 (0.38, 0.95)	0.027
18. At least 10 books are present and visible	305 (24.5)	231 (36.6)	74 (12.1)	4.20 (3.14, 5.62)	0.000
19. Family has a pet	599 (48.2)	124 (19.7)	475 (77.6)	0.07 (0.05, 0.09)	0.000

	Overall n= (%)	Urban n(%)	Rural n(%)	OR (% CI)	P value
Organization of physical and temporal environment					
20. Care is provided by of 3 regular substitutes, when primary caregiver is away	754 (60.7)	381 (60.4)	373 (60.9)	0.98 (0.78, 1.23)	0.838
21. Child is taken to grocery store at least once/week	1058 (85.1)	547 (86.7)	511 (83.5)	1.29 (0.94, 1.76)	0.11
22. Child gets out of house at least four times/week (12m)	1044 (84.0)	532 (84.3)	512 (83.7)	1.05 (0. 76, 1.42)	0.76
23. Child is taken regularly to doctor's office or clinic	981 (78.9)	538 (85.3)	443 (72.4)	2.21 (1.66, 2.93)	0.000
24. Child has a special place for toys and treasures	432 (34.8)	307 (48.7)	125 (20.4)	3.69 (2.87, 4.75)	0.000
25. Child's play environment is safe	950 (76.4)	553 (87.6)	397 (64.9)	3.84 (2.88, 5.13)	0.000
Provision of appropriate play materials					
26. Muscle activity toys or equipment available	521 (41.9)	351 (55.7)	170 (27.8)	3.27 (2.58, 4.14)	0.000
27. Push or pull toy available	382 (30.8)	267 (42.4)	115 (18.8)	3.18 (2.46, 4.11)	0.000
28. Stroller or walker, kiddie car, scooter, or tricycle available	367 (29.5)	276 (43.8)	91 (14.9)	4.46 (3.40, 5.86)	0.000
29. Parent provides toys for child during visit	313 (25.2)	223 (35.4)	90 (14.7)	3.18 (2.41, 4.19)	0.000
30. Learning equipment appropriate to age (cuddly or role-playing toys)	526 (42.4)	374 (59.4)	152 (24.8)	4.42 (3.50, 5.64)	0.000
31. Learning facilitators—mobile table and chairs, high chair, play pen	546 (44.0)	377 (59.8)	169 (27.6)	3.91 (3.08, 4.96)	0.000
32. Simple eye-hand coordination toys	738 (59.4)	467 (74.1)	271 (44.3)	3.61 (2.84, 4.58)	0.000
33. Complex eye-hand coordination toys	106 (8.5)	89 (14.1)	17 (2.8)	5.76 (3.38, 9.80)	0.000
34. Toys for literature and music	332 (26.7)	227 (36.0)	105 (17.2)	2.72 (2.09, 3.55)	0.000
Parental involvement with child					
35. Parent keeps child in visual range, looks at often	1148 (92.4)	598 (94.9)	550 (89.9)	2.11 (1.35, 3.28)	0.001
36. Parent talks to child while doing household work	859 (69.2)	475 (75.4)	384 (62.7)	1.82 (1.42, 2.32)	0.000
37. Parent consciously encourages developmental advance	494 (39.8)	296 (47.0)	198 (32.4)	1.85 (1.47, 2.33)	0.000
38. Parent invests maturing toys with value via personal attention	186 (15.0)	149 (23.7)	37 (6.0)	4.81 (3.29, 7.04)	0.000
39. Parent structures child's play periods	221 (17.8)	159 (25.2)	62 (10.1)	3.00 (2.18, 4.12)	0.000
40. Parent provides toys that challenge child to develop new skills	196 (15.8)	162(25.7)	34 (5.6)	5.89 (3.99, 8.69)	0.000
Opportunities for variety in daily stimulation					
41. Father provides some care daily	979 (78.8)	515 (81.7)	464 (75.8)	1.43 (1.09, 1.88)	0.011
42. Parent reads stories to child at least three times weekly	221 (17.8)	143 (22.7)	78 (12.7)	2.01 (1.49, 2.72)	0.000
43. Child eats at least one meal per day with mother and father	684 (55.1)	371 (58.9)	313 (51.1)	1.37 (1.09, 1.71)	0.006
44. Family visits with relatives or friends once a month or so	1086 (87.4)	556 (88.3)	530 (86.6)	1.162 (0.83, 1.63)	0.380
45. Child has three or more books of his or her own	121 (9.7)	90 (14.3)	31 (5.1)	3.12 (2.04, 4.78)	0.000