Differences in smoking by location of residence, ethnic group and country of origin: The Ghanaian perspective in sub-Saharan Africa and Europe.

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Declaration

I, Rachel Amelia Brathwaite, confirm that the work presented in this thesis is my own. Where information has been derived from other sources. I confirm that this has been indicated in the thesis.

Rachel Brathwaite

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Abbreviations and Acronyms

CI	Confidence Interval
CPS	Current Population Survey
EA	Enumeration Area
EU	European Union
DHS	Demographic Health Survey
HELIUS	Healthy Life in an Urban Setting
IOM	International Organization on Migration
IQR	Interquartile range
OECD	Organization for Economic Cooperation and Development
PR	Prevalence Ratio
RODAM	Research on Obesity and Diabetes among African Migrants
SD	Standard Deviation
SSA	Sub-Saharan Africa
SES	Socio-economic status
UN	United Nations
WHO	World Health Organization
WHO FCTC	World Health Organization Framework Convention on Tobacco Control
WMA	World Medical Association

Abstract of PhD

This PhD research examined how: smoking varied among a homogenous population from Ghana living in different locations; among different ethnic groups living in Amsterdam and; across the sub-Saharan African region. Ghanaians comprised one of the largest African migrant groups living in Europe. This provided an opportunity to study how smoking differed between migrant and non-migrant Ghanaians and to other ethnic groups. The factors associated with smoking were determined to inform strategies to prevent smoking among immigrant ethnic-minority groups living in developed countries.

Three study methods were used: a systematic review of smoking in sub-Saharan Africa; a cross-sectional study of Ghanaian populations living in 3 European cities and Ghana (RODAM); and a cross-sectional study of ethnic groups living in Amsterdam (HELIUS).

The main findings that emerged showed that gender seems to be the strongest determinant of smoking among adults in sub-Saharan Africa. Smoking among the Ghanaian migrant population is multi-factorial in nature, with exposure to a high smoking environment having a strong influence, though the prevalences are still far lower than the European population. Factors including one's immediate social networks operating through family, religion, social communities, culture and higher education are associated with a lower uptake of smoking. Compared to the Dutch and other ethnic groups in the Netherlands, Ghanaians smoked significantly less. However, the higher levels of smoking prevalence and higher levels of smoking cessation among some ethnic minority groups compared to the Dutch are largely, but not completely explained by SES. Smoking among migrant populations is related to cultural attitudes that exist towards smoking in both the country of origin and the host country.

It implies that if smoking is made culturally abnormal, as in Ghana, a significant reduction in the prevalence and onset can occur in developing countries where the smoking epidemic is increasing. Anti-smoking policies designed to target smoking within the lower SES groups of ethnic minority groups may substantially reduce ethnic inequalities in smoking.

Role in data collection

Throughout the PhD, I was a part of the data collection team for the RODAM project at the London location. Data collection was conducted during 2012 and 2015. The team was responsible for recruiting Ghanaian residents living in London into the study and collecting data according to the study protocol. To accomplish this, the team visited several locations across the London boroughs where Ghanaian communities often congregated for church services or meetings. This usually occurred on Sundays or Saturdays, depending on the occasion. At these meetings, the project was advertised to the Ghanaian community and invitations to participate were sent out. After an informed consent to participate was received, participants visited the data collection venue to participate in the study. I was often assigned the responsibility of taking physical anthropometric measurements from participants including weight and height, waist and hip ratios, bio-electrical impedance monitor, sitting blood pressure and lying blood pressure measurements. Due to my inability to speak the local Ghanaian language, I was unable to interview participants who often preferred to speak their local Asante Twi language. During September 2013, for two weeks, I visited the study location in Ghana, to participate in the fieldwork activities at the Kumasi and Obuasi locations.

Chapter 1 Introduction

1.1 Burden of smoking

To date, there is sufficient evidence which confirms the adverse effects of active smoking and passive smoking (exposure to second hand smoke or environmental tobacco smoke) on health.[1-9] Active smoking causes cancer of the lung, cardiovascular and respiratory diseases, negatively affects reproductive health and is associated with several other premature adverse health outcomes and death.[1] Exposure to second hand smoke can also cause lung cancer and cardiovascular diseases in persons who have never smoked.[1] Approximately 12% of all deaths among adults over 30 years globally and 16% in Europe (25% of men, 7% of women) are caused by smoking.[10] In 2016, lung cancer was predicted to cause approximately 274,000 deaths in men and women across countries of the European Union (EU) (28 as of 2013) [11] This will have accounted for 20% of all cancer deaths in both men and women in the EU.

Smoking is preventable, yet enormous health and financial burdens have been caused globally. In the United States, the economic burden of smoking translates into billions of dollars spent on health care (US$289-332.5 billion for 2009-2012), which includes billions lost in productivity because of premature mortality (US$151 billion in 2005-2009) and loss of productivity from being exposed to second-hand smoke (US$5.6 billion for 2006).[1] In the EU, the annual cost due to smoking was €517 billion with over €379 billion expended due to diseases of the lung (2011).[12]

1.2 Distribution of smoking globally

The prevalence of smoking varies across regions of the world. Among the 6 World Health Organization (WHO) regions, smoking is most prevalent in Europe (28%) and least prevalent in Africa (15%) (2011 estimates).[13] Although enormous health and economic burdens are as a result of tobacco consumption, cigarette consumption has risen by approximately 37% in the African region and declined by 5% in the European region from 1990 to 2013.[14] The rise in consumption among low and middle income countries is partly due to the marketing strategies of the tobacco industry which is directed towards new markets where population and economic growth is occurring.[15-17] Changes in social norms and attitudes towards smoking are also evident in these countries. Approximately 80% of the 6 million deaths from tobacco occurred in low and middle income countries in 2011[14].

1.3 Trends in smoking within the African region

The African region has experienced substantial economic[18] and population growth in recent decades.[19] As of 2015, the population of Africa represented 16% of the world population and this proportion is expected to surge to 25% in the year 2050.[20] The population growth rate and improved economic ability of the African region, allows persons to live longer but also presents more opportunities for cigarette consumption and the effects of cigarette consumption to be realized. Compared to the other WHO regions, the prevalence of current smoking among men in Africa (22%) is the lowest compared to men in the Americas (26%), South-East Asia (34%), Eastern Mediterranean (38%), European (38%) and the Western Pacific region (47%).[21] However for women, the low prevalence of 7% among women in Africa has slightly surpassed women in the Eastern Mediterranean (4%), South-East Asia (4%), and Western Pacific region (3%), but much lower than women in the Americas (16%) and Europe (19%). This suggests that the widespread social norms and attitudes towards smoking among African women may be becoming more tolerant in Africa but still less tolerant than the developed areas of Americas and Europe.

However among the younger generation, smoking trends are different.[19] Among boys, the prevalence in Africa (9%) is marginally higher than boys in South-East Asia (8%), the Eastern Mediterranean (8%) and the Western Pacific region (6%) but lower than boys in the Americas (15%) and Europe (15%).[22] Furthermore, the prevalence of smoking among African girls (3%) is similar to and slightly higher than girls in the Eastern Mediterranean, South-East Asia and Western Pacific regions but significantly lower than girls in the Americas (15%) and Europe (13%).[19] Although adult African men smoke the least compared to men in the other WHO regions, African women, African boys and girls appear to smoke more than other developing regions. These slightly higher prevalences among women and in the younger generation spark concerns about future increases in smoking within the African region.

The global differences in the prevalence of smoking reflects variations in underlying attitudes towards smoking which exists among men and women in different geographical regions of the world. It is reasonable to expect that migrating to different regions may affect changes in the attitudes of migrant groups in respective regions or countries. Given the distribution of smoking globally, male and female African migrants may be most at risk of experiencing a drastic change in wider smoking norms and prevalences when they relocate to a high-income country in Europe for example, bearing in mind that changes are already occurring among women and the younger generation within Africa itself.

1.4 Migration, its effects and influence on smoking, an overview

1.4.1 International migration trends

Individuals or groups migrate internationally for a variety of reasons including work opportunities, perceived net benefits in healthcare, education, improved financial stability, starting families and new lives in the new country of residence.[23] Over the years, developing low-income countries have overall experienced net emigration while developed high-income countries experienced net immigration.[24] Migrants to high-income countries usually travel from lower-income developing regions of the world.[23]

Europe is a popular destination of choice to which migrants from Africa choose to reside. According to the Organisation for Economic Co-operation and Development (OECD) Database on Expatriates and Immigrants, 2004 (Census Data 1999-2003), 13.6% of the foreign-born living in the EU were from Africa.[25] Approximately 4.6 million African migrants were living in Europe compared to only 890,000 living in the United States of America, this is according to estimates from the 2005 International Organization on Migration (IOM).[26] Of the sub-Saharan African migrants living in Europe, the majority came from West Africa, namely Ghana, Nigeria and Senegal.[27] According to the UN 2006 estimates, Ghanaians comprised 5% of the African Diaspora in the UK, 3% in Italy and 3% in Germany.

1.4.2 Ethnic and socio-economic Inequalities in health in developed countries

In the US, diabetes and cardiovascular diseases such as hypertension and its risk factors often affects minority ethnic groups like Blacks more than the native Whites in the population.[28] In Europe, risk factors for obesity and diabetes seem to disproportionately affect minority ethnic groups including West-African migrant groups than the local European populations.[29, 30] The prevalence of chronic diseases such as diabetes and obesity among West-African migrant groups in developed countries is also higher than their counterparts in their home country.[31, 32] It

may be due to migration-related changes in lifestyles which increases the risk for chronic disease in such migrant groups.

Previous research has recognized the relationship between lower socioeconomic status and increased risk factors for ill health.[33] In developed high-income countries, this socioeconomic disadvantage often more likely affects migrant and minority ethnic groups than the host populations.[34]

For smoking, the Centers for Disease Control and Prevention has observed that the risk of cigarette smoking tends to be higher among persons of lower socio-economic status than among persons of a higher socioeconomic status.[35] In Britain, rates of smoking appear to be the highest among the lowest income earning groups.[36],[37] Given that migrant minority ethnic groups in developed countries may be more prone to lower socioeconomic positions in society,[34] cigarette smoking may also be higher among certain minority ethnic groups.

1.4.3 Ethnic and generational differences in the prevalence of smoking in developed countries

Data show important ethnic variations in the prevalence of smoking in developed countries including the US,[38] the UK,[39] Spain,[40-42] and the Netherlands[43-46]. For example, research from the minority ethnic group health survey conducted in England in 2004,[47] compared the prevalence of smoking in males and females of different self-defined ethnic groups.[39] Indian men (20%) had the lowest prevalence of smoking while Bangladeshi men (40%) had the highest prevalence of smoking. Smoking prevalence among Black African men (21%) were more comparable to the UK general population (24%) which included the Pakistani, Indian, Bangladeshi, Chinese, Irish and Indian ethnic group. This was also similar to the prevalence of smoking among Black Caribbean men (25%). Among women, on the other hand, the lowest prevalence of smoking was among Bangladeshi (2%) while the highest prevalence

was among Irish (26%). Contrary to that seen among men, fewer women of Black African descent (10%) were smokers compared to Black Caribbean women (24%) and women in the general population (23%). This suggests that in spite of being of African descent, region of origin influences smoking among women more than men.

In the Netherlands, most research in the Netherlands have compared smoking rates in Turkish, Moroccan, Surinamese and Antillean immigrant groups to the native Dutch ethnic groups. In comparing Turkish to Dutch men, a higher prevalence of smoking was seen in 24-44 year old Turkish men (70%) than the native Dutch (43%). However, Turkish women had a lower smoking prevalence than Dutch women (prevalence not mentioned in the paper).[45] A literature review which covered the period 1985 to 2001 concluded that smoking is less common among Surinamese in the Netherlands compared to the indigenous Dutch population,[44] but recent research observed that the Surinamese men (52.5% of Dutch-based African Surinamese and 54.5% of Dutch-based Hindustan Surinamese) have higher smoking rates than Dutch-based men of European origin in the Netherlands (39.3%).[43]

Even generational differences in the prevalence of smoking among Turkish and Moroccan men and women were observed in the Netherlands.[46] Past research shows that the first generation Turkish men (54.9%) smoked more than second generation Turkish men (45.6%) and much more than the native Dutch men (36.2%), but the reverse is seen among women as second generation Turkish women (44.4%) smoked much more than first generation Turkish women (35.1%) who were similar to native Dutch women (32.8%).

One can hypothesize that the differences in the prevalence of smoking among ethnic groups and across generations in developed high income countries may be a reflection of the immigrants' pre-migratory smoking status, or factors of the post-migratory environment (socio-economic, social or cultural) which may influence smoking behaviour. The changes may involve a convergence towards the wider smoking norm but it may vary by gender.[46]

1.5 Migration-related theories and factors that may explain the different smoking rates among migrants compared to natives in the country of origin and the host population

Certain characteristics of immigrant populations including age, gender, age at the time of migration, period of migration, duration of stay, acculturation, exposure to tobacco control policies, influences of the country of origin or concepts such as the healthy migrant effect may influence migrants' smoking behaviour.

The following theories have been proposed.

1.5.1 Acculturation

Acculturation is defined as a process by which the cultural practices of a group, which in most cases is a minority ethnic group, changes after continuously interacting with another cultural group, the larger dominant group, overtime.[48] Cultural practices of a group broadly include but are not restricted to the behaviour, language, styles of dress, forms of music and art. The process by which these cultural features change overtime after continuous interaction with another cultural group is described in three stages. The first stage is *Contact*, which occurs either through social or more formal reasons such as for education, employment or medical care. The second stage, *Conflict*, occurs at the individual or societal level when cultural belief systems tend to oppose each other through differences in social norms, food and health habits. The third phase is *Adaptation*, which can manifest in three ways. One way in which Adaptation occurs is through *Adjustmen*t. This is where the minority group's lifestyle behaviours and cultural practices gradually resembles the dominant population, for example, in the use of language. Another form of Adaptation is *Reaction*. Here the minority group rejects features of the dominant group and as a result, the dominant group shows hostility towards them in a subtle or

direct manner. The minority group may often advocate for rights and acceptance of their own culture. *Withdrawal* is another form of Adaptation, which leads to segregation of the minority group due to failure to integrate into the wider society. The method by which an individual chooses to adapt is influenced by one's family, socio-ecological and multi-cultural influences. Two theories attempt to describe the process by which acculturation occurs, either in a one-dimensional or multi-dimensional method. The one-dimensional approach suggests that individuals gradually adopt the practices of the dominant culture but to varying extents and while their affiliation to their original culture is weakening over time, the dominant culture remains unchanged. A low acculturated individual will therefore show high features of the native culture and low features of the new dominant culture whereas a high acculturated individual will show low features of the native culture and high features of the new dominant culture.[48]

Berry et.al has defined 4 dimensions of acculturation: integration, assimilation, separation and marginalization, to reflect the different extents and scenarios in which the group can develop relationships with the larger society and maintain their original cultural heritage.[49]

Integration refers to when there are relationships developed with the larger society as well as maintaining one's cultural heritage. Assimilation occurs when there are relationships with the larger society but no maintenance of one's original cultural heritage. Separation refers to rejection of relationships with the larger society but maintenance of one's original culture. Marginalization on the other hand refers to both the rejection of relationships with the larger society and rejection of one's cultural heritage.[49]

Measuring acculturation

The following can be investigated in a one-dimensional approach using it one at a time or in a multi-dimensional approach assessing a combination of factors simultaneously.

The indicators most frequently used to measure acculturation from research conducted in the US include the following:[48]

1. The use of and ease of using language while speaking, reading and thinking
2. Duration of residence in the host country (US)
3. First or second generation, and birth place of parents
4. Ethnic group of past friends and current friends
5. Majority ethnic composition of one's past neighbourhood and the one currently residing in
6. Preference for different types of music, radio stations, television programs, movies, newspapers and print media, books, celebrating holidays, and types of food.

Relationship between acculturation and smoking

Past research have assessed the relationship between acculturation and smoking by measuring the degree of acculturation by using the preferred language used as an indicator in a one-dimensional approach. In the US, the likelihood of cigarette smoking among Black immigrant groups was higher among those who had higher levels of language acculturation compared to persons with low language acculturation.[50] After adjusting for age and gender, persons with higher levels of language acculturation or those who adopted more of the American language, were 2.8 times more likely (95% CI 1.26, 6.22) to be current smokers than those with low to moderate levels of language acculturation.

Since acculturation refers to the adoption of values and behaviours of the present social environment in which ones lives,[38, 51] this implies that the longer a particular group lives in a

country, the more likely they are to adopt the habits of the host population. The relationship between acculturation and smoking may vary according to gender, ethnicity and age group.[52, 53]

1.5.1.1 Duration of residence

Duration of residence or length of stay is an indirect proxy measure of acculturation.[48] As was seen in studies in Mexican-Americans, duration of residence was significantly positively correlated with language acculturation. Language acculturation accurately predicts changes in health behaviour and the greater the minority group adapts the language of the dominant culture the more likely their health behaviour resembles the dominant group's norms.[54] Duration of stay can be used as a substitute for language acculturation measures since it assumes that the longer a person lives in the environment the more likely they are to better speak the language of the host country.

Residing for at least 12 years in the US was associated with higher rates of smoking in Mexican immigrants whereas those who stayed less than 12 years had a lower prevalence.[38] This suggested the longer persons were exposed to the American culture, the greater they were influenced to adopt the wider smoking habits.

The risk of current smoking among Turkish immigrants in Germany and the Netherlands differed according to a combination of their duration of stay in both the country of origin before migration and in the host country of Germany or the Netherlands after migration. Duration of stay was assessed according to short, medium or long length of stay.[55] The prevalence of smoking among male Turkish residents in Germany was much lower among those who lived for more than 32 years in Germany than those who lived for less than 32 years in Germany.[56] The smoking prevalence among residents who stayed for more than 32 years was similar to the native born German population, suggesting a convergence to the host population, and this was so for men with both high and low levels of education.

In addition to acculturation, a few schools of thought attempt to explain the reasons for adaptations in smoking behaviour upon migrating to a new environment.

1.5.2 Social Control Theory

The social control theory suggests that once an individual is removed from their social control structure comprising their families and local communities, their behaviour may drift away from what they normally do at home. This could explain the possibility for migrants to participate in unfavourable health behaviours like smoking when away from their normal environment.[52, 53]

1.5.3 Social Isolation Theory

Social isolation theory also attempts to justify the increased likelihood of engaging in risky health behaviours including smoking after migration due to the lack of social integration in the living environments migrants find themselves upon leaving home.[57, 58]

1.5.4 Segmented Assimilation Theory

Similar to the multi-dimensional approach of acculturation described above,[48] segmented assimilation theory states that although a person adopts some characteristics of the new cultural environment, they still retain and preserve a strong ethnic identity.[59] Therefore, the values and beliefs once practiced in their country of origin will influence their smoking behaviour in the new environment.[60]

1.5.5 Healthy migrant effect and immigrant generation

The healthy migrant effect describes the phenomenon by which although migrants may be of lower socioeconomic status than the host population, first generation immigrants are often healthier than persons of similar ethnic backgrounds who were born in the host country. This may be as a result of healthier and richer people being more likely to migrate, a type of self-selection. This phenomenon has been observed in research conducted in several developed countries including the US,[61, 62] Canada,[63] and Australia[64]. With the increase in immigration occurring in recent years across Europe,[65] some immigrants have reported and experienced poorer health outcomes than those born in the host country.[66, 67] Moreover it is projected that immigrants' health declines over subsequent generations [60] and as the time spent in the host country increases.[62, 68]

During 1995-1996 a nationally representative survey, the Current Population Survey (CPS) of over 220,000 non-institutionalized US residents including both first and second generation migrant populations was conducted. The relationship between daily smoking and first or second generation migration status was investigated.[60] Persons who were born in a foreign country or second generation immigrants with foreign born parents were less likely to smoke than persons who were born in the host country (US) with both parents born in the US or only one parent born in a foreign country.[60] This may indicate the presence of cultural norms being handed down through the generations which influences smoking behaviour.

Along with the above theories, a number of key migration-related factors may influence changes in smoking behaviour.

1.5.6 Age of migration

Adolescent immigrant groups seemed to be more vulnerable to taking up smoking than native adolescents. Approximately 49% of the adolescent immigrants in Spain consumed cigarettes throughout their lifetime compared to 39% of the native Spanish adolescents.[69] Similarly in the US, higher proportions of Latino adolescents than non-Hispanic native white adolescent Americans used cigarettes.[70] Later research on US Hispanic populations found that migrating at a younger age, probably earlier than 15 years, was a significant predictor of smoking.[38] "Ever smokers" were more likely to be those who were born in Mexico and migrated to the US at a younger age and therefore lived in the US for a longer time than "never smokers". This indicated the possibility of certain peak periods in the developmental stage where the likelihood of beginning smoking is greater.[38]

The relative risk of smoking varied across second and first generation migrants who first migrated during different key age groups of 0-19, 20-39 and 40-85 years to the US. Significant differences in the risk of smoking was present across these age groups for migrants from thirteen countries.[71] However, the linear relationship between increasing age at the time of migration and lower risk of smoking was only present in immigrants from the Philippines in the US.

1.5.7 Period of migration

The peak periods during which adults migrate to the same host country may vary according to different historical events occurring in different countries.[72, 73] Residents of the Netherlands of Ghanaian, Moroccan, Turkish, and Surinamese descent had different circumstances occurring in each country which resulted in mass migration to the Netherlands during different peak periods.[72] Political instability during 1975 and 1980 in the former Dutch colony of Suriname caused descendants of West African and North Indian origin living in Suriname to move to the

Netherlands. The Turks and Moroccans migrated during the 1960's and early 1970's to supply the demand for unskilled labour in the Netherlands. Subsequently these workers brought their families to settle in the Netherlands during 1970 to 1980.

During the late 1970's, economic and political crisis forced many immigrants along with skilled Ghanaian workers to leave Ghana to find employment mainly in Nigeria and also European destinations including the Netherlands.[74] Ghana was experiencing net emigration, many doctors, teachers and administrators left. However, later during mid 1980's economic decline in Nigeria also forced over a million Ghanaians out of Nigeria.[74]

An earlier historical period of migration corresponds to being exposed to former smoking norms in the country of origin which may be different to the habits practiced now. Also it may reflect a longer exposure to more comprehensive tobacco control policies in the host country compared to weaker policies in country of origin for migrants who move from a developing to a developed country.[75]

1.6 Comparison of smoking among homogenous groups in different locations

Comparing groups of the same ethnicity or country of origin in different locations is useful for understanding risk factors intrinsic within the group as a whole and those that lie in the environment.

1.6.1 International migration and smoking

Smoking data of migrants residing in the US was obtained from the Tobacco Use Supplement of the Current Population Survey conducted in the US, and this was compared to the smoking prevalence of populations in the respective countries of origins for which data was obtained from the World Health Survey.[71] Comparisons of smoking prevalences were made between

immigrants from Ethiopia and other African countries (Ghana, Kenya and South Africa) with residents in their home countries and to the native US residents.[71] The study showed that the age-standardized smoking prevalence of male Ethiopian immigrants resident in the US were similar to Ethiopian men residing in Ethiopia (approximately 10% in each location). However, the smoking prevalence for women of Ethiopian descent in the US (approximately 6%), seemed significantly higher than women in Ethiopia (approximately 1%). For men and women from other African countries, migrants seemed to smoke less than persons in the country of origin. One limitation however is the smoking prevalence for persons from Ghana, Kenya and South Africa were combined so the true smoking prevalence in each country was not known. The smoking rates in Ghana may differ substantially from smoking rates in South Africa and their migrants in the US. In comparison to the population born in the US, the prevalence and relative risk of smoking among migrants from Ethiopia and Other Africa were consistently lower.

Turkish adults who migrated to the Netherlands (44.3%) smoked more than those who migrated to Germany (37.2%).[55] This suggested that the smoking behaviour of the Turkish immigrant group becomes similar to the majority host population of the country that they lived in as time increased. This was supported by the findings that Turkish men with a shorter length of stay in either the Netherlands or Germany were less likely to smoke than those with longer length of stay in the Netherlands or Germany. The trend can increase or decrease overtime varying by gender.

1.6.2 Rural to urban migration and smoking

Although it appeared that some migrant groups tend to smoke less than native populations,[38, 40-42, 50, 76] migration from rural to urban cities has been associated with a higher prevalence of smoking among women.[77, 78] Another study comprising over 4,000 rural to urban migrant workers found that workers' smoking rates increased after migrating to large urban Chinese cities.[79] Although China is the largest producer and consumer of cigarettes in the world,[22]

the authors proposed circumstances like solitude, stress and higher income put these migrants at risk of starting smoking following migration.[79]

1.7 Smoking initiation

1.7.1 Reasons for taking up smoking

Several factors influence whether a person would begin smoking. Brannon and Feist,[80] highlighted several different reasons why individuals smoke. The diagram below shows the different factors that may be associated with smoking initiation among migrants.(Adapted from Brannon and Feist).[81] In addition to factors identified by Brannon and Feist, tobacco control measures at the population level such as the absence of comprehensive bans on tobacco advertising and promotion can influence vulnerable adolescents to start smoking (Figure 1.4).[82]

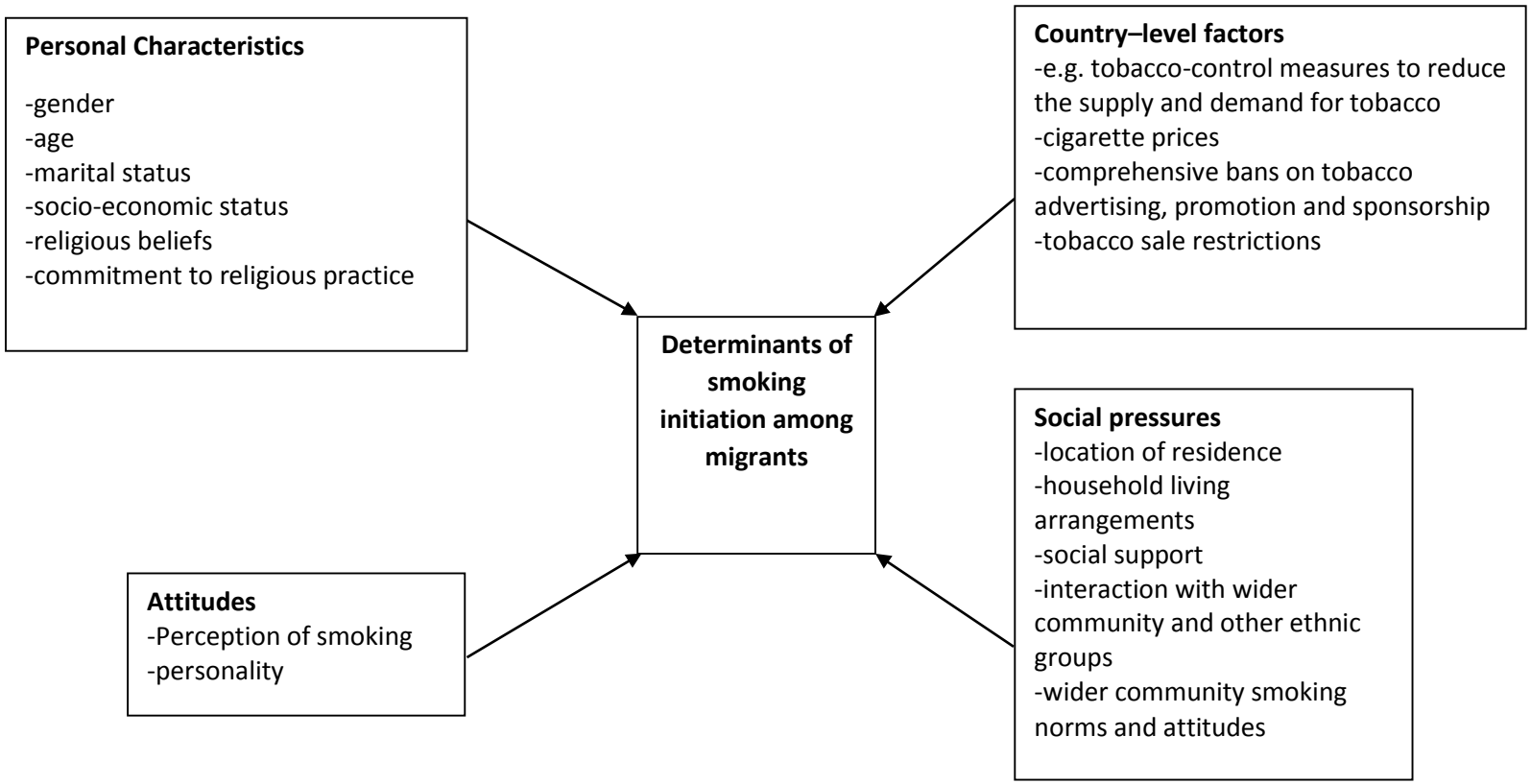

Figure 1.1 Determinants of smoking initiation

SOURCE: [Adapted from Brannon and Feist].[81]

1.8 Smoking cessation

1.8.1 Definition of smoking cessation

Smoking cessation is the process by which a current smoker has made an attempt to stop smoking and a change in their smoking status from current to former or ex-smoker occurs for a significant period of time.[83]

1.8.2 Benefits of smoking cessation

The million women study in the UK[84] and research conducted in the US[85] have shown that stopping smoking by the age of 40 will prevent 90% of the smoking related mortality, and 97% of the smoking-related mortality if a smoker stops at the age of 30.[84] Women who smoked fewer than 10 cigarettes daily at the time of recruitment in the UK had twice the mortality rate of non-smokers 12 years later. Among smokers, 93% of the deaths from lung cancer, 89% of deaths from respiratory disease, 69% of deaths from ischaemic heart disease, 61% of deaths from vascular diseases, and 40% of deaths from stroke are attributable to smoking.[85] Stopping smoking significantly reduces the risk of cardiovascular and the above mentioned diseases.[86] The earlier adults stopped smoking, the more years of life will be gained due to the aversion of deaths caused by smoking.[84, 85]

1.8.3 Importance of smoking cessation for policy

Smoking prevalence in combination with smoking cessation prevalence are useful monitoring statistics for tobacco control policy makers.[87] If the prevalence of smoking remains high and the percentage of smokers who have quit remains low, then it is an indication that tobacco control interventions are not working.[35] Smoking prevalence is a combination of both smoking initiation and smoking cessation that has happened in a population over time. Throughout the human lifespan, smoking initiation typically begins during adolescence while smoking cessation occurs in adulthood.[88] Although an increase in smoking among adolescents can increase the prevalence of smoking, smoking-related morbidity and mortality among adolescents will be delayed for several decades.[84, 85] Smoking cessation prevalence rates can be useful for understanding whether smoking behaviour is changing over time. This is even more important for regular smokers in which the effects of smoking can be drastically reduced after quitting.

The reasons for stopping smoking would be different for young persons than regular smokers. A young adult under the age of 25 may still be experimenting with smoking and have not yet become a regular smoker. Therefore, a younger person's reasons for quitting smoking may be very different from a regular smoker who have decided to stop.[87] Similarly an occasional smoker's positive response to quitting smoking may not be a real cessation. Caution should be made not to include persons under the age of 25 and occasional smokers in cessation analyses as was done in previous research.[87]

1.8.4 Measuring smoking cessation using quit ratios

Quit ratios have been used to assess smoking cessation rates at the population level in a number of studies.[43, 89-91] Quit ratios represents the ratio of the number of former smokers to the

number of ever smokers in a population. The quit ratio is a cumulative measure of smoking cessation in a population of smokers over time and not a reflection of recent smoking cessation as a result of a tobacco control intervention or smoking cessation occurring at the individual level.[92]

1.8.5 Reasons for quitting smoking

There exists a complex interplay of factors associated with quitting smoking. The diagram below, adapted from van Loon et al. 2005, illustrates the interplay of several factors related to deciding to continue smoking or deciding to quit smoking among migrants (Figure 1.2).[81] In addition to the factors outlined by Van Loon, the presence of anti-smoking legislation, tobacco control measures in the environment can also influence smoking outcomes.[82, 93]

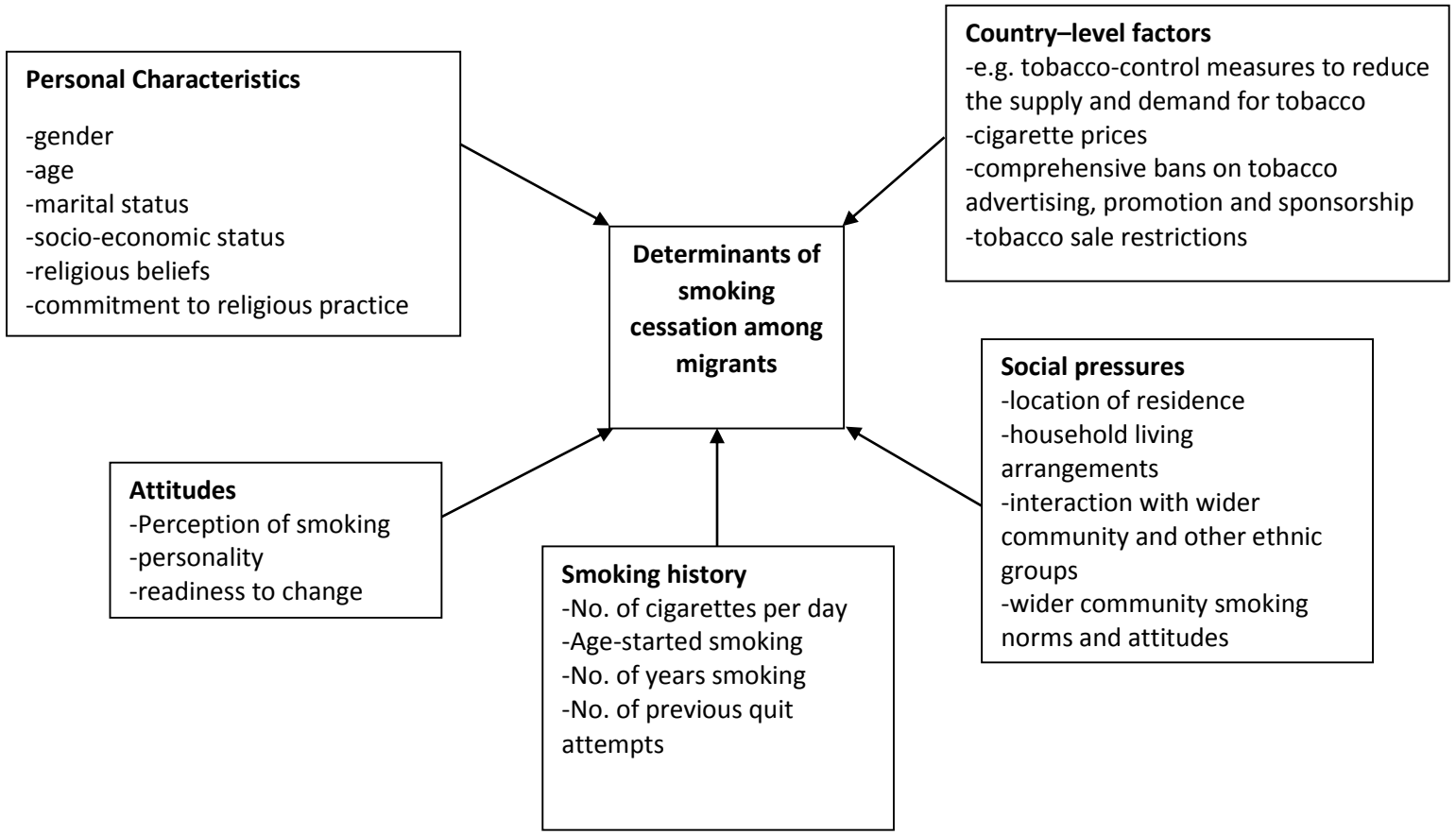

Figure 1.2 Determinants of smoking cessation SOURCE: [Adapted from Brannon and Feist].[81]

1.9 Importance of migrant health studies

In 2013, Europe hosted 72 million international migrants, with approximately two thirds of all international migrants living in European and Asian countries.[94] Among the European countries, Germany and the UK were in the top 10 countries globally with the highest number of international migrants during 1990 to 2013, 10 million and 8 million respectively.[94] Between 1990 and 2013, Europe saw an increase of 23 million international migrants, equivalent to approximately 1 million migrants entering the region per year. After North America, Europe received the second largest increase in the number of international immigrants. The overall proportion of international migrants living in the total population increased rapidly in the European region, increasing from 7% in 1990 to 10% in 2013. Among this additional 23 million international migrants settling in Europe, 18% were born in Africa.

This influx of immigrants into the European region has diversified the face of the European population, creating a rising number of ethnic minority groups with different lifestyle practices, health risks and health outcomes than the destination country. These health risks and lifestyle practices of migrants therefore needs to be monitored, studied, and targeted health interventions be designed and incorporated into national health policies given the changing face of European countries.[95]

The presence of health inequalities observed between migrant ethnic minority populations and the destination country confirms that risks are different and targeted ethnic specific health interventions are necessary. The difference in health outcomes between migrant groups and non-migrant groups in countries of origin probes further investigation into the contribution of genetic and environmental determinants that influence health. The World Health Organization report on the Health of Migrants has resolved to take specific action with regards to monitoring the health of migrants.[95] Suggested actions encourage using new approaches to collect health related data on migrants with the ultimate aim of improving their health. This mandate emphasizes the importance and value of migrant studies to improving the health of ethnic

minority populations in European countries. Studying migrant groups in different locations improves the understanding of the impact of genetics and the environment on health risk and outcomes. The theoretical framework underlying the study of migrant groups is that upon moving to different destinations, structural and cultural aspects of the new environment along with genetic, and cultural and behavioural traits brought from the country of origin interplay to influence differences in risk of diseases. Disentangling of these factors helps identify those risk factors that can be changed and those that are inherent to the migrant group and even those that are altered by environmental influences.

Epidemiological studies looking at the health of migrant populations in destination countries can be analysed in two approaches.[96] The first option is to measure the prevalence of the health outcome at the time of arrival in the migrant population and compare this to the prevalence in the host population. The second option is to measure the prevalence or incidence of the health outcome in the migrant population after migration and compare to the host population or the non-migrants in the country of origin. Research on migrant health has previously focused on controlling the spread of communicable diseases after migration.[97] More recently, with increasing international migration, other aspects of migrants' health has taken research priority. Research now consider the influence of genetic and ethnic profiles,[98] on morbidity from chronic diseases,[99-101] and also how lifestyle practices and prior health statuses are affected due to migration.[102]

Research on the health of migrants at the population level is important since it studies the movement of populations between different health environments with different prevalences of diseases and risk factors.[103] Variations in health outcomes between populations are attributable to social and economic factors, access to and availability of health care, behavioural and cultural practices and population and cultural norms. Migrant populations carry with them health characteristics of their countries of origin when they migrate.[104] For example, migrant populations may travel from a country with a high prevalence of disease or low access to

healthcare interventions. On settling in the new country the migrant population will show differing incidence and prevalence of health outcomes compared to the host population and also exhibit different levels of awareness and uptake of preventative, diagnostic, promotional and therapeutic healthcare services to name a few as a consequence of exposure to the health environment in their country of origin.[103]

Over the last half century, a number of major historical events have changed the face of emigration and immigration globally.[103] The end of colonialism by European countries after World War II in Africa, Asia, the Middle East and Latin America and the Caribbean has removed migration restrictions on millions of individuals in these regions. For example, in North America, during 1960 to 2000, most immigrants came from Asia, Africa, Central and South America and the Middle East which was a shift from the traditional European origins.[105] Increasing international travel facilitated greater transfer of these migrants to and from Europe and the Americas, the regions with the greatest increase in international arrivals over 1950 to 2000.[106] This increase in migration and travel to and from areas with different prevalence of diseases can cause migrant populations to have different patterns of disease and health risk behaviours than the host population since they carry their risks with them. This pattern has been observed for infectious diseases including tuberculosis,[107] and HIV,[108] which are more common in migrant populations than the European population due to different lifestyle behaviours practiced between the country of origin and destination country. These patterns are also present for non-communicable diseases since migrants from less developed countries may not be exposed to preventative health care, screening, therapeutic interventions and other health promotion programmes such as for smoking, alcohol and drug abuse. Therefore, in the absence of these health interventions, migrants from less developed countries may display later stages of disease when first detected compared to those in the developed host country.[109]

1.10 Introduction to research question

1.10.1 Summary of previous sections

Smoking is more prevalent among the population in European countries than sub-Saharan African countries.[16, 110, 111] Furthermore, smoking is particularly uncommon among women in SSA compared to women in Europe. However, the prevalence of smoking in SSA is expected to rise. There are indications of a higher smoking prevalence among the younger generation of girls and boys[19] and in certain countries the gender gap appears to be narrowing.[112, 113] Since smoking differs across geographic regions of the world, we could expect the smoking behaviour of migrants and non-migrants from SSA to differ somewhat due to exposure to different smoking norms and cultures. Some studies have recognized different prevalences of smoking between adult groups from the same country of origin living in different developed countries e.g. the Netherlands and Germany and the US.[55, 71]

1.10.2 Critique of the literature

Research on ethnic differences in smoking often group persons of African descent into a broad category of persons of Black descent.[47, 60] Some have made more defined categories by looking at the African ethnicity more specifically according to region of birth, either born in Africa, the Caribbean or in the host country.[50] Yet differences in smoking exist across countries in Africa and within countries and combining populations into broad categories obscures these variances.[114, 115]

1.10.3 Gaps in the research

Few studies compared the smoking prevalence of adults from the same country living in different locations.[55, 71] Particularly for adult migrants from the African region, the region with the lowest prevalence of smoking,[110] and therefore at most risk of being influenced by exposure to a different smoking culture upon migration to the European region.

This lack of research on smoking among African migrants is evident in Europe.[43-45] How comparable the smoking behaviour of sub-Saharan African migrants is to other ethnic groups in Europe is unknown. Furthermore, the generational differences in smoking among sub-Saharan African migrants have not been analysed.[46] More specifically, research on the risk factors and migration-related factors associated with current smoking among sub-Saharan migrants in developed countries have not been done.

It is not sure to what extent men and women from SSA diverge from the smoking norms of their country of origin after migration. Given the wide gender gap in smoking present among most countries in SSA,[114, 115] it is unclear whether the smoking gender gap among migrants differs from what is observed in countries of origin since there are suggestions of migrant Ethiopian women smoking more than women in country of origin.[71] It is uncertain whether the theory of segmented assimilation is more applicable to sub-Saharan African migrants than integration with regards to smoking behaviour.

1.10.4 Rationale for research

Evidence shows that internal and international migration is accompanied by changes in lifestyle behaviours due to exposure to new environments, norms and interactions with dominant and other cultures. Smoking is one such lifestyle behaviour that differs across geographical locations and high income and low-income regions. Smoking behaviour may change due to the acculturation of one ethnic group towards the smoking norms of the host population. Exposure to the implementation of tobacco control policies and anti-smoking interventions in an environment, along with personal, family-level and community level attitudes can influence whether smoking initiation and smoking cessation occurs. Current smoking prevalence is a product of changes occurring in the environment in which smokers, persons who are vulnerable to taking up smoking and persons who are prone to a smoking cessation relapse live.[88]

While some evidence shows that migrant groups in host countries tend to smoke less than the native born host populations, there is an inclination to expect that the longer certain groups reside in host countries, the more likely they may be to smoke compared to recently immigrated groups. This lies on the assumption that smoking may be less common in the country from which persons have migrated and more common in the country of destination. On the other hand, being resident in an urban area may influence higher cigarette smoking prevalence than in rural areas and may affect women differently to men, depending on whether smoking is more common in urban areas than rural areas. One can also hypothesize that the longer migrant groups reside in a host country where smoking is common, the more different their smoking rates would be to the population of their original home country and the more similar it would be to the country in which they reside. It can be expected that the migrant group in the host country would have a higher rate of smoking than those living in their home country if the smoking rates in the home country are lower than the respective host country.

Changes in smoking behaviour post migration have been documented in Ethiopian immigrants in Toronto, where more females than males begin smoking after migrating.[71, 116] However, much less is known about the effects of international migration from sub-Saharan Africa to Europe, and the smoking rates of sub-Saharan African groups in Europe have not been compared to the smoking rates in sub-Saharan Africa itself.

Taking into consideration the impact of explanatory factors such as age, gender, educational level and professional level on smoking prevalence this research thesis will investigate whether smoking prevalence differs among different ethnic groups within a country and also between the same ethnic group in different countries, using a cross-sectional comparative approach.

With respect to smoking cessation, determining whether individual current smokers have stopped smoking over time is not possible due to the cross-sectional design. Therefore, quit ratios will be used to indirectly determine the cumulative rate at which smoking cessation is occurring within ethnic groups.

There are many different types of tobacco products used worldwide including cigarettes, cigars, pipes, water pipes, bidis, kreteks, chewing tobacco, moist snuff, and dry snuff. Among all the tobacco products sold worldwide, cigarettes account for 92% of the products sold.[22] Cigarettes are also the most common smoked tobacco product. Investigating cigarette smoking is therefore a good indicator of tobacco use. Therefore, this research has predominantly focused on assessing cigarette smoking. However, the systematic review has included the use of other tobacco products if this was how tobacco use was assessed in the respective studies.

1.11 PhD Aims and objectives

1.11.1 Aim

To investigate the smoking prevalence and patterns in a group of black Africans in different settings.

1.11.2 Objectives

1. To systematically review the literature on the prevalence of smoking among sub-Saharan African countries for the period 2007 to 2016.
2. To compare the smoking prevalence among adult Ghanaians living in rural and urban areas of Ghana and in European cities of London, Amsterdam and Berlin.
3. To explore the factors associated with smoking among Ghanaians in their home country and in three European cities.
4. To compare ethnic differences in current smoking and smoking cessation and the association with socioeconomic factors among ethnic groups in the Netherlands.

Chapter 2 A systematic review of tobacco smoking prevalence and description of tobacco control strategies in sub-Saharan African countries; 2007 to 2014: Research paper 1

This chapter focuses on reviewing the literature on the prevalence of smoking within the sub-Saharan African region. It presents the recent estimates of smoking prevalences for countries in SSA and identifies differences in smoking across rural and urban locations within countries in the region. This systematic review has been published.[117] See Appendix 2.1. This has since been updated to include relevant studies published after May 2014 to May 2016.

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SECTION A- Student Details

Student	Rachel Brathwaite
Principal Supervisor	Liam Smeeth
Thesis Title	Differences in smoking by location of residence, ethnic group and country of origin: The Ghanaian perspective in sub-Saharan Africa and Europe

If the Research Paper has previously been published, please complete Section B, if not please move to Section C

SECTION B- Paper already published

Where was the work published?	PLOS ONE		
When was the work published?	July 10, 2015		
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Stage of publication	Choose an item.

SECTION D- Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	Rachel Brathwaite performed the search of the databases for articles to be included and excluded from the systematic review. The first draft was written by RB and constantly revised after receiving feedback from co-authors

Student Signature: Rachel A Brathwaite **Date:** 10/10/2016

Supervisor Signature: L Smeeth **Date:** 10/10/2016

2.1 Abstract

Objective

To systematically review current smoking prevalence among adults in sub-Saharan Africa from 2007 to May 2014 and to describe the context of tobacco control strategies in these countries.

Data sources

Five databases, MEDLINE, Embase, Africa-wide Information, CINAHL Plus, and Global Health were searched using a systematic search strategy. There were no language restrictions.

Study selection

26 included studies measured current smoking prevalence in nationally representative adult populations in sub-Saharan African countries.

Data extraction

Study details were independently extracted using a standard datasheet. Data on tobacco control policies, taxation and trends in prices were obtained from the Implementation Database of the WHO FCTC website.

Results

Studies represented 13 countries. Current smoking prevalence varied widely ranging from 1.8% in Zambia to 25.8% in Sierra Leone. The prevalence of smoking was consistently lower in women compared to men with the widest gender difference observed in Malawi (men 25.9%, women 2.9%). Rwanda had the highest prevalence of women smokers (12.6%) and Ghana had the lowest (0.2%). Rural, urban patterns were inconsistent. Most countries have implemented demand-reduction measures including bans on advertising, and taxation rates but to different extents.

Conclusion

Smoking prevalence varied widely across sub-Saharan Africa, even between similar country regions, but was always higher in men. High smoking rates were observed among countries in the eastern and southern regions of Africa, mainly among men in Ethiopia, Malawi, Rwanda, and Zambia and women in Rwanda and rural Zambia. Effective action to reduce smoking across sub-Saharan Africa, particularly targeting population groups at increased risk remains a pressing public health priority.

2.2 Background

The prevalence of smoking differs widely across populations in the world.[22, 118] Many factors are known to influence smoking prevalence and trends in prevalence, from individual level factors such as education level, to country-level factors such as national economic development and implementation of tobacco control policies.[119, 120] The highest prevalence of tobacco consumption has previously been found in high-income Western European countries, with a 37% prevalence among men and 25% among women.[16, 22] During the years 1990 to 2009, cigarette consumption in Western Europe declined by approximately 26%. Simultaneously during the same period, cigarette consumption in Africa and some middle Eastern countries increased by 57%.[22] Sub-Saharan Africa (SSA) is considered to be in stage one of the tobacco epidemic continuum.[121] One characteristic of this first stage is a predominantly higher prevalence of smoking among men than among women. The estimated prevalence of smoking in SSA in 2010 was 14% in males and 2% in females, which supported this first stage criteria.[16] A previous systematic review published in 2006 on the prevalence of smoking among adult populations in SSA was conducted using studies published before 2005.[114] In that review, men smoked more than women in all the sub-Saharan African countries represented. However, most of the studies in the review used study samples that were not representative of the national general populations, since only 6 national studies were amongst those included of which 4 were from South Africa and one each from Malawi and Zambia.

2.3 Aim of the review

The aim of this study was to systematically review the literature in order to provide contemporary estimates of the prevalence of smoking among adults in SSA from January 2007 to May 2014. The country-level tobacco policies across SSA were described to give some context and background about what is occurring to tackle smoking prevalence.

2.4 Materials and Methods

2.4.1 Search strategy for relevant articles

In May 2014, five databases of MEDLINE, Embase, Africa-wide Information, CINAHL Plus and Global Health were searched using a strategy merging terms for sub-Saharan Africa and the countries in them, smoking, and terms for types of studies. Appendix 2.2 provides details of the search strategy used. All of the references cited by the included studies were screened for other relevant articles.

2.4.2 Inclusion criteria

The titles and abstracts of the results generated from the searches were screened using the following inclusion criteria:

i. The participant recruitment strategy of each study must have involved sampling from a representative sample of the general population, and/or from a rural or urban area in a country in sub-Saharan Africa
ii. The sample size must comprise more than 1000 participants
iii. The research must have estimated the prevalence of current smoking in the sample
iv. Data must have been collected during 2007 and May 2014

The searches were limited by date of publication from 2007 to May 2014, but not by language of publication. Research studies conducted in a sub-Saharan African population in another part of the world, or using unrepresentative population samples within Africa (e.g. only adolescents or older populations, employed workers, hospital patients or community-based unrepresentative samples) were excluded. (Refer to Appendix 2.3 which indicates the reasons why studies were excluded from the review).

Potentially relevant articles were obtained after screening titles and abstracts, and decisions on including studies were made after reading the full texts. Data were extracted following a standard protocol and using standard data collection forms and checklist by a single reviewer (RB) with uncertainties resolved by discussion with the co-authors.

2.4.3 Appraisal of study validity

To assess the quality of individual studies and to determine whether it would be included in the review, the following criteria were used:

1. Likely representativeness of the general population: whether nationwide sampling frames or more locally based populations were used; whether random population sampling, multi-stage sampling, or all participants were recruited from the entire sampling area.

2. In addition to a good representative sample, the study must have used either a large sample size and or obtained a high response rate. If the response rate was not reported in the study, the sample size and the recruitment method was assessed to see if it was sufficient to indicate if the study was of good quality.

2.4.4 Rationale for inclusion criteria

The above mentioned inclusion criteria was applied to minimize the presence of selection bias affecting the results obtained.[122] This ensured that the included studies addressed the question of interest and provided evidence on the prevalence of smoking in a sub-Saharan African area. The way in which participants were chosen to participate, and the participation rates can be a major source of selection bias and therefore these methods were assessed before a study was included. As a result, only studies that ensured that the recruited individuals were representative of the target population and or the selection process involved a form of randomization were included. In combination with having a fairly random recruitment method, which should yield a representative sample, including studies with a minimum sample size of 1000 would ensure that a more precise estimate of current smoking in the target population was obtained due to less sampling error compared to a smaller sample size.

2.4.5 Search for preventative measures

In an attempt to explore some contextual factors which might be influencing the prevalence of current adult smoking among countries in sub-Saharan Africa, the preventative measures that were in place at the country level to reduce tobacco consumption were described. The documentary evidence for the implementation status of Articles 6 and 13, the last two components of the MPOWER policy package, which falls under the Demand Reduction measures of the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) Treaty were examined.[17, 93] These included whether the country has enforced bans on tobacco advertising, promotion and sponsorship and whether taxes on tobacco has been raised. Some components of Article 16 under the Supply reduction measures of the Treaty provisions, which requires bans to be placed on sales to and by minors were also examined. The information

on preventative measures was obtained from the Implementation Database of the WHO FCTC website.[93, 118] For each included country, data was extracted where available on the date of adoption of the WHO FCTC and the status of the following were recorded: whether tax policies to reduce tobacco consumption were present; what proportion of the retail price of cigarettes comprised taxes; and whether there has been an increasing or decreasing trend in tobacco prices. Also under the tobacco advertising and sponsorship article, data on whether smoking was banned in public places and if comprehensive bans on all tobacco advertising, promotion and sponsorship were present was gathered. Under the supply reduction measures, prohibition on the sale of tobacco products from vending machines and of individually packaged or packets of small cigarettes were examined.[93]

2.5 Results

2.5.1 Description of study populations and methods of measuring current smoking

26 papers were included in the review (Figure 2.1). These described 21 studies which represented research conducted in 13 countries of sub-Saharan Africa. The characteristics of study populations are presented in Table 2.1. Among these 13 countries, five were geographically located in the west (Ghana, Nigeria, Senegal, Sierra Leone, and Togo), one in the central region (Congo) and seven located in the eastern and southernmost regions of Africa (Ethiopia, Kenya, Malawi, Rwanda, Uganda, Zambia and South Africa). Estimates of the prevalence of current smoking obtained from the included studies represented the period 2007 to 2012, with sample sizes that ranged from 1,412 in Congo to 72,292 participants in Kenya.

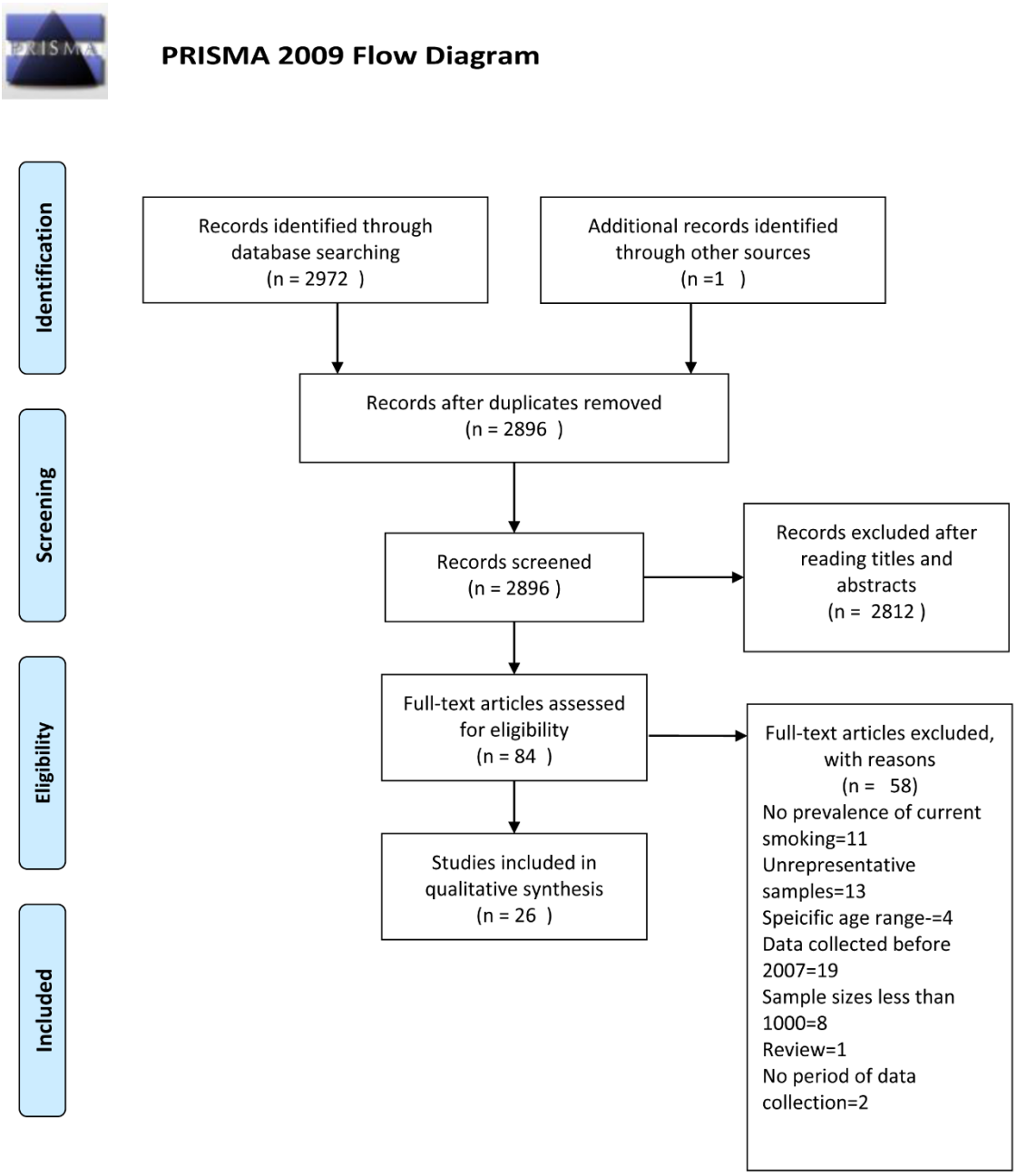

Figure 2.1 Flow diagram of inclusion and exclusion of articles in systematic review

Table 2.1 Characteristics of study populations of included studies

First Author [year of publication]	Country, year of data collection, reference	Age range	Median (IQR) Age	Mean (SD)	Total sample size	Response Rates %	Definition of current smoking as measured in the study
Nyembue, T.D. [2012]	Congo, 2010,[123]	5-83	-	29 (16)	1412	93.4	-Active smoking
Alemseged, F. [2012]	Ethiopia, 2008-09,[124]	15-64	-	-	5500	81.3	-Current smoker No/Yes
John, R.M. [2012]	Ghana, 2008,[125]	15-49	-	-	9484	98.9	-Currently consumed cigarettes
Owusu-Dabo E. [2009]	Ghana, 2007-08,[126]	14-105	31	-	6258	88.0	-Smokes at least 100 cigarettes in his or her lifetime and smokes nowadays
Bloomfield, G.S. [2013]	Kenya, March to July 2010,[127]	>18	35 (26,50)	-	4037	93.0	-Tobacco smoking- Currently daily (within the last 30 days) -Tobacco smoking- Currently but not daily (within the last 30 days)
Ayah, R. [2013]	Kenya, 2010,[128]	>18	-	33.4 (11.6)	2061	-	-Current cigarette smokers
Lo, T.Q. [2013]	Kenya, 2011,[129]	>18	-	-	72292	-	-Currently smoked at least 100 cigarettes and smoking at the time of the interview -Smoked daily
Msyamboza, K.P. [2011]	Malawi, 2009,[130]	25-64	-	-	5206	94.5	-Tobacco smokers
Tafawa, A.O. [2012]	Nigeria, 2008,[131]	15-59	-	-	48871	98.3	-Use of smoking tobacco- cigarette, pipe or other
Ulasi, I. [2010]	Nigeria, 2007,[132]	25-64	-	43.8 (13.7)	1458	-	-Prevalence of tobacco smoking
Musafiri, S. [2011]	Rwanda, 2008-2009,[112]	15-80	-	38.3	1824	97.7	-Currently smoking at least one cigarette per day
	(Huye- rural)	-	-	-	788	-	
	(Kigali- urban)	-	-	-	1036	-	
Pessinaba, S. [2013]	Senegal, 2010,[133]	>15	-	43.4 (17.8)	1424	-	-Tobacco smokers- active smoking

First Author [year of publication]	Country, year of data collection, reference	Age range	Median (IQR) Age	Mean (SD)	Total sample size	Response Rates %	Definition of current smoking as measured in the study
Samai, M. [2011]	Sierra Leone, 2009,[134]	25-64	-	-	4997	91.0	-Current tobacco use (smoke and smokeless)
Alaba, O. [2013]	South Africa, 2008,[135]	>15	-	40 (16.7)	11638	69.0	-Non-smoker or smoker
Baragou, S. [2012]	Togo, October 2009 to January 2010,[136]	>18	-	45 (10)	2000	-	-Consumed at least one cigarette per day
Kinyanda, E. [2011]	Uganda, December 2008 to November 2009,[137]	>13	-	-	6663	65.6	-Current cigarette smoker of both manufactured and local cigarettes
Murphy, G.A.V. [2013]	Uganda, 2011,[138]	>13	-	34.4	6867	93.9	-Current daily smoking
Nuwaha, F. [2013]	Uganda, July to September 2012,[139]	>18	-	36.5 (15.2)	4142	-	-Currently consume tobacco
Mulenga, D. [2013]	Zambia, December 2008 to 2009,[140]	>25	-	-	2093 (total)	-	-Current smoking- do you currently smoke any tobacco products such as cigarettes, cigars or pipes
	(Kasama- rural)	-	-	-	1198	-	
	(Kaoma- rural)	-	-	-	895	-	
Zyaambo, C. [2013]	Zambia, 2011,[113]	>25	-	-	1627	-	-Current smoking- do you currently smoke any tobacco products such as cigarettes, cigars, or pipes
Siziya, S. [2011]	Zambia, 2008,[141]	>25	-	33.4 (11.6)	1928	-	-Currently smoked cigarettes

SD- Standard deviation; IQR-Interquartile range; -Data not available

Among the studies, current smoking among adults was determined using five broad criteria. Some researchers measured either 1) smoking of tobacco including all its products or 2) cigarettes only, while some assessed 3) the frequency of current smoking, that is, either daily or occasionally or 4) regularly during a specific time period prior to the study. 5) A few research studies measured the quantity of consumption within this time period.

From the 26 studies, age-specific smoking prevalence estimates were only presented in a total of four studies that were conducted in Ghana (2),[125, 126] Kenya[129] and Sierra Leone.[134] From this limited data we observed that the prevalence of smoking increased as the age category increased then decreased slightly in the older age groups.

2.5.2 Quality of evidence

Research using a nationwide sampling frame were conducted in Ghana,[125] Malawi,[130] Nigeria,[131] Sierra Leone,[134] South Africa,[135] and Uganda.[142] These studies therefore provided the strongest evidence on the prevalence of current smoking since the sampling methodology was the most representative of the general population area of the country. These studies had large sample sizes (4,997 in Sierra Leone,[134] 5,206 in Malawi,[130] 6,678 in Uganda,[142] 9,484 in Ghana,[125] 11,638 in South Africa[135] and 34,070 in Nigeria).[131] The response rates were also high among these national studies, with the lowest response rates observed in the Ugandan (65.9%)[142] and South African (69%) studies.[135] (Refer to Appendix 2.4 for supplementary data on details of the sampling methodology used in each study). In contrast high response rates were obtained in the studies in Sierra Leone (91%),[134] Malawi (94.5%),[130] Nigeria (98.3%)[131] and Ghana (98.9%).[125]

Other studies sampled from sub-regions of the population so the prevalence was less representative of the entire national population. However, the sampling methodology used ensured that the samples were representative of the area and that area was similar in characteristics to the general population. All studies used either multi-stage sampling strategies

to ensure random selection of participants or census type surveys where all residents in areas were eligible to participate. In addition, all studies recruited participants from a wide age range, apart from a few exceptions, most were from over 15 and 25 years up to age 64 which meant that most of the results were generalizable to not just a specific age group. Adequate sample sizes and good response rates were also observed among these sub-national samples.

Although response rates were not known for 9 studies, the methodology employed was of a high standard and the final sample size was large enough to justify the study of good quality to be included.[128, 129, 132, 133, 136, 139-141]

2.5.3 Main findings

The prevalence of smoking varied immensely among countries in sub-Saharan Africa ranging from 1.8% in Zambia to 25.8% in Sierra Leone (Table 2.2). Similarly, the state of implementation of tobacco control policies varied across the region (Table 2.3). The highest smoking prevalences in SSA were reported in South Africa, Sierra Leone and Zambia. In general, smoking prevalences were higher in national and sub-national studies conducted in Malawi, Nigeria, Rwanda, Sierra Leone, and South Africa compared to prevalences in Ghana, Senegal, Togo and Uganda.

Table 2.2 Prevalence (95% CI) of current smoking among adults in sub-Saharan African countries by rural urban location or nationwide

		Prevalence % (95% CI) among both men and women		
First Author [year of publication]	**Country**	**In urban area**	**In rural area**	**Overall nationwide prevalence**
Nyembue, T.D. [2012]	Congo	21.6	15.4	19.5
Owusu-Dabo, E. [2009]	Ghana	-	-	(U) 3.4 (3.0, 3.9)
	Ghana	-	-	(A") 3.8 (3.1, 4.4)
	Ghana	-	-	(A*) 4.3 (3.6, 5.0)
Bloomsfield, G.S. [2013]	Kenya	4.09	-	-
	Kenya	1.24✓	-	-
Ayah, R. [2013]	Kenya	13.1	-	-
Lo, T.Q. [2013]	Kenya	-	6.3	-
	Kenya	-	5.7π	-
Msyamboza, K.P. [2011]	Malawi	6.6 (4.7, 8.5)	10.9 (10.0, 1.8)	14.1
Tafawa, A.O. [2012]	Nigeria	(WP) 2.8 (2.4, 3.1)	(WP) 2.7 (2.4, 3.0)	(WP) 2.7
Ulasi, I. [2010]	Nigeria	-	-	14.6
Musafiri, S. [2011]	Rwanda	*18.2	*14.6	16.7
Pessinaba, S. [2013]	Senegal	-	-	5.8 (4.7, 7.2)
Samai, M. [2011]	Sierra Leone	-	-	25.8 (23.4, 28.2)
Alaba, O. [2013]	South Africa	-	-	22
Baragou, S. [2012]	Togo	-	-	9.3
Kinyanda, E. [2011]	Uganda	-	2.2	-
	Uganda	-	6.5 (5.8, 7.1)	-
Murphy, G.A.V. [2011]	Uganda	-	-	6.4
Mulenga, D. [2013]	Zambia	-	22.4	-
	Zambia	-	10.8	-
Zyaambo, C. [2013]	Zambia	-	-	1.8
Siziya, S. [2011]	Zambia	6.8	-	-

95% CI- 95% confidence interval; (U): Unadjusted; (A"): Adjusted for male under-response; (A*): Adjusted for male under-representation in the study sample, by population-based weighting using national survey data; (WP): weighted prevalence; *Not presented in paper, but enough data was presented for prevalence to be calculated manually. π Tobacco smoking currently but not daily (within the last 30 days); ✓smoked daily; - Data not available from study

Table 2.3 Status of the implementation of selected articles under the supply and demand reduction measures, Treaty Provisions of the WHO FCTC

		Supply reduction measures		Demand reduction measures				
		Sales to and by minors (components of Article 16)		Tobacco advertising promotion and sponsorship (components of Article 13)		Price and tax measures to reduce the demand of tobacco, (components of Article 6)		
Country	**Date of WHO FCTC ratification**	**Sale of tobacco products from vending machines prohibited**	**Sale of cigarettes individually or in small packets prohibited**	**Tobacco smoking banned in public places**	**Comprehensive ban on all tobacco, advertising promotion and sponsorship**	**Trends in prices**	**Tax policies to reduce tobacco consumption**	**Proportion of the retail price consisting of taxes**
Congo	6 Feb 2007	No	No	Yes	Yes	Increased	Yes	32.0
Ethiopia	25 March 2014	No data	No data	No data	No data	No data	No data	No data
Ghana	29 November 2004	Yes	Yes	Yes	Yes	Constant for 2 years	Yes	88.0
Kenya	25 June 2004	Yes	Yes	Yes	Yes	Constant	Yes	52.0
Malawi	Not ratified	No data	No data	No data	No data	No data	No data	No data
Nigeria	28 June 2004	Yes	Yes	Yes	Yes	Increasing	Yes	Not answered
Rwanda	19 October 2005	Not answered	Not answered	Not answered	Not answered	No answer	Not answered	Not answered
Senegal	27 Jan 2005	No	No	Yes	Yes	Decline	Yes	70.9
Sierra Leone	22 May 2009	No	No	Yes	No	Not answered	No	Not answered
South Africa	19 April 2005	No	No	Yes	Yes	Decline	Yes	Not answered, 52.0 (2012)
Togo	15 Nov 2005	Yes	Yes	Yes	Yes	Stable	Yes	45.0
Uganda	20 June 2007	No	No	Yes	No	Stable for 2 years	Yes	40.3
Zambia	23 May 2008	No data	No data	No data	No data	No data	No data	No data

WHO FCTC- World Health Organization Framework Convention on Tobacco Control

2.5.4 Prevalence of current smoking by gender

The prevalence of smoking was consistently higher in men compared to women in all studies.[112, 113, 124-126, 130, 131, 133, 136, 139] Less than 5% of women reported currently smoking in all the studies included with the exception of Rwanda where more than 12% of women currently smoked.[112] This parallels an even higher prevalence of smoking among men (20.9%) in Rwanda.

2.5.5 Comparison of current smoking prevalence between urban and rural locations

The estimates of the prevalence of current smoking in both urban and rural areas within 8 countries were obtained; Congo,[123] Ghana,[125, 126] Ethiopia,[124] Kenya,[128, 129] Malawi,[130] Nigeria,[131] Rwanda[112] and Zambia.[113, 141] (Tables 2.2 and 2.4).

The greatest difference in current smoking prevalence between urban and rural areas was observed in Zambia. Smoking was 22.4% in rural Zambia,[140] compared to 6.8% in urban Zambia[141]. For Congo,[123] Ghana,[125, 126] Ethiopia,[124] Kenya,[128, 129] Malawi,[130] Nigeria,[131] Rwanda,[112] the difference in smoking between urban and rural areas were less marked. Rwanda and Zambia seemed to have the greatest variation in female smoking between urban and rural areas although with completely opposite patterns. In Zambia, more women smoked in rural areas compared to urban areas (10.8[113] vs 1.5[141]), yet in direct contrast a significantly higher proportion of Rwandan women smoked in urban locations (17 vs 7) than rural areas. The differences in smoking among men varied the most when men in urban and rural areas of residence for Ethiopia (21.6 rural vs 10.3 urban), Kenya (22 urban vs 11.2 rural) and Zambia (39.6 rural vs 17.5 urban) were compared.

Table 2.4 Prevalence % (95% CI) of current smoking by gender and urban and rural locations where available

		Men Prevalence % (95% CI)			Women Prevalence % (95% CI)		
First author [year of publication]	Country	In Urban area	In Rural area	Overall prevalence	Overall prevalence	In Urban area	In Rural area
Alemseged, F. [2012]	Ethiopia	10.3	21.6	18.3	1.0	0.7	1.1
John, R.M. [2012]	Ghana	9.8	5.3	7.1	0.2	0.6	0.2
Owusu-Dabo E. [2009]	Ghana	3.4	3.1	8.9 (7.3, 10.5)	0.3 (0.1, 0.4)	0.22	0.13
Bloomfield, G.S. [2013]	Kenya	9.53	-	-	-	0.7	-
	Kenya	2.50✓	-	-	-	0.45✓	-
Ayah, R. [2013]	Kenya	22	-	-	-	3.8	-
Lo, T.Q. [2013]	Kenya	-	-	11.2	2.6	-	-
	Kenya	-	-	10.2π	2.3π	-	-
Msyamboza, K.P. [2011]	Malawi	-	-	25.9 (23.3, 28.5)	2.9 (2.1, 3.8)	-	-
Tafawa, A.O. [2012]	Nigeria	-	-	(WP) 8.2 (7.6, 8.9)	(WP) 0.1 (0.1, 0.2)	-	-
Musafiri, S. [2011]	Rwanda	*19.5	*22.8	20.9	12.6	*17	*7.0
Pessinaba, S. [2013]	Senegal	-	-	18.4	0.2	-	-
Baragou, S. [2012]	Togo	-	-	20.2	3.0	-	-
Kinyanda, E. [2011]	Uganda	-	-	13.7	0.9	-	-
Murphy, G.A.V. [2013]	Uganda	13.1 (11.7, 14.5)	-	-	-	-	1.3 (9.5,16.8)
Nuwaha, F. [2013]	Uganda	-	-	14.6	2.0	-	-
Mulenga, D. [2013]	Zambia	-	39.6	-	-	-	10.8
	Zambia	-	40.4	-	-	-	7.2
Zyaambo, C. [2013]	Zambia	-	-	18.1	8.7	-	-
Siziya, S. [2011]	Zambia	17.5	-	-	-	1.5	-

95% CI- 95% confidence interval; (WP): weighted prevalence; *Not presented in paper, but enough data was presented for prevalence to be calculated manually.

π Tobacco smoking currently but not daily (within the last 30 days); ✓smoked daily; - Data not available from study

2.5.6 Consistency of findings and time trends

For five countries (Ghana, Kenya, Nigeria, Uganda and Zambia), at least two nationally representative population-based studies were conducted during 2007 to 2014. Variations were observed in the smoking prevalences reported in studies conducted during the same year or time period and similar area e.g. a rural or urban area. For example, two studies conducted in urban areas in Kenya during 2010 estimated very different smoking prevalences 4%[127] and 13%.[128] Two very distinct rural smoking estimates were seen in rural Zambia as well (22.4% vs 10.8%).[140]

However, where cross-sectional studies have been conducted over successive years in the same type of area, both increases and declines in current self-reported smoking prevalence were observed. For Nigeria, a low prevalence of 2.7% in current smoking was reported in 2008[131] compared to 14.6% reported one year previously (2007).[132] The smoking prevalence previously reported in rural Uganda during 2008-2009 (2.2%)[137] increased slightly to 6% in 2011.[135]

2.5.7 Tobacco control strategies present among countries

All countries included in the review except for Malawi are a signatory to the treaty and have ratified or obtained accession to the WHO's Framework Convention on Tobacco Control.[143] Ethiopia took the longest time (10 years) to ratify the convention after becoming a signatory. All other countries took less than 3 years to formally approve the treaty after becoming signatories. Among the 13 countries, according to the results from countries' status of the implementation of the policies under the WHO FCTC, only policies that are considered to be complete and not in draft form were reported on. Data were available for 9 countries (Congo, Ghana, Kenya, Nigeria, Senegal, Sierra Leone, South Africa, Togo, and Uganda) either because of the lack of the

country's authorities submitting a report or not answering a particular survey question (Table 2.3). Of these countries, 7 had comprehensive bans on all tobacco advertising promotion and sponsorship, but Sierra Leone and Uganda did not. All 9 countries had implemented bans on smoking tobacco in public places. All except for Sierra Leone had some taxation policies in place to reduce tobacco consumption. Variations in the percentage tax on the most popular price category of tobacco product were observed among the countries. As of 2014 according to results from the survey, most of the countries for which data was available had set tobacco taxes below 70% except for Ghana (88%) and Senegal (70.9%). Recent trends in cigarette price have been increasing in Congo and Nigeria, but have declined in Senegal and South Africa. However, they have been constant in Ghana, Kenya, Togo and Uganda for approximately 2 years.

2.6 Discussion

2.6.1 Summary of main findings on current smoking prevalence

This review found a wide range of current smoking prevalence among the 13 sub-Saharan African countries included in the review. This highlights the presence of wide gender diversity in smoking prevalence that is much more prominent in sub-Saharan Africa and other developing countries than in developed countries.[22] The low observed prevalence of smoking among women in sub-Saharan Africa may be due to the presence of strong social norms and taboos which discourage women to smoke.[144, 145] In the same way these social norms may depict smoking among women as inappropriate, smoking among men in some societies is viewed as acceptable, and as a symbol of status and social power. There may also be a growing parity between the prevalence of smoking among men in a few sub-Saharan African countries and those in Western societies reflecting global patterns which shows an increasing similarity in the prevalence of smoking among men in low, middle and high income regions of the world.[146] The prevalence of smoking differed according to location of residence among adults in the same

country. More adults residing in urban areas smoked compared to rural areas for some countries. This may be indicative that factors related to urbanization, including economic factors, are having an impact on individuals' ability to have greater access to cigarettes in some African societies.[146] However, it is not known what the underlying characteristics of the urban residents are, for example, whether it is due to higher socioeconomic status which may explain the higher smoking prevalence observed, or simply greater access. Some studies reported diverse prevalence ranges for the same geographical area i.e. rural or urban, which might even illustrate different smoking norms are present among different areas within a country.

The differences in reported smoking prevalence may be a reflection of the different sampling strategies used in the different studies. The differences in smoking observed between studies in Nigeria may be due to differences in the age groups and sample size of the populations studied. The 14.6% prevalence was from a slightly older population aged 25-64 using a sample selected from one region in Nigeria, not using a nation-wide sampling frame and also using a much smaller sample size (1,458) compared to the younger 15-59 population where the 2.7% prevalence was observed from a sample comprising 48,871 participants. It is possible that the higher prevalence observed in Nigeria may be specific to that region and less representative of the wider Nigerian population. It may also be due to inconsistencies in measuring current smoking which we realized varied greatly across studies. Our attempts to compare the different smoking prevalences are limited by the different sampling procedures and methods of measuring current smoking.

2.6.2 Comparison to previous findings

These findings compare to a previous systematic review for the period 2000-2006.[115] In comparing the current review period (2007-2014) to the previous review period, studies that reported an overall prevalence of smoking for an area representative of the entire country and

not just a rural or urban area and separately by gender were compared. Five countries also had an estimate reported in the previous period of 2000-2006. The comparisons are shown in Figures. 2.2 and 2.3.

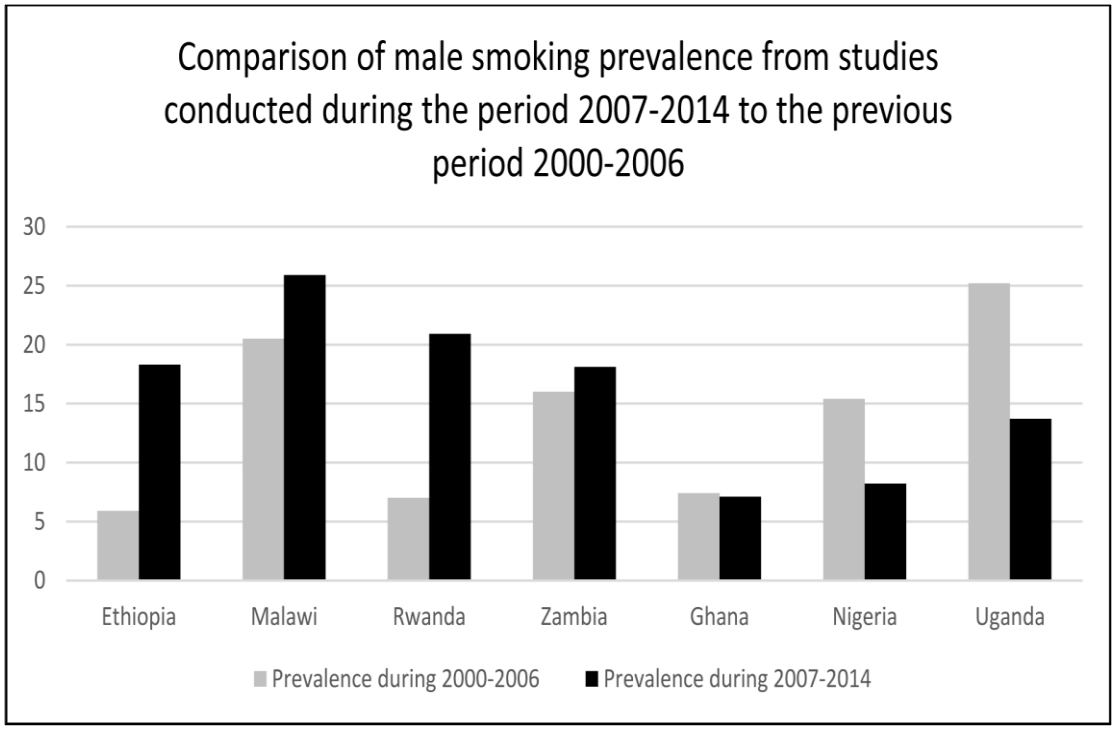

Figure 2.2 Reported smoking prevalence during 2000-2006 and 2007-2014 for men in 7 countries in SSA that were included in the review

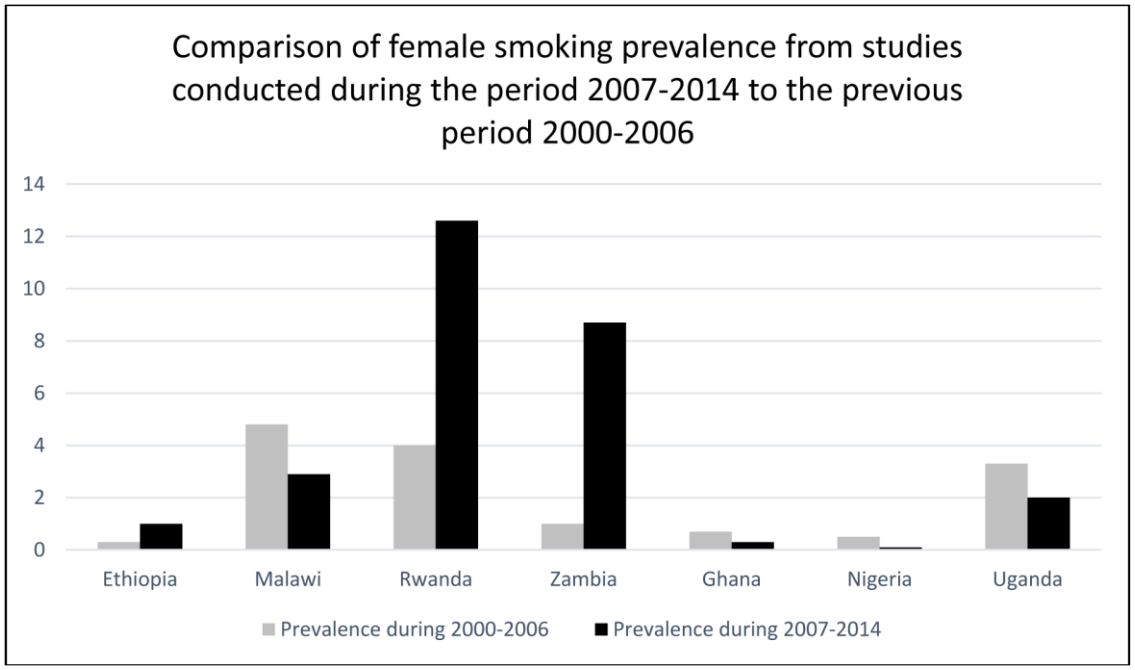

Figure 2.3 Reported smoking prevalence during 2000-2006 and 2007-2014 for women in 7 countries in SSA that were included in the review

The patterns observed from comparing smoking measured during the periods 2000-06 and 2007-14 varied quite markedly by country and by gender. Estimated smoking prevalence was higher in the most recent review among both men and women in Ethiopia, Rwanda and Zambia (Figures 2.2 and 2.3). In contrast, smoking prevalence was lower in studies in the recent review among both men and women in Ghana, Nigeria and Uganda. In Kenya smoking prevalence among women was higher but among men was lower in the latest review while the opposite pattern was seen in Malawi. These descriptive patterns are interesting but we did not conduct further analysis as different methodologies were used in the two periods and the populations studied also differed.

2.6.3 Description of the tobacco control measures present in 13 sub-Saharan African countries

The tobacco industry has been successful in expanding its markets to low and middle-income countries by capitalising on economic growth, changing social norms and population demographics in low income regions.[22] Africa has lower rates of tobacco taxation, weaker smoke-free policies and less stringent tobacco advertising restrictions in comparison to higher income countries.[15, 17] Tobacco companies are known to be attracted to weak policy environments and execute stronger tactics which oppose governments' fight for smoke free environments.[147] From the included studies, very high prevalences of smoking among men was observed in Malawi (25.9%) who is yet to ratify the WHO FCTC convention, and in rural Ethiopia (21.6%) who has ratified the convention very late in 2014, since it was created under the WHO in response to the global tobacco epidemic as a strategy to reduce the demand and supply of tobacco in countries. Malawi's adoption of the WHO FCTC would help in implementing methods to regulate the demand and supply of tobacco which will involve both economic and non-economic measures to be executed and help reduce the high smoking rates among men in

the country. Further to this, Ghana, Nigeria, Togo and Senegal adopted the WHO FCTC earlier and that the data showed that they have lower smoking rates than countries who signed the convention much later such as Sierra Leone. There can be many explanations for such a relationship, but earlier adoption of the WHO FCTC can allow governments the structure to be able to enforce stronger tobacco control policy environments.

Advertising is known to increase tobacco consumption by increasing sales and may even trigger potential users to start smoking.[82] Research conducted among 22 Organization for Economic Cooperation and Development (OECD) countries concluded that the presence of comprehensive bans are better able to reduce consumption than limited bans. In the absence of comprehensive bans in Sierra Leone and Uganda, a considerable proportion of men smoked in Uganda (13.7%) including rural areas (14.0%) and among adults in the population of Sierra Leone (25.8%) have been documented. The absence of robust tobacco control policies might be influencing the high smoking rates in these countries. However, this is not a simple relationship. There is likely to be a wide range of factors influencing whether adults smoke in sub-Saharan Africa, which include cultural and religious factors that determine the social acceptability of smoking, and the effectiveness of the implementation of tobacco control polices.

With respect to taxes, the literature has shown that tobacco taxes when raised to increase prices can reduce and stop consumption among current users and or prevent consumption among potential users, significantly impacting young persons and poorer users.[148, 149] It is recommended that tobacco excise taxes be set above 70% of the retail price of the tobacco product to have a significant impact on increasing prices and thereby reducing consumption. The data reported here do not allow us to draw any conclusions about the effectiveness of control measures. For example, a government concerned about high levels of existing smoking might introduce stricter controls whereas in areas with lower smoking, tobacco policies may receive less attention. The one clear conclusion is that tobacco control policies vary widely in different African countries, with no clear correlation with smoking prevalence.

2.7 Strengths and limitations

The included studies give good estimates of current smoking prevalence in the respective countries, and rural or urban sub-national areas from 2007 to May 2014. It was impossible to make any analysis of the association between preventive measures and smoking prevalence due to several methodological and data limitations. Most importantly is that the date the prevalence of current smoking was measured may precede the implementation of the respective tobacco control measures. It is known that the measures would have been implemented as of 2014 but some of the prevalences reported may not have been impacted by the presence of these tobacco control measures if the measures were implemented after the study was done. Any possible associations are subject to a number of other confounding factors at the individual and community level.

This review may also be limited in the strength of comparisons made between the prevalence of smoking between urban and rural areas and across countries, since the research varied in how smoking was measured, how representative samples were selected, and the period in which the data were collected. The review focused on data within the broad period 2007 to 2012 and not specifically by year, so it was not possible to deduce whether an increasing or decreasing trend in current smoking was present.

Another bias amongst the studies may be in the measurement of current smoking. All included studies assessed current smoking from self-reported statuses. Past research observed underreporting among patients who had their current smoking status confirmed via taking measurements of their carbon monoxide level and concentration of serum cotinine. Approximately 50% of current smokers self-reported to be non-smokers.[150] Furthermore, smoking in certain countries in Africa seems to be stigmatised especially among women.[151] There may be a possibility that the prevalence may be underreported for example in some countries with unusually low prevalence such as Ghana.

2.8 Implications for policy

In spite of the limitations of the data, this review has important implications for public health research and policy in Africa. It shows that smoking levels are still high in the majority of sub-Saharan African countries for which data are available. There is also some evidence to suggest smoking prevalence may be increasing in some areas, especially among women. In addition, the level of implementation of tobacco control measures varies widely for the countries in the review, although due to data limitations an analysis of the effect of prevention policy, nor the effects of policy gaps could not be made. Health policy makers would benefit from more reliable and complete data on smoking prevalence trends for all countries in sub-Saharan Africa including within country patterns of smoking by age, gender and ideally comparing rural-urban environments. Data on smoking prevalence and also better evidence of the effectiveness of tobacco control policies in Africa are needed to demonstrate that smoking should, and can, be addressed as a major population health priority in Africa. The continued influx of international aid for infectious diseases, such as malaria and HIV/AIDS, has caused distortions within health systems and health policy priorities, and continues to draw resources away from tackling non-communicable disease, and the single biggest risk factor, smoking.

2.9 Conclusion

This shows that smoking in some countries of sub-Saharan Africa is increasing. The patterns varied across the region, within sub-regions and by rural urban location within countries. Gender seems to be the strongest determinant of tobacco smoking among adults, with men smoking more than women in all countries. The implementation of tobacco control policies was also found to vary widely, in the study countries. More research is needed on the implementation and effectiveness of tobacco control policies across all countries in sub-Saharan Africa. Effective action to reduce tobacco smoking and to particularly stop the increased uptake of smoking

among women must become a public health priority for sub-Saharan Africa to reduce the burden of disease.

Recap

The review highlighted the very low prevalence of smoking among Ghanaians in sub-Saharan Africa. Previous research showed that smoking prevalence varied among homogenous groups in different locations possibly due to acculturation or adaptation of migrants smoking behaviour. Given the low smoking rates of Ghanaians in SSA, it is interesting to see if this persists on migration to Europe.

2.10 Updated search May 2014 to May 2016

This is an update of the studies included in the systematic review. It shows the nationally representative studies conducted in sub-Saharan Africa that have been published during May 2014 to May 2016 in which the prevalence of smoking has been reported.

Inclusion criteria

The inclusion criteria used in this updated search is as follows:

- A representative sample population of adults living in a sub-Saharan African country or a rural or urban area within that country.
- The study must include a minimum sample size of 1000 participants.
- The research must have been published during 2014 to May 2016.
- The data for the study must have been collected during 2007-2016.
- The prevalence of current smoking within the sample population must have been reported.

Databases searched

In this updated search, only the MEDLINE database was searched. Data on tobacco control policies present in countries were extracted from the survey responses obtained in 2014 from the Implementation Database of the WHO FCTC website.[93, 118].

Search strategy for inclusion and exclusion of studies from systematic review

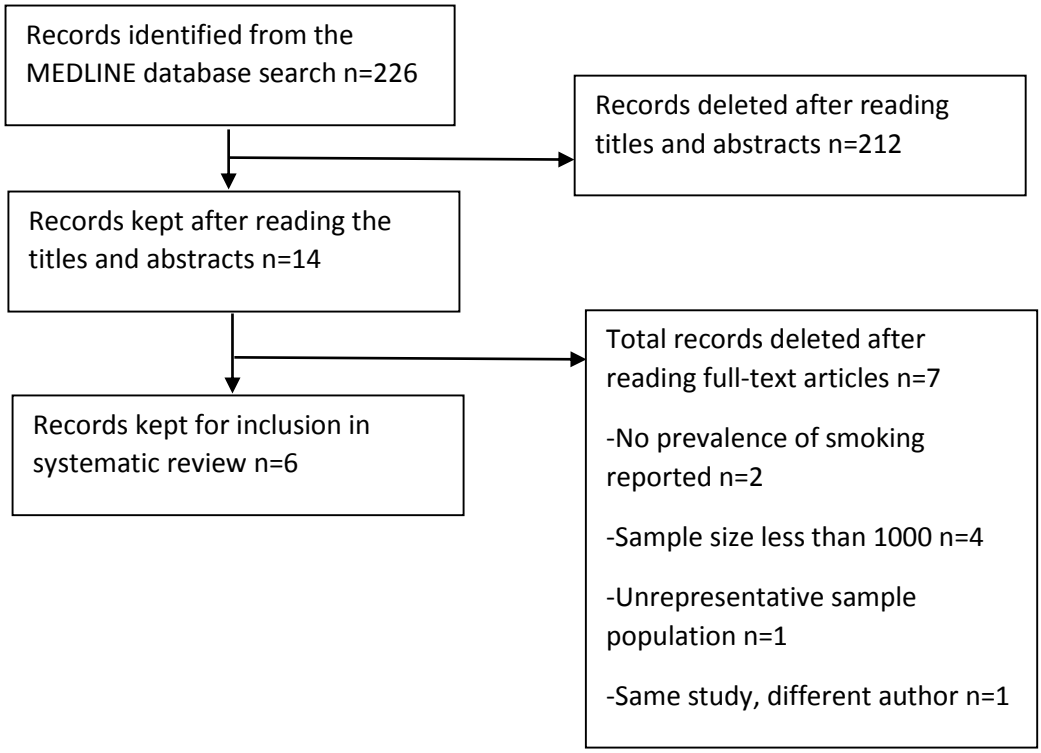

Figure 2.4 Search strategy of articles included and excluded from systematic review [2014-2016]

Main findings

A search of the MEDLINE database for articles published during 2014 to 2016 produced 6 additional articles (Figure 2.4). These studies were conducted in 6 African countries, including Benin and Cameroon in West Africa, Ethiopia, and Tanzania in East Africa, South Africa and the island of Madagascar. The estimated national prevalences of current smoking represented the period, 2008 to 2013. Sample sizes ranged from 1,095 participants in Tanzania to 30,625 participants in Ethiopia (Table 2.5). Data on tobacco control policies was available for all four new countries. Among the studies, current smoking was determined from different criteria, from the use of tobacco and its many products currently or daily or within a recent time period prior to data collection. The lowest overall prevalence of smoking was reported in Berlin (7.6%) (Table 2.6). Higher national prevalences of smoking were reported in Madagascar (12.6%), and South Africa (17.6%).

Prevalence of current smoking by gender

The prevalence of smoking was substantially higher in men than in women in all six countries (Table 2.8). The highest prevalence of smoking among women was observed in South Africa (7.3%). Among men, however, very high prevalence rates of smoking were reported in South Africa (29.2%) and Madagascar (28.5%). Lower smoking prevalence among men was reported in Ethiopia (8.1%) and Benin (17.6%).

Smoking variation by rural urban locations

Where the data was available for smoking by rural urban location, only in Benin, there appeared to be a significant difference in overall smoking rate by rural urban location, with higher rates in rural Benin (9.3%) compared to urban Benin (3.3%) (Table 2.6 and 2.8).

Tobacco control strategies among countries

Benin, Madagascar and the United Republic of Tanzania all ratified the WHO's Framework Convention on Tobacco Control, in less than 3 years after becoming a signatory. Benin and

Madagascar both had comprehensive bans on all tobacco advertising, promotion and sponsorships, smoking was banned in all public places, and there were tax policies in place to reduce tobacco consumption (Table 2.7). Madagascar also prohibited the sale of tobacco products from vending machines, and 73.5% of the retail prices of cigarettes comprised of taxes. The prohibition of the sale of cigarettes individually or in small packets were prohibited in Benin. Prices of cigarettes appeared to be increasing in Madagascar and Tanzania but declined in Benin.

Consistency of findings and time trends

For countries where more than one study was included, the prevalence of smoking was lower in a more recent period than an earlier period. South Africa had the highest prevalence of 17% in 2012, this was lower than the 22% reported in 2008. The same trend was observed in Ethiopia, where in 2012 8% smoked which was lower than the 18.3% in 2008.

Table 2.5 Characteristics of study populations of included studies [2014-2016]

First author [year of publication]	Country, year of data collection, reference no.	Age range	Age, Median (IQR) Age	Age, Mean (SD)	Total sample size, n	Response rates (%)	Definition of current smoking as measured in the study
Houehanou YCN, [2015]	Benin, 2008,[152]	25-64	-	42.8 (0.3)	6762	99%	Daily tobacco smoking during previous 12 months
Pefura-Yone EW, [2015]	Cameroon, Urban, 2013-2014,[153]	19-90	30 (24-42)	34.9 (13.5)	2304	93.4%	Current smokers: smoked at least one cigarette per day for at least one year; smoked at least 20 cigarettes in their lifetime and was still smoking.
Yihunie, L [2015]	Ethiopia, 2012,[154]	15-59	-	29.0 (10.5)	30625	-	Do you currently smoke cigarettes? What type of other tobacco do you currently smoke or use like pipe, chewing tobacco (yes/no), snuff (yes/no), shisha (yes/no), gaya (yes/no) and any other types of tobacco (yes/no). If respondents did not use any tobacco, these were classified as non-tobacco users. If a respondent was a user of tobacco if they used one or more of the tobacco types.
Blecher, E [2014]	Madagascar, 2008-2009,[155]	15-59	-	-	25961	92.9% (men) 95.6% (women)	Current smokers of cigarettes or pipe tobacco

First author [year of publication]	Country, year of data collection, reference no.	Age range	Age, Median (IQR) Age	Age, Mean (SD)	Total sample size, n	Response rates (%)	Definition of current smoking as measured in the study
Reddy, P [2015]	South Africa, 2012, [156]	>15	-	-	15401	-	Current tobacco smoking; Daily smokers Less than daily smokers
Bazil, K [2015]	United Republic of Tanzania, 2012-2013,[157]	>18	-	-	1095	-	Current smoking

SD- Standard Deviation; IQR-Interquartile Range

Table 2.6 Prevalence (95%CI) of current smoking among adults in sub-Saharan African countries by rural urban location or nationwide

First Author [Year of Publication]	Country, year of data collection	Prevalence In urban area % (95% CI)	Prevalence In rural area % (95% CI)	Prevalence National % (95% CI)
Houehanou YCN [2015]	Benin, 2008,[152]	3.3% (95% CI: 2.1, 4.5)	9.3% (95% CI: 8.1, 10.4)	7.6 (6.8–8.5)
Pefura-Yone, EW [2015]	Cameroon, Urban, 2013-2014,[153]	8.4	-	-
Yihunie, L [2015]	Ethiopia, 2012,[154]	4.30 (3.84, 4.79)	4.10 (3.85, 4.36)	-
Blecher, E [2014]	Madagascar, 2008-2009,[155]	-	-	12.6
Reddy, P [2015]	South Africa, 2012, [156]	-	-	17.6 (16.3, 18.9)
Bazil, K [2015]	United Republic of Tanzania, 2012-2013,[157]	-	-	-

95% CI- 95% Confidence Interval

Table 2.7 Status of the implementation of selected articles under the supply and demand reduction measures, Treaty Provisions of the WHO FCTC according to survey responses reported in 2014

		Supply reduction measures			Demand reduction measures			
Country	**Date of WHO FCTC ratification**	**Article 16 Sale of tobacco products from vending machines prohibited**	**Article 16 Sale of cigarettes individually or in small packets prohibited**	**Article 13 Comprehensive ban on all tobacco, advertising promotion and sponsorship**	**Article 8 Tobacco smoking banned in public places**	**Article 6 Trends in prices**	**Article 6 Tax policies to reduce tobacco consumption**	**Article 6 Proportion of the retail price consisting of taxes**
Benin	3 November 2005	No	Yes	Yes	Yes	Declined	Yes	45%
Cameroon	4 May 2006	No	No	Yes	Yes	Stable	No	Answer not reported
Madagascar	22 September 2004	Yes	No	Yes	Yes	Increased	Yes	73.5%
United Republic of Tanzania	30 April 2007	No	No	No	Yes	Increased	No	28.1%

WHO FCTC- World Health Organization Framework Convention on Tobacco Control

Table 2.8 Prevalence (95%CI) of current smoking by gender and urban and rural locations where available

First Author (Year of Publication)	Country, year of data collection, reference	Male prevalence in urban area % (95% CI)	Male prevalence in rural area % (95% CI)	National Prevalence among men % (95% CI)	National Prevalence among women % (95% CI)	Female Prevalence in Urban area % (95% CI)	Female Prevalence in Rural area % (95% CI)
Houehanou YCN [2015]	Benin, 2008 [152]	9.1 (6.5–11.6)	16.1 (13.4–18.9)	13.8 (12.3–15.4)	1.2 (0.7–1.7)	0.3 (0.1–0.4)	1.8 (1.1–2.6)
Pefura-Yone, EW [2015]	Cameroon, 2013-2014 [153]	16.1	-	-	-	2.7	-
Yihunie, L [2015]	Ethiopia, 2012,[154]	-	-	8.10 (7.66, 8.56)	0.80 (0.67, 0.95)	-	-
Blecher, E [2014]	Madagascar, 2008-2009 [155]	33.8	27.5	28.5	0.8	1.7	0.6
Reddy, P [2015]	South Africa, 2012, [156]	-	-	29.2 (26.9, 31.6)	7.3 (6.4, 8.4)	-	-
Bazil, K [2015]	United Republic of Tanzania, 2012-2013 [158]	14.8 (8.2-25.1)	22.7 (17.1- 29.5)	-	-	12.2 (6.3-22.3)	17.4 (11.6-25.4)

95% CI- 95% Confidence Interval

Discussion

This updated search has included estimates for smoking for 4 additional sub-Saharan African countries (Benin, Cameroon, Tanzania and Madagascar) which has not been represented in the systematic review. It was clear that smoking prevalence varied among the countries in sub-Saharan Africa, but high prevalences of smoking were reported especially among men in South Africa and Madagascar.

Overall, no clear relationship between smoking prevalence and tobacco policies were evident as was stated in the published systematic review. However, the high prevalence of smoking among men and women in some areas warrants the need for public health interventions to reduce smoking in these countries.

Chapter 3 Epidemiology of smoking in Ghana

3.1 Introduction to chapter

This chapter aims to give an extensive description of what is known about smoking in Ghana, so that this can be used to explain the smoking patterns among Ghanaian migrants in European locations.

3.2 Brief description of Ghana

Ghana is a developing country in the West of Africa situated 8 degrees north of the Equator with its southernmost border forming a coastline along the Gulf of Guinea. It shares borders with Ivory Coast, Burkina Faso and Togo to the west, north and east of the country respectively. The 2012 census estimated Ghana's population to be approximately 25 million.[159]

In sub-Saharan Africa,[114, 115] the smoking rates are still low in comparison to developed European regions.[160] Within sub-Saharan Africa however, a comparative study of smoking rates in 16 population-based studies which used Demographic Health Survey Data, and in the review conducted in the previous chapter found that Ghana had one of the lowest prevalence of current smokers. Less than 10 percent of the population smoked.[115] Research on self-reported current smoking conducted during 2007 to 2008 by Owusu-Dabo et al.[126] found a 3.8% overall smoking prevalence with 8.9% in males and 0.3% in females. Addo et.al's[151] study on Ghanaian civil servants conducted previously in 2006 similarly found a low prevalence of current smoking of 3.9% in the total population with 6.1% prevalence in men and 0.3% prevalence in women.

3.3 What is known about the epidemiology of smoking in Ghana?

Within sub-Saharan Africa, Ghana has one of the lowest prevalences of smoking in the region.[114, 115, 125, 126] Overall, the prevalence of smoking in Ghana was estimated to be 4.3%; 95% CI (3.6%, 5.0%) after adjusting for male under-response from a nationally representative study conducted in the Ashanti region of Ghana.[126] This study found a number of determinants of smoking among Ghanaians including, age, religion, educational level, wealth, occupation, alcohol use, having friends who smoke, and the frequency of exercise.[126]

The majority of current smokers (47.9%) started smoking as teenagers aged 10-19 years.[126] The age distribution of smoking in Ghana showed that the older age groups had more current and ex-smokers than younger age groups. The highest proportion of current smokers were aged 50-59 years (6.3%), while the highest proportion of ex-smokers (12.6%) were older than 70 years. There also appeared to be a significant increasing trend in the prevalence of current smoking as age categories increased. Compared to adolescents aged 14-19 years old, adults aged 50-59 were approximately 6.7 times more likely to be current smokers in Ghana after adjusting for gender and urban or rural location of residence.

A study on smoking among Ghanaians aged 50 years and older found that ever smoking in Ghana was low (7.6%) compared to more developed countries, however increased prevalences were associated with rural areas, having no health insurance and those who were indifferent or unsatisfied in life.[161] These findings highlighted: the probable use of more smokeless tobacco in rural areas than urban areas; the relationship between lower socio-economic status and higher risk factors for health; and also the impact of poor mental health on making good health choices, all which can further comprise the health of older adults who already may suffer chronic diseases.

Religion also had an impact on smoking in Ghana since type of religion practiced was an important determinant of smoking behaviour. Estimates from the 2014 Demographic Health Survey found the majority of men (75%) and women (80%) to be of Christian faith, compared to

the fewer proportion of Muslims 15.2% of men and 17.6% of women, and even smaller proportion of Traditionalist religions (2% of women and 3.3% of men).[162] In the Ashanti region study,[126] persons of the minority Traditionalist religion (1.3% of the study population) were 7.5 (95% CI 4.4, 12.7%) times more likely to smoke than Christians.

Peers had a significant influence on smoking behaviour. Smokers often had at least one other friend who smoked with those who had more than 3 friends who smoked had a 21 fold increased risk of smoking.

Higher levels of education, and employment, as well as lifestyle behaviours such as abstaining from alcohol use and engagement in frequent exercise had a protective effect on smoking. Higher educated adults appeared less likely to smoke than the illiterate but confidence intervals included 1. For employment level, the self-employed (OR 0.53, 95% CI 0.36, 0.79), and students (0.19, 95% CI 0.08, 0.41) smoked less than the unemployed. Smokers were associated with the use of legal drugs such as alcohol with non-users of alcohol less likely to smoke (0.13, 95% CI 0.08, 0.22). Exercising regularly at least once or more per week was associated with lower risk of smoking than not exercising.

3.4 Country level factors influencing smoking in Ghana

At the national level, the government of Ghana's interference and economic problems may have affected the tobacco industry's development in Ghana and contributed to the low prevalence of smoking observed in Ghana. British American Tobacco (BAT) the main producer of tobacco in Ghana has made several efforts to expand the industry in Ghana since the demand for tobacco grew after men returned to Ghana after serving in the war.[163] BAT began their commercial activity by partnering with local businesses to distribute cigarettes across the country in 1948. Four years later in 1952, the Gold Coast Tobacco Company (GCTC) was established to manage this trade. One year later, the Pioneer Tobacco Company (PTC) was created to specially oversee the cultivation and manufacture of cigarettes in Ghana and the production of cigarettes began

in 1954. The PTC moved under the control of the GCTC in 1959. BAT's activity received mixed support from the Ghanaian government as initially the government encouraged and praised its investment and growth in the private sector, then soon after set laws which brought the control of tobacco marketing under government hands. Ghana's government, later acquired part ownership of PTC (40%), which was operating as a monopoly in Ghana until 1976. During this time there was a shortage in foreign exchange coming into the country during 1968 and 1976 and domestic tobacco leaf production was low, slowing an increase in the production of cigarettes.[126, 163] The scarcity of tobacco caused the cigarette selling price to quadruple. In 1976, a new competitor, International Tobacco Ghana (ITG) was established to manufacture Rothman's King size cigarettes, through a partnership with Rothmans UK. By this time Rothman's king size cigarettes were popular in Ghana due to the smuggling of the product into Ghana from its neighbour Togo. ITG ceased operations in Ghana after the company was fined by Ghana Customs Excise and Preventative Service for failing to pay duty and sales taxes valued at US$ 3.3 million. Rothmans UK in partnership with the Government's Social Security and National Insurance Trust of Ghana together owned the Meridian Tobacco Company (MTC). When ITG closed, its assets were sold to MTC. Rothman was then sold to BAT, and MTC and PTC merged to form the British American Tobacco Ghana, re-establishing BAT to operate as a monopoly in Ghana until 2006 when its operations in Ghana closed and was reallocated to Nigeria.[163] Although the tobacco leaf shortages ended during the 1980s, and the presence of a new competitor would have caused advertisements to increase in an attempt to retain market share, an implementation of a ban on tobacco advertising on television, radio and printed media adverts in 1982 was another strategy that may have deterred the increase in tobacco consumption.

Although the ban on tobacco advertising, governmental control of tobacco marketing, and economical problems in Ghana may have hindered tobacco production and consumption in the early periods, since then Ghana still had not developed national tobacco control legislation or enforced comprehensive bans on advertising. Health promotion and educational programmes

were not widespread and the retail prices of cigarettes were relatively cheap. So Ghana was still an open market for tobacco industry activity in recent periods.

3.5 Cultural factors and attitudes influencing smoking in Ghana

Quite a few research papers have attributed the low prevalence of smoking among Ghanaians to the presence of cultural norms and values among Ghanaians which discourage smoking and consider it to be unacceptable among women.[115, 126, 164] There appears to be a stigma attached to women who smoke as they may be perceived to be promiscuous. One paper also indicated that women may be less economically stable than men and therefore have fewer opportunities to engage in smoking.[126] Smoking is also regarded as a status indicator of power among men and men have more power than women so smoking is more acceptable among men than women.

Although no qualitative research has explored the attitudes towards smoking in Ghana, a small study conducted among five ethnic groups in Kenya have explored some of the reasons for smoking or not smoking among the young generation.[144] Some of the reasons for not smoking highlighted from this study among 4 ethnic groups included the belief that women should not smoke, it has a harmful effect on health, also harmful for children, and it is a bad habit and smells bad. It was interesting to note that among ethnic groups where there was a vast gender difference in the prevalence of smoking, one of the reasons for not smoking suggested that women were not allowed to smoke, and alluded to the fact that women smoking would negatively affect their children, but for men no such social restrictions existed. In ethnic groups where smoking was common among both men and women, the reasons for not smoking did not suggest that there were social prohibitions present in the community acting against women smoking and that it was socially acceptable for both genders to smoke. In both scenarios, men's smoking was not questioned or viewed as inappropriate. In fact, often men had a choice to smoke but women depending on the social structures present were prohibited from smoking.

From the adolescent study of socio-economic position and tobacco use, this study alluded to the use of smokeless tobacco (e.g. tawa) to be more socially acceptable than smoking in the Ghanaian culture.[165]

Research conducted on cultural attitudes and knowledge about smoking policies in Ghana found high levels of support for smoke-free policies and high levels of awareness on the adverse health effects of tobacco use accompanied by high willingness by smokers to quit smoking.[166]

Given the research findings on the epidemiology of smoking in Ghana and the social norms surrounding smoking, It is not clear whether migrants from Ghana have different smoking patterns and behaviours depending on their different location of residence.

Chapter 4 Comparison of smoking among Ghanaians in Ghana and Europe: RODAM paper- Research paper 2

4.1 Introduction to chapter

This chapter focuses on the smoking prevalence of Ghanaians living in different locations and the factors associated with smoking among Ghanaians. The purpose of this chapter is to investigate whether a group of migrants from a low smoking country maintain their low smoking prevalence in different countries with substantially higher smoking rates than Ghana.

The Research on Obesity and Diabetes among African Migrants (RODAM) study is a study of Ghanaian migrants living in three European locations and in rural and urban Ghana. The main aim was to dissect the interplay of genetic and environmental factors on obesity and diabetes health inequalities experienced by migrant sub-Saharan African populations living in Europe. This migrant study is important since it brings new light into environmental factors that influence health behaviour and disease risk among one of the largest African minority populations living in three European countries.

For the analysis of smoking among Ghanaian migrants living in different environments with different rates of smoking, the hypothesis is that the migrant groups will have similar rates of smoking as the destination population implying that environmental influences are a major determinant of smoking.

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SECTION A- Student Details

Student	Rachel Brathwaite
Principal Supervisor	Liam Smeeth
Thesis Title	Differences in smoking by location of residence, ethnic group and country of origin: The Ghanaian perspective in sub-Saharan Africa and Europe

If the Research Paper has previously been published, please complete Section B, if not please move to Section C

SECTION B- Paper already published

Where was the work published?			
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Where is the work intended to be published?	PLOS ONE
Please list the paper's authors in the intended authorship order:	Rachel Brathwaite, Juliet Addo, Anton E. Kunst, Charles Agyemang, Ellis Owusu-Dabo, Ama de-Graft Aikins, Erik Beune, Karlijn Meeks, Kerstin Klipstein-Grobusch, Silver Bahendeka, Frank P. Mockenhaupt, Stephen Amoah, Cecilia Galbete, Matthias B. Schulze, Ina Danquah, Liam Smeeth
Stage of publication	**Submitted**

SECTION D- Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	Rachel Brathwaite drafted the initial research proposal, analysed the data, drafted the manuscript and made revisions to the manuscript after suggestions from all other co-authors.

Student Signature: Rachel A Brathwaite **Date:** ___10/10/2016_____

Supervisor Signature: L Smeeth **Date:** __10/10/2016_____

Smoking prevalence differs by location of residence among Ghanaians in Africa and Europe: The RODAM Study

4.2 Abstract

Introduction

Although the prevalence of smoking is low in Ghana, little is known about the effect of migration on smoking. Comparing Ghanaians living in their country of origin to those living in Europe offers an opportunity to investigate smoking by location of residence and the associations between smoking behaviours and migration-related factors.

Methods

Data on a relatively homogenous group of Ghanaians living in London (n=949), Amsterdam (n=1400), Berlin (n=543), rural Ghana (n=973) and urban Ghana (n=1400) from the cross-sectional RODAM (**R**esearch on **O**besity & **D**iabetes in **A**frican **M**igrants) study were used. Age-standardized prevalences of smoking by location of residence and factors associated with smoking among Ghanaian men were estimated using prevalence ratios (PR: 95% CIs).

Results

Current smoking was non-existent among women in rural and urban Ghana and London but was 3.2% and 3.3% in women in Amsterdam and Berlin, respectively. Smoking prevalence was higher in men in Europe (7.8%) than in both rural and urban Ghana (4.8%): PR 1.91: 95% CI 1.27, 2.88, adjusted for age, marital status, education and employment.

Factors associated with a higher prevalence of smoking among Ghanaian men included European residence, being divorced or widowed, living alone, Islam religion, infrequent attendance at religious services, assimilation (cultural orientation), and low education.

Conclusion

Ghanaians living in Europe are more likely to smoke than their counterparts in Ghana, suggesting convergence to European populations, although prevalence rates are still far below those in the host populations. Social and religious isolation may promote smoking uptake in these communities.

4.3 What this paper adds?

What is already known on this subject?

- Smoking prevalence differs between the European and sub-Saharan Africa (SSA) regions.
- Smoking prevalence is particularly low in Ghana in relation to the rest of SSA especially among women.

What important gaps in knowledge exist on this topic?

- Whether smoking rates differ among people from SSA from countries with very low smoking rates compared to compatriots living in European countries.
- Understanding of the factors associated with smoking among a homogenous population from SSA and one of the largest African ethnic minority groups in Europe

What this study adds?

- Ghanaian migration to Europe is associated with an increased practise of smoking, particularly among women, although levels of smoking do not reach the levels of the European host populations.

4.4 Introduction

Worldwide, tobacco smoking is one of the strongest modifiable risk factors for chronic diseases.[1] Smoking prevalence, i.e., the proportion of current and previous smokers,[88] differs across and within different geographical regions of the world,[167] including sub-Saharan Africa (SSA).[117] The prevalence of smoking in Ghana is considerably low, compared to other countries in SSA and other high income countries.[110, 126] Differences in smoking prevalence between migrants from the same country living in different locations have been observed previously.[55] Evidence shows that within-country migration as well as international migration may be accompanied by changes in lifestyle, such as smoking, due to the new exposures to different environments, social norms and interactions with other dominant cultures.[168]

Smoking behaviour in migrant populations may change partly due to adopting the smoking norms of the host population.[52, 169-171] Also, tobacco control policies and anti-smoking interventions,[172] socio-demographic characteristics,[173] religious affiliations,[174] as well as family-level,[175] and community-level attitudes[176] towards smoking influence smoking behaviour.

Previous research on smoking among SSA migrants from three countries in SSA in the US illustrated significant lower prevalences of smoking among migrants compared to non-migrant peers in their countries of origins.[71] No data are available on smoking behaviour of an African group from a distinct geographical region living in different European locations and in their location of origin. The prevalence of smoking is much higher in the European region (approximately 35%) compared to the Americas (approximately 25%).[177] Therefore, smoking uptake among migrants in Europe is likely higher than in the US but the factors which influence smoking behaviour among SSA migrants in Europe compared to the home countries are not known. Preventing smoking uptake is a crucial step in reducing the disproportionate increased burden of cardiovascular diseases among African ethnic groups in Europe.[29]

The aim of this study was to describe smoking patterns in Ghanaians living in rural and urban Ghana compared to those living in three European cities, namely London, Amsterdam and Berlin and to determine the factors associated with smoking in the different locations.

4.5 Methods

Study design and setting

The RODAM Study (**R**esearch on **O**besity & **D**iabetes among **A**frican **M**igrants) is a multi-centre cross-sectional study of Ghanaians living in London, Amsterdam and Berlin and in rural and urban Ghana. Rationale and methodology have been described in detail elsewhere (Refer to Appendix 3 for further details).[178] Briefly, the RODAM study aimed at exploring prevalence and associated factors of diabetes and obesity among Ghanaians aged 25-70 years living in the above-mentioned locations.

Data were collected through structured questionnaires on socio-demographic factors, lifestyle practices, and health outcomes administered by trained research assistants. Ethical approval was granted by the relevant ethics committees in all study locations, and written informed consent was obtained from all participants (Refer to Appendices 3.1 and 3.2).[178]

Study population

For this study, a Ghanaian was defined by having been born in Ghana, or by having both parents been born in Ghana (second generation). The recruitment strategies have been previously described.[178] Briefly, a multi-stage random sampling method was employed in Ghana using the list of enumeration areas in the Ashanti region stratified by urban and rural areas. In Amsterdam, Ghanaians were randomly selected from the Amsterdam Municipal Health register. In London, recruitment occurred through Ghanaian-based organisations and churches since no list of Ghanaian residents was available. In Berlin, a list of Ghanaian participants was provided by the registration office but due to low response to the written invitation, recruitment was

changed to include Ghanaian-based organisations and churches as the sampling frame. Data were collected between 2012 and 2015.

Smoking assessment

Self-reported smoking status was assessed by a questionnaire. A participant was defined as being a current smoker, ex-smoker or never smoker based on either a 'Yes', 'No, but I used to smoke' or 'No, I've never smoked' response to the question 'Do you smoke at all?'.

Assessment of covariates

Questionnaire items included, among others, marital status, household composition, religious practises, frequency of engagement with religious activities, educational level, employment level (full-time: 32 or more hours of paid work per week), occupational class (manual or non-manual), duration of residence in Europe and age at migration to Europe.

Three forms of acculturation were assessed using the bi-dimensional perspective; cultural orientation and ethnic identity (psychological domains), and social networks (behavioural domain), based on Berry's model of acculturation.[49] The model conceptualises the degree of retention or attachment of participants to both the original Ghanaian culture and the Dutch/German/English culture. Cultural orientation was measured using the Psychological Acculturation Scale.[179] Social networks was determined from the number of Dutch, German and English friends and the amount of time spent with these friends. The ethnic identity measure was determined from the degree to which individuals felt Ghanaian or Dutch, German and English. Answers to questions were scored using a 5 point Likert scale, the mean scores were then grouped into Yes and No if the mean scores were ≥3 or <3 respectively. The acculturation levels were categorized into 4 strategies: 1) Integration: adaptation to the host culture without losing attachment to the original culture. 2) Assimilation: cultural adaptation to the host culture accompanied by loss of original culture. 3) Separation: rejection to host culture and orientation to original culture. 4) Marginalization: rejection of both host and culture of origin.

Data analysis methods

All analyses were conducted using Stata version 14.1.[24] General characteristics using numbers and percentages stratified by location of residence and gender were reported. Between group comparisons were done using chi-squared test for categorical variables and mean difference and t-tests for continuous normally distributed variables. Median and 95% CIs were reported for non-normally distributed continuous variables. To ensure the inclusion of participants reflected the criteria in the RODAM protocol, only the 25 to 70 age group was selected.[21] Age-standardised prevalence rates of current and ex-smokers by location and gender were determined using the entire RODAM population as the standard population stratified by 10-year age groups.

Due to the few male smokers in Ghana (n=35) and Europe (n=94), we investigated the factors associated with smoking among men in all locations together firstly adjusting for age only, and then for age, marital status, education and employment simultaneously to control for possible confounding.

In order to determine whether the effect of residence (Ghana vs Europe) on smoking varied by gender, interactions were tested using likelihood ratio tests. These were also performed to assess potential interaction with other factors (religion, education and marital status) associated with smoking from the overall analysis among men.

Analysis of associations between migration-related factors and smoking were restricted to male first generation migrants. Due to the few female Ghanaian smokers (n=28), regression analysis for factors associated with current smoking was not performed on women.

4.6 Results

Study population

Out of the 5,659 participants, 5,265 with data on smoking were included in this analysis (Figure 4.1). There were no statistically significant differences in the age, gender, marital status and

educational level of persons who did and who did not provide information on smoking status. Table 4.1 shows general characteristics by study location. The sample comprised 62.3% of women and 37.7% of men. Men (mean age, 46.9 ± SD 11.1) were slightly older than women (45.8 ± SD 10.7), $p<0.001$. Most participants in each location were married except in Amsterdam. In London, most participants were highly educated and worked in non-manual full-time occupations. The majority practiced Christianity. Most first generation migrants settled in the European cities between ages 25 and 35 years (50.6% of men and 44.5% of women), and the median duration of residence in Europe was 18 years.

Response rates

The response rates differed across the different study locations. From those invited, 76% in rural Ghana, 74% in urban Ghana, 75% in London and 68% in Berlin participated. In Amsterdam, 67% of those invited responded and of this 53% participated in the study.

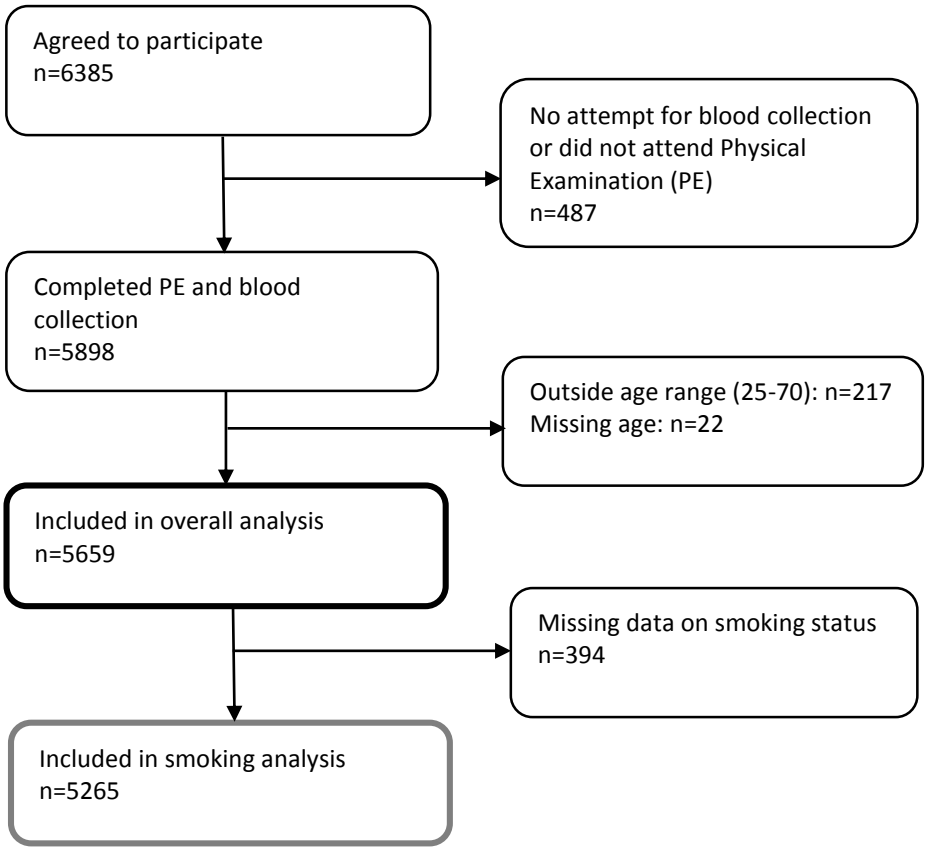

Figure 4.1 Flow chart of RODAM study participation and inclusion in smoking analysis

Table 4.1 Distribution of sample size by study location and gender

Total in each study location	Men n (%)	Women n (%)
Urban Ghana, N=1400	392 (28.0)	1008 (72.0)
Rural Ghana, N=973	381 (39.2)	592 (60.8)
London, N=949	362 (38.2)	587 (61.9)
Amsterdam, N=1400	553 (39.5)	847 (60.5)
Berlin, N=543	297 (54.7)	246 (45.3)
Total, N=5265	1985 (37.7)	3280 (62.3)

Table 4.2 Socio-demographic and migration-related characteristics of male and female Ghanaians in each study location

Characteristics	Rural Ghana N=973		Urban Ghana N=1400		London N=949		Amsterdam N=1400		Berlin N=543	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Number of participants, N	**381**	**592**	**392**	**1008**	**362**	**587**	**553**	**847**	**297**	**246**
Age, Mean (SD)	46.2 (12.8)	46.5 (12.5)	46.6 (11.8)	44.7 (11.2)	46.5 (10.8)	47.7 (10.5)	48.6 (9.3)	45.5 (8.7)	45.8 (11.1)	44.6 (9.3)
Marital status, n (%)										
Married or registered partnership	250 (65.6)	300 (50.7)	284 (72.5)	527 (52.3)	281 (77.6)	335 (57.1)	137 (24.8)	134 (15.8)	143 (48.2)	117 (47.6)
Cohabitating (living together)	66 (17.3)	91 (15.4)	24 (6.1)	91 (9.0)	6 (1.7)	15 (2.6)	133 (24.1)	157 (18.5)	31 (10.4)	15 (6.1)
Unmarried (never married)	27 (7.1)	21 (3.6)	59 (15.1)	77 (7.6)	35 (9.7)	62 (10.6)	154 /(27.9)	243 (28.7)	77 (25.9)	39 (15.9)
Divorced or separated	32 (8.4)	84 (14.2)	21 (5.4)	171 (17.0)	15 (4.1)	118 (20.1)	119 (21.5)	286 (33.8)	44 (14.8)	68 (27.6)
Widow/widower	5 (1.3)	94 (15.9)	3 (0.8)	136 (13.5)	3 (0.8)	29 (4.9)	3 (0.5)	11 (1.3)	0 (0.0)	6 (2.4)
Highest level of education, n (%)										
Never been to school or elementary schooling only	158 (41.5)	396 (66.9)	92 (23.5)	522 (51.8)	16 (4.4)	66 (11.2)	122 (22.1)	359 (42.4)	18 (6.1)	29 (11.8)
Lower vocational schooling or lower secondary schooling	146 (38.2)	164 (27.7)	176 (44.9)	371 (36.8)	102 (28.2)	198 (33.7)	235 (42.5)	277 (32.7)	142 (47.8)	135 (54.9)
Intermediate vocational schooling or intermediate higher secondary schooling	54 (14.2)	19 (3.2)	85 (21.7)	88 (8.7)	67 (18.5)	162 (27.6)	143 (25.9)	161 (19.0)	84 (28.3)	62 (25.2)
Higher vocational schooling or university	23 (6.0)	12 (2.0)	38 (9.7)	27 (2.7)	168 (46.4)	148 (24.2)	49 (8.9)	33 (3.9)	52 (17.5)	19 (7.7)
Religion, n (%)										
Christian-based religion	197 (51.7)	365 (61.7)	234 (59.7)	635 (63.0)	295 (81.5)	517 (88.1)	398 (72.0)	653 (77.1)	185 (62.3)	217 (88.2)
Islamic	35 (9.2)	23 (3.9)	41 (10.5)	99 (9.8)	0 (0.0)	0 (0.0)	16 (2.9)	16 (1.9)	18 (6.1)	2 (0.8)
Other religion	22 (5.8)	39 (6.6)	6 (1.5)	28 (2.8)	14 (3.9)	13 (2.2)	31 (5.6)	53 (6.3)	5 (1.7)	4 (1.6)
Frequency of attending religious services, n (%)										
Once a week	226 (59.3)	388 (65.5)	260 (66.3)	731 (72.5)	280 (77.4)	492 (83.8)	304 (55.0)	571 (67.4)	304 (55.0)	175 (71.1)
Less than once a week	24 (6.3)	34 (5.7)	15 (3.8)	32 (3.2)	28 (7.7)	27 (4.6)	102 (18.4)	112 (13.2)	102 (18.4)	41 (16.7)
Never	2 (0.5)	3 (0.5)	6 (1.5)	1 (0.1)	0 (0.0)	2 (0.3)	27 (4.9)	21 (2.5)	27 (4.9)	5 (2.0)
Employment status, n (%)										
Employed	340 (89.2)	535 (90.4)	336 (85.7)	856 (84.9)	305 (84.3)	437 (74.5)	390 (70.5)	450 (53.1)	213 (71.7)	151 (61.4)
Unemployed	40 (10.5)	56 (9.5)	56 (14.3)	152 (15.1)	48 (13.3)	135 (23.0)	160 (28.9)	373 (44.0)	82 (27.6)	94 (38.2)
Occupational class, n (%)										
Non-manual	46 (12.1)	69 (11.7)	122 (31.1)	364 (36.1)	202 (55.8)	328 (55.9)	84 (15.2)	100 (11.8)	78 (26.3)	78 (31.7)
Manual	320 (84.0)	486 (82.1)	260 (66.30	569 (56.5)	120 (33.2)	201 (34.2)	316 (57.1)	373 (44.0)	182 (61.3)	135 (54.9)
Immigrant generation, n (%)										
First generation	n/a	n/a	n/a	n/a	350 (96.7)	563 (95.9)	544 (98.4)	841 (99.3)	295 (99.3)	245 (99.6)

Characteristics	Rural Ghana N=973		Urban Ghana N=1400		London N=949		Amsterdam N=1400		Berlin N=543	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Second generation	n/a	n/a	n/a	n/a	12 (3.3)	21 (3.6)	8 (1.5)	6 (0.7)	2 (0.7)	1 (0.4)
Duration of years of residence in European area among first generation migrants, Median (95% CI)	n/a	n/a	n/a	n/a	13 (13, 14)	15 (14, 16)	22 (20, 23)	19 (19, 20)	18 (16, 20)	18 (16, 21)
Age at first migration, Median (95% CI) years	n/a	n/a	n/a	n/a	29 (28, 31)	28 (27, 30)	29 (29, 30)	27 (26, 28)	28 (27, 29)	26 (25, 27)
Age group at first migration among first generation migrants, n (%)										
>25 years	n/a	n/a	n/a	n/a	247 (70.6)	346 (61.5)	413 (75.9)	551 (65.5)	213 (72.2)	151 (61.6)
16-25 years	n/a	n/a	n/a	n/a	68 (19.4)	156 (27.7)	59 (16.4)	185 (22.0)	65 (22.0)	77 (31.4)
Less than 16 years	n/a	n/a	n/a	n/a	13 (3.7)	23 (4.1)	33 (6.1)	82 (9.8)	12 (4.1)	12 (4.9)

n/a- not applicable

Prevalence of smoking

The prevalence of smoking was lower in Ghana (1.5%) than in Europe (4.2%), p<0.001. In men, this prevalence was 4.8% and 7.8% respectively, p<0.01. Figure 4.2 shows the age-standardized prevalence rates of current and ex-smokers among Ghanaians in each location of residence for men, and Figure 4.3 for women.

Current smoking was most common among Ghanaian men living in Berlin (14.8%; 95% CI 10.8% to 18.9%) followed by Amsterdam (7.8%; 95% CI 5.4% to 10.0%), rural Ghana (6.2%; 95% CI 3.6% to 8.6%) and urban Ghana (3.4%; 95% CI 1.6% to 5.3%). Smoking was much less common in men in London (1.4%, 95% CI 0.2% to 2.6%).

For women, current smoking was, again, most common in Berlin (3.3%; 95% CI 1.0% to 5.5%), followed by Amsterdam (3.2%; 95% CI 1.0% to 5.4%), London (0.2%, 95% CI -0.2% to 0.6%), and urban Ghana (0.1%, 95% CI -0.1% to 0.2%) while no women smoked in rural Ghana.

Patterns of smoking and ex-smoking

Current smokers smoked a median of 5 (95% CI, 4-6) cigarettes per day. The median length of time ex-smokers smoked before quitting was 7 years (95% CI, 5-10) for men and 3 years (95% CI, 2-6) for women. Most ex-smokers had quit smoking more than a decade ago (66.2%). Approximately 6% of all ex-smokers had recently quit smoking (less than 1 year ago).

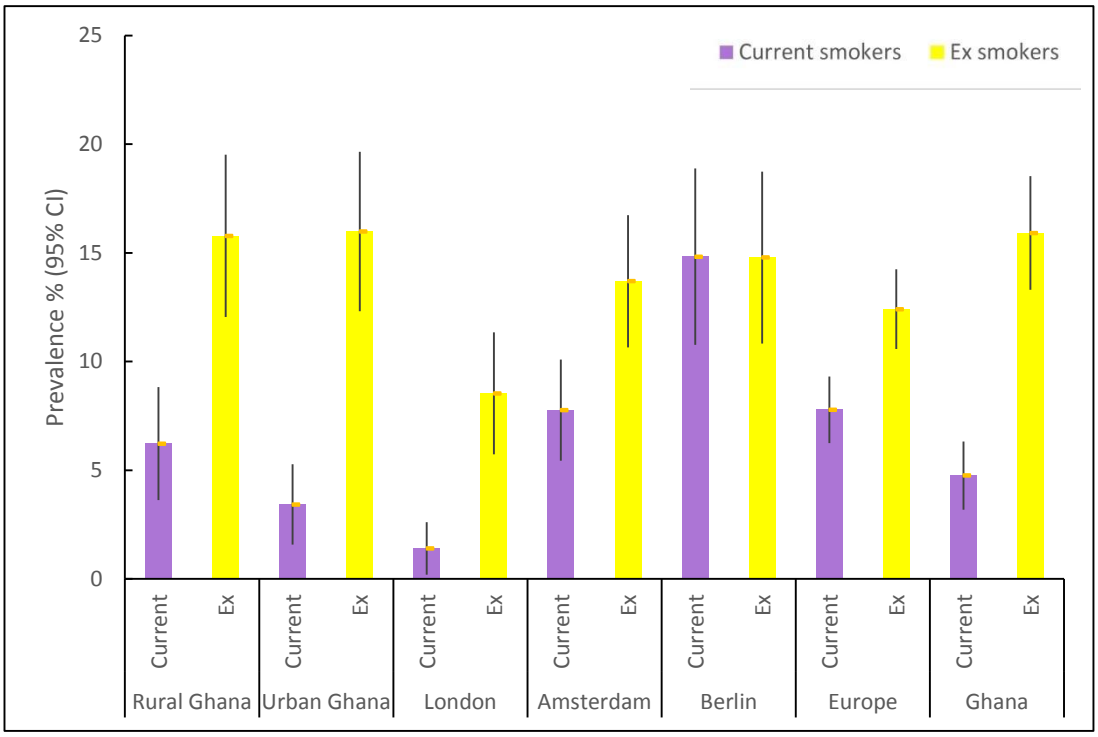

Figure 4.2 Age-standardized prevalence of current and ex-smokers among men

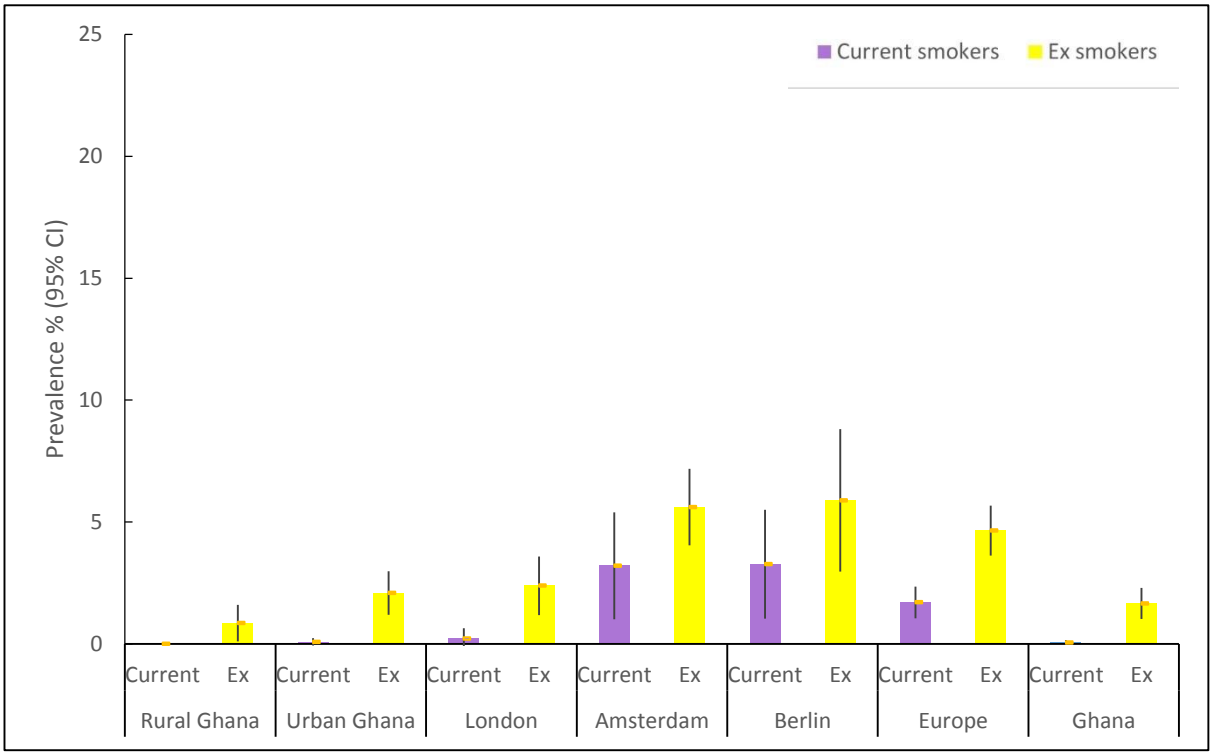

Figure 4.3 Age-standardized prevalence of current and ex-smokers among women

Factors associated with smoking among Ghanaian men

After adjusting for age, marital status, education and employment, the factors associated with current smoking among men included residence, marital status, living arrangements, religion practiced, frequency of attending religious services and educational level (Table 4.3). Within Ghana, there was no difference in smoking prevalence by location.

Overall, men in Europe were 1.9 times more likely to smoke than men in Ghana but smoking prevalence in Ghana and London was similar. In contrast, men in Amsterdam and Berlin were 1.7 times and 3.8 times, respectively, more likely to smoke than men in Ghana.

Divorced or widowed men were 1.7 times more likely to smoke than married or cohabitating men (Table 4.3). Men living alone were 2.9 times as likely to smoke than men who lived with children. Further positively associated factors included Islam religion, rare attendance at religious services, and lower secondary or no education.

Table 4.3 Factors associated with current smoking among Ghanaian men in all locations

	Total men	Current smokers		
Characteristics	**N=1985**	**n (%)**	**Adjusted for age only PR (95% CI)**	**Adjusted for age, marital status, education and employment PR (95% CI)**
Age group				
25-34	368	20 (5.4)	1.00*	1.00
35-44	428	27 (6.3)	1.16 (0.66, 2.03)	1.15 (0.64, 2.07)
45-54	638	46 (7.2)	1.33 (0.80, 2.21)	1.23 (0.71, 2.13)
55-70	551	36 (6.5)	1.20 (0.71, 2.04)	1.08 (0.60, 1.93)
Site				
Rural Ghana	381	22 (5.8)	1.00	1.00
Urban Ghana	392	13 (3.3)	0.57 (0.29, 1.12)	0.64 (0.33, 1.27)
Both urban and rural Ghana	773	35 (4.5)	1.00	1.00
London	362	5 (1.4)	**0.30 (0.12, 0.77)**	0.56 (0.21, 1.49)
Amsterdam	553	45 (8.1)	**1.75 (1.14, 2.70)**	**1.74 (1.02, 2.96)**
Berlin	297	44 (8.1)	**3.26 (2.13, 4.99)**	**3.81 (2.35, 6.16)**
All European locations	1212	94 (7.8)	**1.69 (1.15, 2.47)**	**1.91 (1.27, 2.88)**
Marital status				
Married or cohabitating	1095	57 (5.2)	1.00	1.00
Never married	260	16 (6.2)	1.22 (0.71, 2.08)	0.99 (0.57, 1.74)
Divorced or widowed	597	56 (9.4)	**1.93 (1.32, 2.82)**	**1.71 (1.15, 2.53)**
Household				
Living with children	417	16 (3.8)	1.00	1.00
Living alone	157	23 (14.7)	**3.98 (2.08, 7.59)**	**2.88 (1.51, 5.48)**
Living with family or other adults	266	23 (5.7)	**2.36 (1.24, 4.49)**	1.86 (0.99, 3.51)
Religion				
Christian-based religion	1309	53 (4.1)	1.00	1.00
Islam religion	110	12 (10.9)	**2.73 (1.51, 4.94)**	**2.43 (1.30, 4.54)**
Other religions or faiths	78	5 (6.4)	1.57 (0.65, 3.82)	1.60 (0.65, 3.89)
Frequency of attending religious services*				
Once a week or more	1200	45 (3.8)	1.00	1.00
Less than once a week	236	20 (8.5)	**2.28 (1.37, 3.79)**	**1.98 (1.16, 3.36)**
Never	46	4 (8.7)	2.27 (0.84, 6.15)	2.28 (0.82, 6.33)
Education				
Lower vocational and below	1207	96 (8.0)	1.00	1.00
Intermediate vocational/ higher secondary	433	28 (6.5)	0.82 (0.54, 1.24)	0.85 (0.56, 1.28)
Higher vocational school/ university	330	5 (1.5)	**0.19 (0.08, 0.48)**	**0.23 (0.09, 0.58)**
Employment				
Employed	1584	94 (5.9)	1.00	1.00
Unemployed	386	33 (8.6)	1.48 (1.00, 2.18)	1.33 (0.89, 1.98)
Occupational class				
Non-manual	532	25 (4.7)	1.00	1.00
Manual	1198	78 (6.5)	1.36 (0.88, 2.12)	0.91 (0.58, 1.41)

***Only age in the model**

Presence of interactions between location (Ghana/Europe) and potential risk factors

The effect of location (Ghana vs Europe) on smoking differed significantly with gender ($p<0.001$). Ghanaian women in Europe were 12 times more likely to smoke than women in Ghana (PR 12.42; 95% CI, 1.34, 115.35), while this difference was only 2-fold for men (PR 1.99; 95% CI, 1.26-3.14) after adjusting for age, marital status, education, and employment.

No other significant interactions between smoking and religion, education and marital status were present.

Association between migration-related factors and smoking

Among first generation men who migrated to Europe at the age of 25 or older, duration of residence and age of migration were not significantly associated with smoking (Table 4.4). Only men whose cultural orientation showed signs of assimilation were more likely to smoke than men whose cultural orientation showed signs of integration. The other acculturation measures, ethnic identity and social networks were not associated with smoking.

Table 4.4 Association between duration of current residence, age at migration, measures of acculturation and smoking among male first generation migrants who migrated after 25 years

	Total men	Current smokers		
	N=1678	n (%)	Adjusted for age only PR (95% CI)	Adjusted for age, marital status, education and employment PR (95% CI)
Duration of residence in European area (years)	n/a	n/a	1.01 (0.98, 1.03)	1.10 (1.00, 1.21)
Duration of residence in European area (categories)				
Less than 10 years	224	20 (8.9)	1.00	1.00
10 to 19 years	285	17 (6.0)	0.90 (0.40, 2.06)	0.93 (0.41, 2.09)
20 to 29 years	302	24 (8.0)	1.08 (0.47, 2.47)	0.92 (0.39, 2.16)
30 or more years	62	10 (16.1)	2.10 (0.76, 5.80)	1.68 (0.58, 4.87)
Age at first migration (years)	n/a	n/a	0.98 (0.65, 1.02)	0.99 (0.95, 1.03)
Acculturation: Cultural Orientation				
Integration	685	54 (7.9)	1.00	1.00
Assimilation	6	3 (50.0)	**6.77 (3.25, 14.11)**	**9.51 (3.36, 26.92)**
Separation	214	15 (7.0)	0.90 (0.52, 1.56)	0.61 (0.35, 1.09)
Marginalization	4	1 (25.0)	3.07 (0.60, 15.78)	1.09 (0.28, 4.29)
Acculturation: Ethnic identity				
Integration	481	41 (8.5)	1.00	1.00
Assimilation	19	0 (0.0)	-	-
Separation	371	30 (8.1)	0.94 (0.60, 1.48)	1.02 (0.65, 1.61)
Marginalization	38	2 (5.3)	0.70 (0.17, 2.82)	1.28 (0.32, 5.15)
Acculturation: Social Network				
Integration	512	37 (7.2)	1.00	1.00
Assimilation	147	12 (8.2)	1.07 (0.57, 2.01)	1.12 (0.59, 2.14)
Separation	155	15 (9.7)	1.33 (0.75, 2.36)	1.23 (0.69, 2.19)
Marginalization	95	9 (9.5)	1.31 (0.66, 2.62)	1.25 (0.62, 2.52)

n/a- not applicable

Smoking initiation and migration

Among the 88 current smokers who were first generation migrants and migrated at age 25 or older, the majority started smoking after having migrated to Europe (Table 4.5). 57.1% of men started smoking in Amsterdam but in Berlin, 51.4% had started smoking before migrating. Among women, 53.6% of women started smoking in Amsterdam. No man or woman smoked before going to London. Also, no woman started smoking while living in London but of the women who were smokers in Berlin, 2 started smoking in Ghana and the other 2 in Berlin respectively.

Table 4.5 Period when first generation current smokers started smoking by gender and European location of residence (restricted to those who migrated after age 25)

Gender	Period when started smoking	Amsterdam n (%)	Berlin n (%)	London n (%)	All European locations n (%)
Men	Total current smokers	35	35	3	73
	Before migration*	15 (42.9)	18 (51.4)	0 (0.0)	33 (45.2)
	After migration**	20 (57.1)	17 (48.6)	3 (100.0)	40 (54.8)
Women	Total current smokers	11	4	0 (0.0)	15
	Before migration*	4 (36.4)	2 (50.0)	0 (0.0)	6 (40.0)
	After migration**	7 (63.6)	2 (50.0)	0 (0.0)	9 (60.0)

*assuming when in Ghana; **while residing in European location

4.7 Discussion

Key findings

Smoking is remarkably uncommon among Ghanaians when compared to European populations, and particularly so for Ghanaians in their home country. Among women, smoking in Ghana and London is almost non-existent and still rare in Amsterdam and Berlin. Among men, the prevalence of smoking is higher in Amsterdam and Berlin (but not in London) than in Ghana but, overall, far below the European average. More than half of first generation men and the majority of women started smoking in Europe. All smokers were light smokers.

Among Ghanaian men in Europe, migration-related factors including duration of residence and age at migration were not associated with smoking. Assimilation in the context of cultural orientation was associated with an increase in smoking, but not in other measures such as ethnic identity or social networks.

Discussion of key findings

The prevalence of smoking among the migrant Ghanaian population showed patterns of convergence to the European population since it reflected the ranking of smoking prevalence among adults in the three European host countries in which they now lived. Smoking prevalence was highest in Berlin, followed by Amsterdam and London. Recent national estimates indicate smoking prevalence in men and women of 33% and 27% in Germany,[180] of 29% and 23% in the Netherlands,[17] and of each 22% in the UK.[17]

The low prevalence of smoking among Ghanaian men in Ghana corresponds to data in neighbouring West African countries including Nigeria,[131] and Benin.[181] Low prevalence was also observed in Ethiopia and Sao Tome & Principe.[181] These similarities may relate to the substantial Christian population.[182] In other sub-Saharan African countries, the smoking prevalence in men is much higher,[181] possibly due to cultural attitudes and ethnic

compositions. The very low smoking prevalence among women in Ghana accords with previous studies,[126] and in most other SSA countries suggesting a widespread cultural norm discouraging women from smoking.[117]

The finding that most of the first generation migrant smokers started smoking only in Europe suggests a respective influence of the European environment with its substantially greater proportion of smokers in native European populations. Smokers usually begin smoking before the age of 18 years.[183] Interestingly, the average age of migration among Ghanaian men who smoked in Europe was 29 years (95% CI: 27 to 30). This average age of migration among first generation smokers indicated that smoking began on average much later among the 54.8% of male smokers in Europe, as compared to European-origin populations.[184]

More non-smokers migrated to London as compared to Amsterdam and Berlin, suggesting selective movement of Ghanaian smokers and non-smokers between Amsterdam, Berlin and London.[185] It might be that the non-smokers may have migrated to London for reasons such as education and employment opportunities as was supported by the higher proportion of highly educated participants in London than Berlin and Amsterdam (46%, 17.5% and 8.7% of men respectively). Due to these reasons which reflects a higher socio-economic position, the non-smokers were probably more economically capable of migrating to London than smokers who may be of lower socio-economic status.

Within Europe, assimilated men were more likely to smoke than men who have adapted the host culture without losing attachment to the original culture (integration). However, this link was inconsistent as it was only present for the cultural orientation measure and not for the categories of ethnic identity and social behaviour. The difference in smoking prevalence among Ghanaian women in Ghana and Europe also hints to the influence of the Western lifestyle (a form of unhealthy assimilation).[186] Other research has shown that strong ethnic pride and identity can be protective against unhealthy behaviours including smoking.[187-189] The inconsistency of our findings regarding the impact of acculturation suggests that any form of

convergence is halted in the Ghanaian migrant community but requires further elucidation. This implies that those protective factors such as beliefs associated with Christianity, family values, and collectivism are still influential in the Ghanaian migrant community.

Previous research in the US has shown that assimilation has a positive effect on smoking for immigrants from countries with lower smoking rates than USA, while this has a negative effect on smoking among immigrants from countries with higher smoking rates than USA.[186] Thus, although Ghana has lower smoking rate than Europe, we found no conclusive support for the effect of assimilation on increased smoking in the Ghanaian community.

Infrequent attendance to religious services was associated with higher smoking prevalence. The finding that Islamic men smoked more is consistent with the substantially increased prevalence of smoking in Islamic populations globally.[190] The once neutral position on smoking in the Islamic world may contribute to the higher rates still observed today.[190] Even though, respective discouragement is increasing also in the Islamic community.[191]

As to marital status, being divorced or widowed associated with an increased prevalence of smoking compared to married men. Marriage or cohabitating has been linked to better health through its support (financial, psychological, social) for healthier behaviours.[192, 193] This falls in line with the finding that living with a child or children in the household prevents smoking.

Higher levels of education accompanied lower prevalence of current smoking compared to men with lower levels of education. This supports presence of a socio-economic gradient for smoking,[33] and also among immigrant males.[194] This pattern corresponds to the last stages of the smoking epidemic rather than the initial stages, where smoking is more common among higher educational groups. This observation thus suggests that the smoking epidemic had already peaked among Ghanaian men, despite their lower prevalence and consumption rates as compared to native European populations. Since the most highly educated male Ghanaians lived in London (46.4%), this may explain part of the lower prevalence of smoking reported in London itself given the trends discussed previously. Possibly suggesting that a type of selective migration

may have occurred among Ghanaian men with different kinds of people migrating to London than to Amsterdam and Berlin or for different reasons education being a major one of them.

Strengths and limitations

The strength of this study is the restriction to a relatively homogenous population of Ghanaians. In many studies on smoking, persons of African ancestry are often combined due to uncertainty on the actual origin. Using standardised questions across all sites removed the problem of variable smoking definitions. Standard population-based recruitment strategies were employed. Although, selection bias may result from the recruitment of many participants from churches in London and Berlin, and Christians may be over-represented. However, the majority of the population of Ghana practices Christianity (71.2%), with smaller proportions practicing Islam (17.6%), mostly in the North of the country) or traditional religions (5.2%).[159] Smoking may be under-reported in our study population due to a tendency towards responses considered socially desirable.[195, 196] In addition, the use of objective measures to confirm smoking status, such as urine analysis of nicotine metabolites, was not conducted.[150, 197] The small number of smokers impaired the preciseness of some of the estimates on smoking risk factors. However, the sample size was sufficient to detect a significant difference in smoking prevalence by location. Key parameters of respondents and non-respondents did not differ significantly.

Implications

This study draws attention to environmental or societal influences on the smoking behaviour of ethnic minority groups from SSA in high-income European countries. Although smoking is still rare among Ghanaian women, their higher taking up of smoking as compared to males' points to the vulnerability of female migrants and women among ethnic minority groups in high-income countries. Particular attention should be placed on migrants from countries with low smoking prevalence.

The higher rates of smoking upon migration may further increase the burden of tobacco-related diseases including cardiovascular disease and diabetes among ethnic minority migrant populations in Europe.[198, 199] Although this may not be realised among Ghanaian women since their smoking prevalence and intensity rates are substantially lower compared to native European women. Longitudinal study designs following up migrant populations, which track the change in smoking status would be ideal for answering the question on the impact of migration on smoking behaviour.

4.8 Conclusions

Smoking behaviour among this migrant population is multifactorial in nature, with exposure to a high smoking environment having a strong influence, though the prevalences are still far lower than the European population. It seems that one's immediate social networks through family, religion, social communities, culture as well as higher education are associated with a lower uptake of smoking. Research on the impact of location on women's attitude towards smoking would help elucidate the societal factors underlying the lower smoking uptake among women in some locations and the higher smoking uptake in others.

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Declaration of interests

None declared

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4.9 Additional analyses not included in paper

Among Ghanaians living in different locations, smoking cessation prevalence was lower in Berlin and Amsterdam where more Ghanaian men and women smoked and it was higher in locations where fewer Ghanaian men and women smokers lived (Figures 4.4 and 4.5).

Lower smoking cessation rates corresponded with higher rates of smoking among both men and women.

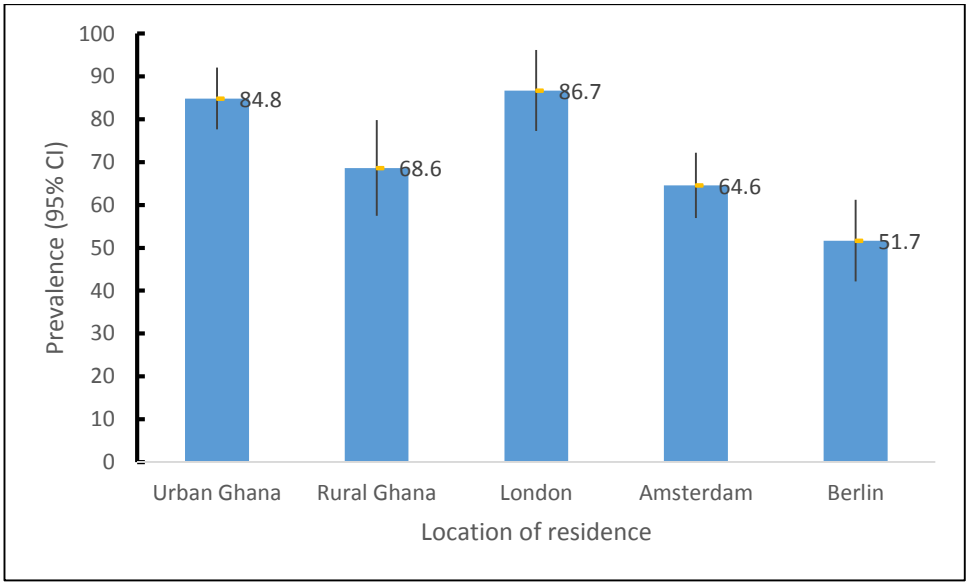

Figure 4.4 Age-standardized prevalence of smoking cessation among Ghanaian men in each location

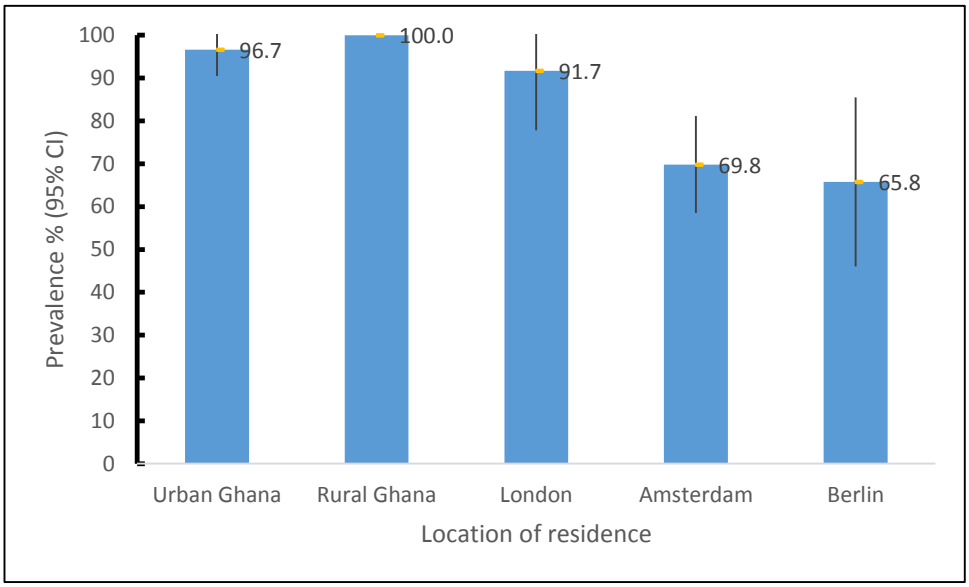

Figure 4.5 Age-standardized prevalence of smoking cessation among Ghanaian women in each location

Post-hoc power analysis

The respective power of the study to detect differences in the prevalences of smoking in each location at the 0.05 alpha significance level given the actual sample sizes used in the analysis and the prevalence of smoking observed in each location (Table 3.2). From this post-hoc power analysis, it shows that the study had high statistical power to significantly detect a difference in the prevalence of smoking between Ghana and Europe.

Table 4.6 Estimated power given actual samples sizes and estimates of smoking obtained in the analysis to detect a difference in the prevalence of smoking between 2 respective locations

	Sig level	Location 1	Actual sample Size in location 1	Location 2	Actual sample Size in location 2	Proportion in location 1	Proportion in location 2	Estimated power of the study
Overall								
1	0.05	Ghana	2373	Europe	2892	0.0152	0.0418	99.99%
2	0.05	Urban Ghana	1400	Rural Ghana	973	0.0100	0.0226	68.33%
3	0.05	Ghana	2373	London	949	0.0152	0.0063	55.37%
4	0.05	Ghana	2373	Berlin	543	0.0958	0.0063	100%
5	0.05	Ghana	2373	Amsterdam	1400	0.0450	0.0063	100%
Men								
1	0.05	Ghana	773	Europe	1212	0.0453	0.0776	82.58%
2	0.05	Urban Ghana	392	Rural Ghana	381	0.0332	0.0577	37.41%
3	0.05	Ghana	773	London	362	0.0453	0.0138	80.97%
4	0.05	Ghana	773	Berlin	297	0.0453	0.1481	99.90%
5	0.05	Ghana	773	Amsterdam	553	0.0453	0.0814	76.75%
Women								
1	0.05	Ghana	1600	Europe	1680	0.0006	0.0161	99.48%
2	0.05	Urban Ghana	1008	Rural Ghana	592	0.0010	0.0000	Unable to detect
3	0.05	Ghana	1600	London	587	0.0006	0.0017	18.43%
4	0.05	Ghana	1600	Berlin	246	0.0006	0.0325	97.70%
5	0.05	Ghana	1600	Amsterdam	847	0.0006	0.0213	100%

NB: Ghana refers to both urban and rural Ghana

4.10 How the epidemiology of smoking in Ghana might explain the smoking patterns among Ghanaian migrants

Age distribution of smoking among Ghanaian migrants

Table 4.7 Overall age distribution of smoking among male Ghanaian migrants

Age group	Current smokers n (%)	Ex-smokers n (%)	Never smokers n (%)	Total
25-34	13 (13.8)	15 (9.7)	162 (16.8)	190
35-44	20 (21.3)	18 (11.7)	222 (23.0)	260
45-54	33 (35.1)	57 (37.0)	348 (36.1)	438
55-70	28 (29.8)	64 (41.6)	232 (24.1)	324
Total	94	154	964	1212

Among Ghanaian migrant men, current smoking appeared to increase as age increased, peaking in the 45-54 age category then decreasing in the 55 to 70 age group.

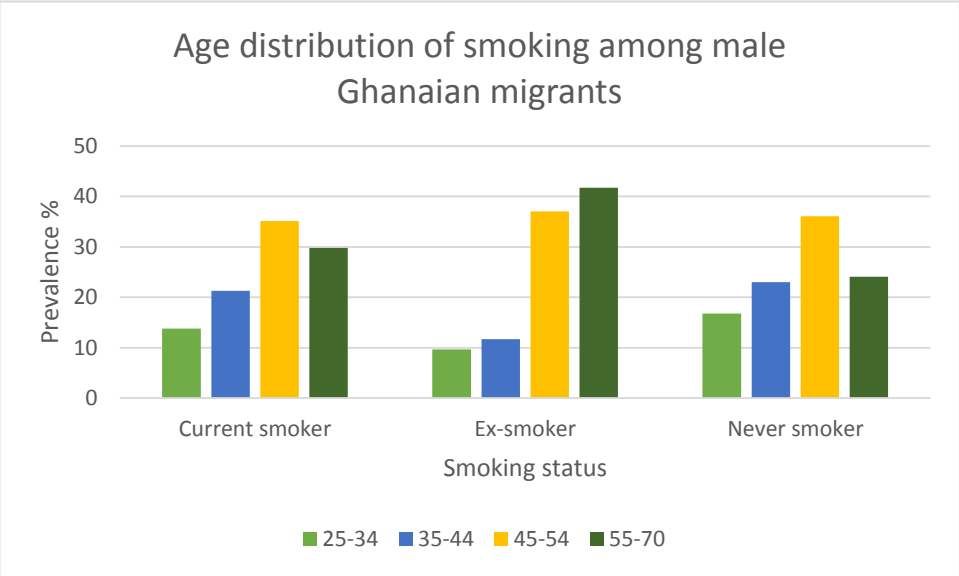

Figure 4.6 Age distribution of smoking among male Ghanaian migrants

Table 4.8 Overall age distribution of smoking among female Ghanaian migrants

Age group	Current smokers n (%)	Ex-smokers n (%)	Never smokers n (%)	Total
25-34	7 (25.9)	9 (11.5)	239 (15.2)	255
35-44	3 (11.1)	11 (14.1)	433 (27.5)	447
45-54	11 (40.7)	38 (48.7)	600 (38.1)	649
55-70	6 (22.2)	20 (25.6)	303 (19.2)	329
Total	27	78	1575	1680

Among female Ghanaian migrants, women aged 45-70 smoked the most while women aged 35-44 smoked the least.

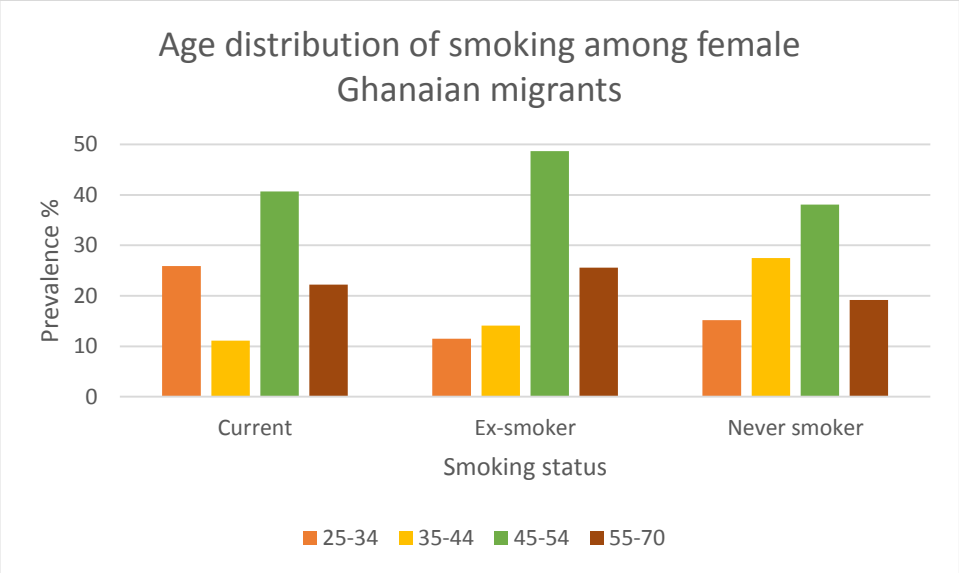

Figure 4.7 Age distribution of smoking among female Ghanaian migrants

Table 4.9 Age distribution of current smoking among male Ghanaian migrants in London, Amsterdam and Berlin

	Current Smokers		
Age group	**London n (%)**	**Berlin n (%)**	**Amsterdam n (%)**
25-34	2 (40.0)	9 (20.5)	2 (4.4)
35-44	1 (20.0)	8 (18.2)	11 (24.4)
45-54	1 (20.0)	15 (34.1)	17 (37.8)
55-70	1 (20.0)	12 (27.3)	15 (33.3)
Total	5	44	45

Table 4.10 Age distribution of current smoking among female Ghanaian migrants in London, Amsterdam and Berlin

	Current Smokers		
Age group	**London n (%)**	**Berlin n (%)**	**Amsterdam n (%)**
25-34	1 (100.0)	3 (37.5)	3 (16.7)
35-44	0	1 (12.5)	2 (11.1)
45-54	0	3 (37.5)	8 (44.4)
55-70	0	1 (12.5)	5 (27.8)
Total	1	8	18

The older Ghanaian migrants smoked more than the younger migrants did. This pattern of increasing smoking prevalence with increasing age was similar to the trend observed from research conducted in Ghana. Research conducted in Ghana observed that smoking was more common among older age groups.[126] Other factors that may contribute to this higher prevalence of smoking among older age groups may be due to the closing down of BAT in Ghana and government interference in tobacco industry activities around that time. After BAT's closure and restrictions on advertising of tobacco products in Ghana were in force, tobacco products were now less available to the public. Stricter regulations meant that access was limited. The normal supply of cigarettes was interrupted thereby making purchases difficult for future generations. The older age groups who may have been accustomed to unrestricted availability of cigarettes in Ghana when they migrated now continued their habit of smoking in the new host country. It may be that the aftermath of BAT's closure in Ghana brought with it a cultural change in smoking behaviour and this was especially evident among the younger age groups. It might be that the Ghanaian smokers in London, Amsterdam and Berlin were already smokers in Ghana prior to BAT'S closure and the time when weaker tobacco control policies were in place. Upon migrating to European locations, these same older adults took up smoking again in the new environment where cigarettes were more widely available and the cultural norms towards smoking was more tolerant.

The RODAM study also found smoking to be higher in rural Ghana. Like some studies in the systematic review also found higher prevalences of tobacco use in rural areas. This challenges previous assumptions about urbanisation and the increase in the Western lifestyle health risk behaviours. The picture may well be different across sub-Sahara Africa, in that tobacco use may be more prevalent in rural areas rather than urban areas. This is important to note so that tobacco control interventions are not targeted to the wrong population in urban areas where in fact the majority of smokers in SSA maybe in rural areas.

Chapter 5 Exploring the relationship between smoking and ethnicity: HELIUS Paper- Research paper 3

5.1 Introduction to Chapter

This chapter focused on assessing ethnic differences in smoking prevalence and smoking cessation in a European location. The analysis included a comparison of adults of the Ghanaian migrant ethnic group along with minority ethnic groups of Turkish, Moroccan, African-Surinamese and South-Asian Surinamese in Amsterdam to the native Dutch ethnic population. The purpose of this chapter is to better understand how Ghanaians smoking behaviour compare to other ethnic minority ethnic groups in the same location. It also strived to determine how much SES, a major explanatory factor of smoking explains the difference between ethnic groups.

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Thesis Title	Differences in smoking by location of residence, ethnic group and country of origin: The Ghanaian perspective in sub-Saharan Africa and Europe

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SECTION D- Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	Rachel Brathwaite drafted the initial research proposal, analysed the data, drafted the manuscript and made revisions to the manuscript after suggestions from all other co-authors.

Student Signature: Rachel A Brathwaite **Date:** ___10/10/2016_____

Supervisor Signature: L Smeeth **Date:** ___10/10/2016____

5.2 Abstract

Title: Ethnic differences in smoking in the Netherlands and the contribution of socio-economic factors: the HELIUS Study

Background: Data exploring how much of the ethnic differences in smoking prevalence and cessation are explained by socioeconomic factors are lacking. We therefore assessed ethnic differences in smoking prevalence and cessation and the contribution of both educational level and occupational-related SES to the observed ethnic differences in smoking behaviour.

Methods: Data of 22,929 participants (aged 18-70 years) from the multi-ethnic cross-sectional HELIUS study in the Netherlands were analysed. Poisson regression models with a robust variance were used to estimate prevalence ratios.

Results: Compared to the Dutch, after adjustment for age and marital status, smoking prevalence was higher in men of Turkish (PR 1.69, 95% CI 1.54 to 1.86), African Surinamese (1.55, 1.41 to 1.69) and South-Asian Surinamese (1.53, 1.40 to 1.68), whereas among women, smoking prevalence was higher in Turkish, similar in African-Surinamese but lower in all other ethnic origin groups. All ethnic minority groups, except Ghanaians, had a significantly lower smoking cessation prevalence than the Dutch. Socio-economic gradients in smoking (higher prevalence among those lower educated and with lower level employment) were observed in all groups except Ghanaian women (a higher prevalence was observed in the higher educated). Ethnic differences in smoking prevalence and cessation are largely, but not completely, explained by socioeconomic factors.

Conclusions: Our findings imply that anti-smoking policies designed to target smoking within the lower socioeconomic groups of ethnic minority populations may substantially reduce ethnic inequalities in smoking, particularly among men. For Ghanaians however, smoking prevention measures may be better focused on higher educated women.

WHAT IS ALREADY KNOWN ON THIS SUBJECT?

In the Netherlands, ethnic differences in smoking has been observed among the Turkish, Surinamese and Moroccan ethnic minority groups with smoking being associated with most lower educated men and higher educated women. However, this was only investigated in the 35-60 age group, without distinguishing between African-Surinamese and South-Asian Surinamese and without including adults of Ghanaian descent one of the largest ethnic minority groups in the Netherlands. Comparisons of both smoking prevalence and cessation has not been compared to the Dutch host population and the extent to which both educational level and occupational level explains ethnic differences in smoking and cessation has not been done.

WHAT DOES THIS STUDY ADD?

This study compared smoking prevalence and cessation of four of the largest ethnic minority populations to the Dutch. The findings suggest that ethnic differences in smoking prevalence and cessation in the Netherlands are largely but not completely explained by socio-economic differences. These findings imply that anti-smoking policies designed to target smoking within the lower socio-economic groups of ethnic minority groups may substantially reduce ethnic inequalities in smoking particularly among men in the Netherlands. However, among Ghanaian women, smoking prevention measures may be better focused on higher educated women.

5.3 Introduction

Ethnic differences in mortality rates and prevalence of lifestyle risk factors for diseases have been observed in the Netherlands.[200] Smoking is a leading lifestyle risk factor that accounts for premature morbidity and mortality from several diseases in populations worldwide.[201] Higher rates of smoking, as well as lower rates of smoking cessation are more present in disadvantaged than advantaged groups in society.[36, 37, 202] Most ethnic minority groups may be of lower socio-economic status (SES) than European host populations.[203] Evidence suggests variations in smoking prevalence across ethnic groups in high-income countries.[38, 39] Differences in smoking prevalence among ethnic minority groups in European countries may be a reflection of their pre-migratory smoking status, or factors of the post-migratory environment, which influences smoking behaviour.[53, 204] Smoking is associated with socio-economic,[194] social, and cultural factors which undergo changes following migration to new environments. In the Netherlands, researchers observed socio-economic gradients in smoking (smoking prevalence is higher as you have a lower socioeconomic groups) among some ethnic minority populations, but not in sub-Saharan ethnic groups.[194] Inverse socio-economic gradients in smoking cessation (smoking cessation rate is lower as you have a lower socio-economic group) were recognised in other research.[205] Few studies examined how much these differences in smoking and smoking cessation among ethnic minority groups relative to the Dutch were explained by socio-economic factors using both educational level and occupational level as socioeconomic indicators.[43, 194]

The main aim of this paper was to assess ethnic differences in smoking prevalence and cessation among the Dutch, Ghanaian, Moroccan, Turkish, African-Surinamese and South-Asian Surinamese origin ethnic groups in the Netherlands, and to study to what extent these ethnic differences could be possibly explained by differences in SES. In order to be able to address this general aim, whether the smoking prevalence and cessation was related to low SES was assessed

not only among those of Dutch origin, but also among the ethnic minority groups. Age-standardized prevalences of current smoking and cessation by ethnic group and gender was calculated and the differences in smoking prevalence and cessation in each minority ethnic group were compared to the Dutch host population.

5.4 Methods

Study design and setting

Baseline data from the multi-ethnic HELIUS (**H**ealthy **LI**ife in an **U**rban **S**etting) study were used. Ethical approval was granted by the Institutional Review Board of the Academic Medical Center at the University of Amsterdam, and all participants provided informed consent. In brief, HELIUS is investigating the patterns of health and health care utilization among the largest ethnic groups resident in Amsterdam, the Netherlands, including the Dutch host population and the ethnic minority groups of Ghanaian, Moroccan, Turkish, South-Asian Surinamese and African Surinamese origin (See Appendix 4.1.).[72]

Participants

Participants aged 18 to 70 years were randomly sampled from the Amsterdam municipal population register, stratified by ethnicity. Participants' ethnicity was defined according to the country of birth of the participant as well as that of his/her parents, which is currently the most widely accepted and most valid assessment of ethnicity in the Netherlands.[206] Specifically, a participant was considered as of ethnic minority origin if he/she fulfilled either of the following criteria: 1) he/she was born abroad and has at least one parent born abroad (first generation); or 2) he/she was born in the Netherlands but both his/her parents were born abroad (second generation). The Surinamese group was further classified according to self-reported ethnic origin into 'African', 'South-Asian', or other. Participants were considered of European Dutch ethnic origin (henceforth, Dutch) if the participant and both parents were born in the Netherlands. Data for the HELIUS study were collected via the use of a questionnaire and a physical examination from January 2011 to November 2015. For the current study, data from 23,942 participants for whom questionnaire data were available was used. Participants with an unknown/other ethnicity (n=50), Javanese Surinamese (n=250) or other/unknown Surinamese ethnicity (n=286), and those with missing data on smoking status (n=107), marital status

(n=134), and/or educational level (n=186) were excluded, resulting in a total sample size of 22,929 participants which was used in the current analyses.

Smoking variables

Smoking status was determined by the question 'Do you smoke at all?' Current smoking prevalence was calculated as the percentage of individuals in each ethnic group who responded 'yes' to this question. The prevalence of smoking cessation, also known as quit ratio percent,[207] in each ethnic group was determined by dividing the number of ex-smokers, (those who responded 'No, but I used to smoke') by the number of ever-smokers (the sum of ex and current smokers).

Socioeconomic status variables

The highest level of educational qualification attained (either in the Netherlands or in the country of origin) was grouped into three categories: 1) never been to school, or had elementary schooling only, or lower vocational schooling, or lower secondary schooling; 2) intermediate vocational schooling or higher secondary education schooling and; 3) higher vocational schooling or university level education. Occupational level was classified according to Dutch Standard Occupational Classification system for 2010.[208] This document provides an extensive systematic list of all professions in the Dutch system. Based on this document, occupational level was classified into 'elementary', 'lower', 'intermediate', 'higher', or 'graduate', based on job title and job description, including a question on fulfilling an executive function. Occupation-related SES was created by combining employment status (unemployed, not in working force (retired, student or full-time homeworker), incapacitated, or employed) with occupational level (elementary, lower, middle, higher or graduate level) among those who were employed. This resulted in the following categories: 1) unemployed, 2) not in the workforce, 3) incapacitated 4) employed at elementary/lower occupational level, and 5) employed at intermediate to graduate occupational level. The sixth category represented participants who were employed but there was insufficient data to define their occupational level.

Statistical methods

Men and women were analysed separately since literature shows that smoking behaviour, including the usage and reasons for using tobacco and cessation, differs substantially by gender.[209] To make fair comparisons of the smoking prevalence across all ethnic groups, age-standardized prevalence rates for current smoking and cessation were calculated using the entire HELIUS population as the standard population, stratified by 10-year age groups. A likelihood ratio test was used to test whether there were interactions between ethnicity and educational level and between ethnicity and occupation-related SES.

A Poisson regression model with a robust variance estimator was used to directly estimate adjusted prevalence ratios with 95% confidence intervals for current smoking and smoking cessation in each ethnic minority group relative to the Dutch.[210] Prevalence ratios have been widely recommended in the literature as the preferred estimate if the outcome of interest is common as odds ratio tends to greatly overestimate the risk ratio in cross-sectional studies.[210, 211]

It was anticipated that SES may lie on the causal pathway between ethnicity and smoking behaviour.[72] Therefore the extent to which socio-economic factors explained ethnic variations in current smoking and smoking cessation were assessed by adjusting ethnic differences in smoking and smoking cessation for educational level and occupation-related SES along with age and marital status. This was compared to the models adjusted for age and marital status only.

Due to the presence of significant interactions between ethnicity and educational level ($p<0.0001$) and occupation-related SES ($p<0.0001$) across all ethnic groups. The analysis was further stratified by ethnic group to assess the relationship between SES and smoking prevalence and cessation while adjusting for age and marital status. All analyses were performed using STATA Version 14.1 and bar charts were plotted using Excel 2013.

5.5 Results

Socio-demographic characteristics of study population

Table 5.1 shows the characteristics of the study population by gender and ethnic groups. On average, Moroccan and Turkish participants were younger than the Dutch, Ghanaian and Surinamese groups. Dutch men and women were more highly educated and had the lowest proportion of unemployed participants as compared with the ethnic minority groups.

Table 5.1 Socio-economic characteristics of the study population by ethnicity and sex

	Dutch	Moroccan	Turkish	African Surinamese	South-Asian Surinamese	Ghanaian
TOTAL SAMPLE SIZE N=22929	**N=4598**	**N=4262**	**N=3985**	**N=4369**	**N=3320**	**N=2395**
MEN N=9745	**N=2115**	**N=1601**	**N=1800**	**N=1764**	**N=1536**	**N=929**
Age, mean (SD)	46.9 (13.8)	41.5 (12.9)	40.2 (12.4)	47.5 (13.4)	44.3 (13.8)	46.2 (12.0)
Education, n (%)						
Higher vocational/ university	1257 (59.4)	297 (18.6)	278 (15.4)	312 (17.7)	360 (23.4)	85 (9.2)
Intermediate vocational/ higher secondary	497 (23.5)	539 (33.7)	527 (29.3)	608 (34.5)	484 (31.5)	283 (30.5)
Lower vocational or secondary and below	361 (17.1)	765 (47.8)	995 (55.3)	844 (47.9)	692 (45.1)	561 (60.4)
Occupation, n (%)						
Unemployed	124 (5.9)	271 (17.0)	285 (16.1)	323 (18.5)	227 (15.0)	158 (16.1)
Not in the working force$^{\pi}$	338 (16.0)	127 (8.0)	129 (7.3)	195 (11.2)	180 (11.9)	66 (7.2)
Incapacitated$^{\beta}$	57 (2.7)	166 (10.4)	158 (8.9)	132 (7.6)	126 (8.3)	51 (5.5)
Employed at elementary/lower occupational level	186 (8.8)	515 (32.3)	681 (38.3)	529 (30.4)	389 (25.6)	517 (56.1)
Employed at middle to graduate occupational level	1370 (64.8)	452 (28.4)	462 (26.0)	510 (29.3)	555 (36.6)	94 (10.2)
Employed but unknown occupational level*	38 (1.8)	63 (4.0)	61 (3.4)	54 (3.1)	41 (2.7)	35 (3.8)
WOMEN N=13184	**N=2483**	**N=2661**	**N=2185**	**N=2605**	**N=1784**	**N=1466**
Age, mean (SD)	45.4 (14.2)	38.6 (13.0)	39.5 (12.4)	47.5 (12.4)	45.7 (13.3)	42.9 (11.0)
Education, n (%)						
Higher vocational/ university	1522 (61.3)	439 (16.5)	304 (13.9)	672 (25.8)	390 (21.9)	66 (4.5)
Intermediate vocational/ higher secondary	516 (20.8)	633 (29.0)	923 (34.7)	958 (36.8)	513 (28.8)	333 (22.7)
Lower vocational or secondary and below	445 (17.9)	1299 (48.8)	1248 (57.1)	975 (37.4)	881 (49.4)	1067 (72.8)
Occupation, n (%)						
Unemployed	130 (5.3)	389 (14.8)	300 (13.9)	385 (14.9)	277 (15.7)	408 (28.4)
Not in the working force$^{\pi}$	465 (18.8)	1048 (39.9)	792 (36.8)	323 (12.5)	297 (16.8)	115 (8.0)
Incapacitated$^{\beta}$	84 (3.4)	177 (6.7)	199 (9.2)	267 (10.3)	179 (10.1)	161 (11.2)
Employed at elementary/lower occupational level	240 (9.7)	349 (13.3)	380 (17.6)	417 (16.1)	371 (21.0)	611 (42.6)
Employed at middle to graduate occupational level	1532 (61.9)	607 (23.1)	615 (34.8)	1121 (43.4)	615 (34.8)	104 (7.3)
Employed but unknown occupational level*	25 (1.0)	59 (2.2)	31 (1.8)	73 (2.8)	31 (1.8)	36 (2.5)

*working but did not provide sufficient information when describing their jobs; $^{\pi}$ retired or student or full-time homeworker; $^{\beta}$ disabled or unfit for work

Current smoking

Among men, smoking was more common in those of Turkish, African Surinamese and South-Asian Surinamese origin than Moroccan and Dutch origin while Ghanaians smoked the least (Figure 5.1). Among women, fewer Ghanaian and Moroccan women smoked compared to Dutch, Turkish, African Surinamese and South-Asian Surinamese women (Figure 5.1). After adjustment for age and marital status, men of Turkish, African Surinamese and South-Asian Surinamese origin were significantly more likely than men of Dutch origin to be current smokers, whereas Moroccan men did not significantly differ from the Dutch (Table 5.2, model 1). Additional adjustment for SES variables reduced the increased prevalence ratio of current smoking observed among Turkish, South-Asian Surinamese and African-Surinamese men relative to Dutch men, however, they still smoked significantly more than the Dutch (Table 5.2, models 2). The direction of the association changed for Moroccan men from 10% more likely to 18% less likely to smoke than Dutch men and the likelihood that Ghanaian men were less likely to smoke increased from 74% to 81% less likely (95% CI 85% to 75%) than Dutch men to be smokers.

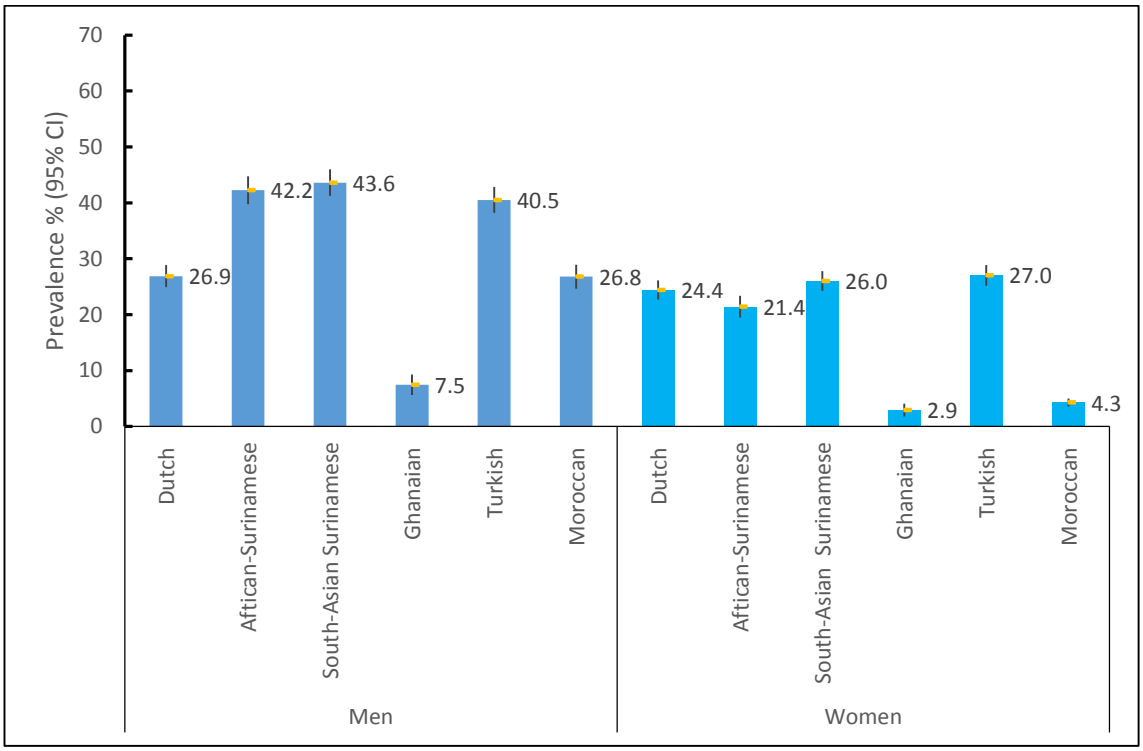

Figure 5.1 Age-standardized prevalence of current smoking by gender and ethnicity

Among women, only Turkish women were significantly more likely to be current smokers as compared with Dutch women, whereas Moroccan, South-Asian Surinamese and Ghanaian women were significantly less likely to be current smokers than women of Dutch origin (Table 5.2, model 1). For women, after additional adjustment for SES, women from all ethnic minority groups except Turkish were significantly less likely to smoke compared with Dutch women. Turkish women did not significantly differ from Dutch women anymore, after adjustment for SES (Table 5.2, models 2), whereas adjustment for SES made African-Surinamese women significantly less likely to be smokers than Dutch women.

Table 5.2 Adjusted prevalence ratios (PRs) with 95% CIs of current smoking and smoking cessation of ethnic minority groups compared with Dutch

	Current smoking			Smoking cessation/ Quit ratio percent		
Ethnic group		**Model 1**	**Model 2**		**Model 1**	**Model 2**
	Prevalence n/N (%)	**PR (95% CI)**	**PR (95% CI)**	**Prevalence n/N (%)**	**PR (95% CI)**	**PR (95% CI)**
Men						
Dutch	562/2115 (26.6)	1.00	1.00	827/1389 (59.5)	1.00	1.00
Turkish men	772/1800 (42.9)	1.69 (1.54, 1.86)	1.23 (1.11, 1.36)	442/1214 (36.4)	0.67 (0.62, 0.74)	0.79 (0.72, 0.87)
African Surinamese	780/1764 (44.2)	1.55 (1.41, 1.69)	1.20 (1.09, 1.32)	363/1143 (31.8)	0.57 (0.52, 0.63)	0.64 (0.58, 0.71)
South-Asian Surinamese	645/1536 (42.0)	1.53 (1.40, 1.68)	1.21 (1.10, 1.33)	239/884 (27.0)	0.50 (0.45, 0.56)	0.57 (0.50, 0.64)
Moroccan	446/1601 (27.9)	1.10 (0.99, 1.23)	0.82 (0.73, 0.92)	432/878 (49.2)	0.88 (0.82, 0.95)	1.02 (0.94, 1.12)
Ghanaian	69/929 (7.4)	0.26 (0.20, 0.33)	0.19 (0.15, 0.24)	118/187 (63.1)	1.08 (0.96, 1.22)	1.28 (1.12, 1.45)
Women						
Dutch	593/2483 (23.9)	1.00	1.00	918/1511 (60.8)	1.00	1.00
Turkish women	647/2185 (29.6)	1.26 (1.14, 1.40)	1.03 (0.92, 1.15)	253/900 (28.1)	0.54 (0.48, 0.61)	0.66 (0.59, 0.75)
African Surinamese	660/2605 (25.3)	0.95 (0.86, 1.05)	0.75 (0.68, 0.83)	470/1130 (41.6)	0.75 (0.69, 0.81)	0.85 (0.78, 0.92)
South-Asian Surinamese	370/1784 (20.7)	0.82 (0.73, 0.92)	0.65 (0.58, 0.73)	193/563 (34.3)	0.64 (0.56, 0.72)	0.73 (0.65, 0.83)
Moroccan	145/2661 (5.5)	0.23 (0.19, 0.27)	0.19 (0.16, 0.23)	93/238 (39.1)	0.87 (0.74, 1.03)	1.01 (0.86, 1.19)
Ghanaian	37/1466 (2.5)	0.09 (0.06, 0.12)	0.06 (0.05, 0.09)	75/112 (67.0)	1.24 (1.07, 1.43)	1.57 (1.34, 1.83)

Model 1: Adjusted for age and marital status; Model 2: Adjusted for age, marital status, education and occupation-related SES

Smoking cessation

Among both sexes, the highest prevalence of smoking cessation was in Ghanaians while the lowest was in African-Surinamese men and Turkish women (Figure 5.2). All ethnic minority groups were significantly less likely to quit smoking as compared with Dutch, except for Ghanaians who were more likely to have quit (although not statistically significant in men) (Table 5.2, models 1). For smoking cessation, although the Turkish, Surinamese and Moroccan ethnic groups appeared to be less likely to quit smoking than the Dutch, the lower likelihoods were partly explained by socio-economic factors (Table 5.2, model 2). Ghanaians were even more likely to have a higher smoking cessation rate than the Dutch after socio-economic factors were accounted for.

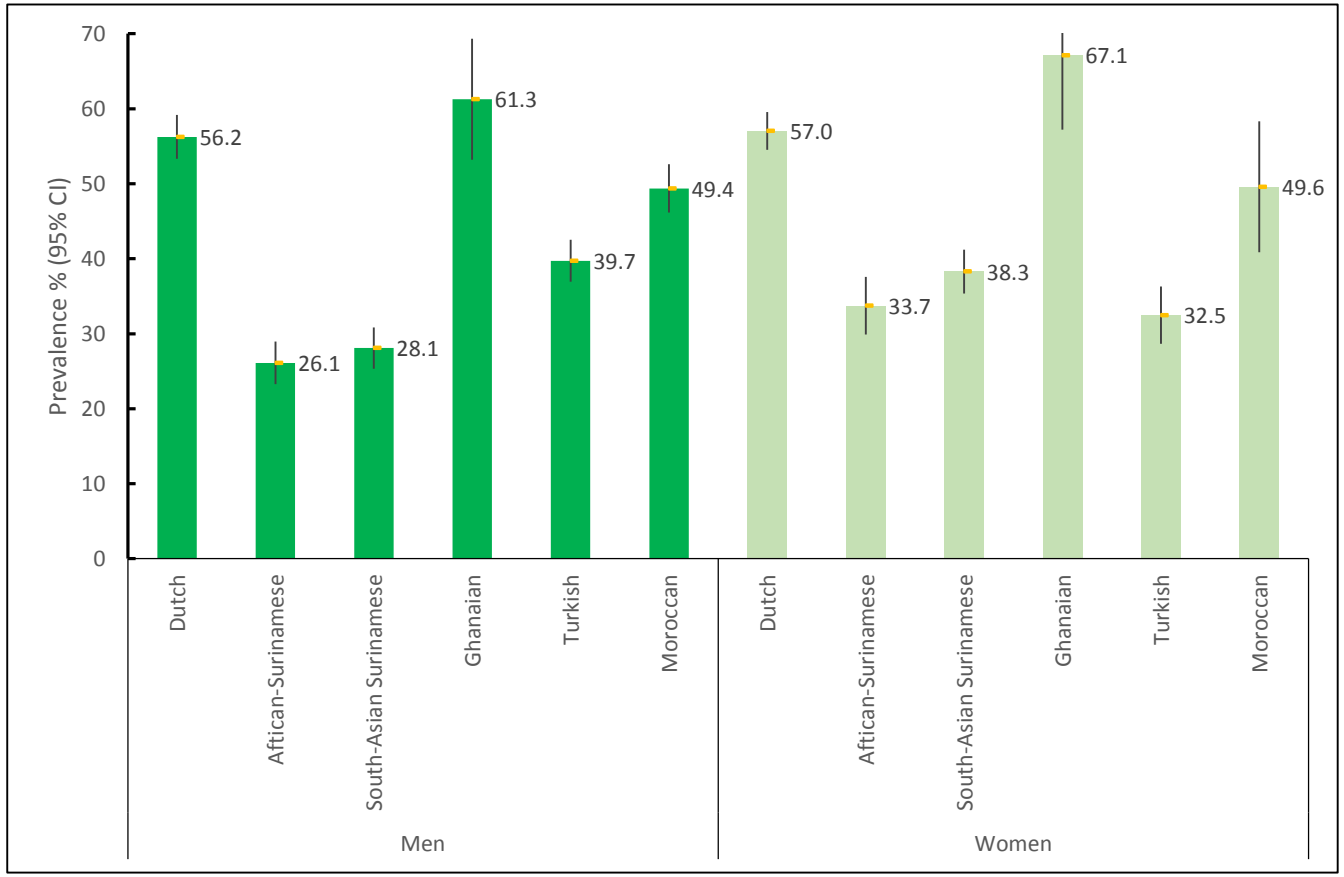

Figure 5.2 Age-standardized prevalence of smoking cessation by gender and ethnicity

The relationship between SES and smoking prevalence and cessation within each ethnic group

Within each ethnic group, SES inequalities in smoking prevalence were observed (Table 5.3). For both sexes, participants with higher educational levels were less likely to smoke than those with lower educational levels in all ethnic groups, although not always statistically significant. Although very wide confidence intervals were obtained for Ghanaian women, those with higher vocational schooling or university level education smoked more than women with little or no education.

Compared to those employed in middle to graduate level positions, all unemployed men smoked more in all ethnic groups. Although not always statistically significant all unemployed and lower level professional women except Ghanaians were more likely to smoke. Persons who were disabled or unfit for work (incapacitated) also had a higher prevalence of smoking in all ethnic groups, although not statistically significant.

Within each ethnic group, SES inequalities were observed in smoking cessation (Table 5.4). For both sexes, participants with higher levels of education were more likely to quit smoking although not significant for Moroccan men and women. Higher educated Ghanaian women seemed less likely to quit smoking yet this was not significant. For both sexes, unemployed participants were less likely to quit compared to the middle or graduate level. Participants employed in lower level professional jobs were less likely to quit than those employed at the middle or graduate level except for Ghanaian women who appeared to be more likely to quit. A similar lower likelihood of quitting was observed among the incapacitated with the exception of Moroccan women.

Table 5.3 Current smoking prevalence ratios (95% CI) among men and women of different educational levels and occupation-related socio-economic status within each ethnic group

Indicator of socioeconomic status	Dutch	South-Asian Surinamese	African Surinamese	Turkish	Moroccan	Ghanaian
	PR (95% CI)*	PR (95% CI)*	PR (95% CI)*	PR (95% CI)*	PR (95% CI)*	PR (95% CI)*
Men						
Education						
Higher vocational school/ university	0.57 (0.47, 0.69)	0.44 (0.36, 0.53)	0.65 (0.55, 0.78)	0.50 (0.41, 0.62)	0.62 (0.49, 0.80)	0.28 (0.07, 1.19)
Intermediate vocational/ higher secondary	0.57 (0.57, 0.87)	0.69 (0..61, 0.80)	0.92 (0.82, 1.03)	0.83 (0.73, 0.94)	0.83 (0.70, 0.99)	0.78 (0.46, 1.33)
Lower vocational and below	1.00	1.00	1.00	1.00	1.00	1.00
Occupation-related SES						
Unemployed	1.91 (1.53, 2.38)	1.69 (1.43, 1.99)	1.58 (1.35, 1.85)	1.32 (1.11, 1.56)	1.81 (1.46, 2.26)	5.10 (1.17, 22.30)
Not in the working force$^{\pi}$	1.11 (0.87, 1.42)	0.99 (0.76, 1.29)	1.22 (0.96, 1.54)	0.73 (0.53, 1.02)	0.60 (0.36, 1.01)	2.37 (0.37, 15.33)
Incapacitated$^{\beta}$	1.58 (1.10, 2.30)	1.30 (1.02, 1.65)	1.48 (1.21, 1.81)	1.11 (0.88, 1.41)	1.49 (1.11, 2.00)	4.34 (0.83, 22.77)
Employed at elementary/lower occupational level	1.50 (1.20, 1.87)	1.57 (1.34, 1.84)	1.32 (1.13, 1.53)	1.27 (1.10, 1.46)	1.33 (1.07, 1.64)	3.37 (0.79, 14.37)
Employed at middle to graduate occupational level	1.00	1.00	1.00	1.00	1.00	1.00
Women						
Education						
Higher vocational school/university	0.39 (0.33, 0.46)	0.61 (0.47, 0.80)	0.58 (0.48, 0.70)	0.72 (0.56, 0.91)	0.87 (0.53, 1.45)	6.02 (2.23, 16.25)
Intermediate vocational/ higher secondary	0.60 (0.50, 0.73)	0.87 (0.70, 1.08)	0.75 (0.65, 0.87)	1.01 (0.87, 1.17)	0.90 (0.59, 1.37)	0.56 (0.19, 1.62)
Lower vocational and below	1.00	1.00	1.00	1.00	1.00	1.00
Occupation-related SES						
Unemployed	1.27 (0.96, 1.67)	1.66 (1.30, 2.12)	1.54 (1.29, 1.84)	1.16 (0.94, 1.43)	1.42 (0.90, 2.22)	0.70 (0.18, 2.68)
Not in the working force$^{\pi}$	1.09 (0.86, 1.38)	1.04 (0.74, 1.45)	1.11 (0.86, 1.45)	1.03 (0.85, 1.25)	0.86 (0.53, 1.39)	1.44 (0.33, 6.25)
Incapacitated$^{\beta}$	1.38 (1.01, 1.90)	1.82 (1.34, 2.47)	1.47 (1.17, 1.84)	1.22 (0.95, 1.56)	1.40 (0.77, 2.57)	0.76 (0.17, 3.49)
Employed at elementary/lower occupational level	1.69 (1.39, 2.07)	1.23 (0.94, 1.61)	1.34 (1.11, 1.62)	1.29 (1.06, 1.57)	1.22 (0.75, 1.99)	0.44 (0.12, 1.67)
Employed at middle to graduate occupational level	1.00	1.00	1.00	1.00	1.00	1.00

-*PR Adjusted for age and marital status; $^{\pi}$ retired or student or full-time homeworker; $^{\beta}$ disabled or unfit for work

Table 5.4 Smoking cessation prevalence ratios (95% CI) among men and women of different educational levels and occupation-related socio-economic status within each ethnic group

Indicator of socioeconomic status	Dutch	South-Asian Surinamese	African Surinamese	Turkish	Moroccan	Ghanaian
	PR (95% CI)*	PR (95% CI)*	PR (95% CI)*	PR (95% CI)*	PR (95% CI)*	PR (95% CI)*
Men						
Education						
Higher vocational school/ university	1.28 (1.14, 1.45)	1.84 (1.44, 2.37)	1.38 (1.12, 1.69)	1.54 (1.27, 1.87)	1.16 (0.95, 1.41)	1.38 (1.05, 1.82)
Intermediate vocational/ higher secondary	1.19 (1.04, 1.37)	1.09 (0.82, 1.44)	0.97 (0.80, 1.19)	1.12 (0.94, 1.34)	1.02 (0.88, 1.19)	1.09 (0.84, 1.41)
Lower vocational and below	1.00	1.00	1.00	1.00	1.00	1.00
Occupation-related SES						
Unemployed	0.71 (0.56, 0.89)	0.59 (0.41, 0.86)	0.58 (0.44, 0.76)	0.85 (0.67, 1.08)	0.77 (0.61, 0.96)	0.66 (0.47, 0.91)
Not in the working force$^{\pi}$	1.02 (0.91, 1.14)	0.91 (0.64, 1.31)	0.81 (0.62, 1.07)	0.89 (0.60, 1.32)	0.99 (0.75, 1.29)	0.65 (0.36, 1.15)
Incapacitated$^{\beta}$	0.83 (0.63, 1.09)	0.79 (0.52, 1.17)	0.68 (0.48, 0.97)	0.96 (0.74, 1.23)	0.88 (0.70, 1.09)	0.77 (0.51, 1.18)
Employed at elementary/lower occupational level	0.82 (0.69, 0.98)	0.57 (0.43, 0.76)	0.72 (0.58, 0.89)	0.85 (0.70, 1.03)	0.93 (0.78, 1.11)	0.63 (0.47, 0.84)
Employed at middle to graduate occupational level	1.00	1.00	1.00	1.00	1.00	1.00
Women						
Education						
Higher vocational school/university	1.71 (1.52, 1.93)	1.99 (1.33, 2.31)	1.31 (1.10, 1.55)	1.73 (1.33, 2.25)	1.09 (0.71, 1.66)	0.72 (0.36, 1.41)
Intermediate vocational/ higher secondary	1.41 (1.21, 1.62)	1.75 (1.33, 2.31)	1.18 (1.00, 1.38)	1.21 (0.95, 1.56)	1.12 (0.78, 1.61)	1.28 (0.98, 1.65)
Lower vocational and below	1.00	1.00	1.00	1.00	1.00	1.00
Occupation-related SES						
Unemployed	0.89 (0.73, 1.08)	0.62 (0.44, 0.88)	0.73 (0.58, 0.92)	0.66 (0.48, 0.91)	0.97 (0.61, 1.53)	0.95 (0.60, 1.51)
Not in the working force$^{\pi}$	0.92 (0.83, 1.03)	0.77 (0.55, 1.07)	0.98 (0.79, 1.20)	0.54 (0.40, 0.73)	1.02 (0.64, 1.62)	0.52 (0.22, 1.22)
Incapacitated$^{\beta}$	0.86 (0.69, 1.08)	0.57 (0.38, 0.87)	0.85 (0.69, 1.05)	0.65 (0.45, 0.96)	1.20 (0.75, 1.91)	0.97 (0.55, 1.71)
Employed at elementary/lower occupational level	0.76 (0.65, 0.89)	0.48 (0.32, 0.73)	0.76 (0.61, 0.94)	0.60 (0.43, 0.82)	0.84 (0.49, 1.44)	1.07 (0.69, 1.66)
Employed at middle to graduate occupational level	1.00	1.00	1.00	1.00	1.00	1.00

-*PR Adjusted for age and marital status; $^{\pi}$ retired or student or full-time homeworker; $^{\beta}$ disabled or unfit for work

5.6 Discussion

Discussion of key findings

Smoking behaviour differed among the various ethnic minority groups compared with the Dutch. The prevalence of smoking among Ghanaians in the Netherlands has not been previously studied. Comparable studies in Amsterdam, which used the same country of birth criteria for ethnicity, indicates that smoking prevalence among adults aged 35-60 years has reduced over the last decade (from 2000/2003 to 2011/2015) in Moroccan, Turkish, and Surinamese groups.[194] Age-standardized estimates of smoking prevalence among Turkish men (63%) declined to ~41.7%, and from 55% to 44.8% in Surinamese men, but remained fairly constant in Moroccan men (~29%). However, a slight increase in smoking prevalence from <1% to ~2.6% among Moroccan women was observed. The presence of stronger tobacco control policies in the Netherlands after 2001 may be a contributing factor for the decline in smoking prevalence among Turkish and Surinamese men over the last decade bringing it closer to Dutch men.[212]

When referring to estimates of smoking from population-based studies conducted in the respective countries of origin, there was more variability observed between women in the home country vs women in Amsterdam: 13% vs 27% (Turkish),[213] 9.9% vs 24.2% (Surinamese),[214] 3.3% vs 4.3% (Moroccan),[215] and 0.3% vs 2.9% (Ghanaian).[126] Whereas for men, closer parallels between men in their home countries and men in Amsterdam: 41% vs 40.5% (Turkish),[213] 38.4% vs 44.8% (Surinamese),[214] ; 31.5% vs 26.8% (Moroccan),[215]; and 8.9% vs 7.5% (Ghanaian) were detected.[126] These differences, especially among women, allude to the possible impact of acculturation, and different social norms on smoking.[38, 51, 53, 204]

From our findings, lower SES was related to higher smoking prevalence and lower cessation more in men in most ethnic groups and is consistent with findings from past research.[216-218] Smoking was more common among lower educated men of Turkish and host populations in a study conducted in Germany and the Netherlands.[55] However, higher educated Turkish women smoked more than lower educated while the reverse was evident in the host

population.[55] Higher smoking among the more educated women was observed only in Ghanaian women but very wide confidence intervals were obtained due to small numbers. Higher smoking among the more educated women in Amsterdam may flag the signs of the early stages of tobacco smoking epidemic among Ghanaian women,[219, 220] who may be challenging cultural norms and taboos towards smoking present especially among women in the Ghanaian community.

For smoking cessation, higher prevalences among the Dutch than African and South-Asian Surinamese are known.[43] This study confirmed that Turkish and Surinamese smokers have lower cessation prevalence while Ghanaian smokers are more likely to quit than the Dutch. There were indications that Moroccan and Dutch had similar quit ratios. Others factors including lack of social support, more stressful lives, or living in deprived neighbourhoods may be ways in which lower SES indirectly influences smoking cessation.[221]

Higher rates of smoking were observed among both men and women employed in lower level professional jobs than those in higher professional jobs of all ethnic groups except Ghanaian and Moroccan men in which the difference may not have been detected due to small numbers. Enforcing restrictions on smoking on the workplace can make it more difficult for even workers in lower level jobs to smoke on the job.[87] This emergence of socioeconomic gradients in smoking among ethnic groups reflects on the recent findings in the Netherlands which shows increasing hazard ratios for acute myocardial infarction and stroke across medium and lower SES ethnic groups compared to the higher SES groups.[222, 223] Since smoking is attributable to death from a number of causes including myocardial infarction and stroke, reducing smoking and or increasing cessation among ethnic minority groups can help reduce the high all-cause mortality and cardiovascular disease incidence already seen among Turkish and Surinamese in the Netherlands.[200, 224, 225]

Strengths and limitations

The HELIUS study utilized large sample sizes in each ethnic group and participants were recruited in a systematic manner to reflect a representative sample of adults in each ethnic group living in Amsterdam.[72]

Smoking status may be underreported since biochemical methods were not used to verify self-reported smoking statuses. People tend to underreport undesirable health behaviours especially those stigmatized within the wider society.[195] Urine analysis of cotinine levels, the main metabolite of nicotine, is a useful biochemical indicator that can be used to validate current smoking among participants.[197] This study was therefore limited in its ability to accurately confirm current smoking, and thus it may be underestimated in this study. Smoking cessation was assessed by using quit ratios, which is a cumulative measure of a number of smoking cessation in the ethnic group, which occurred over time and not necessarily an indicator of a recent smoking cessation or assessment at the individual level.[87]

5.7 Conclusion

Smoking prevalence and cessation varies by ethnic group in the Netherlands. The higher levels of smoking prevalence and the lower levels of smoking cessation among some ethnic minority groups compared to the Dutch are largely, but not completely, explained by socioeconomic factors. Differences in SES are related to smoking prevalence and cessation among ethnic groups. Anti-smoking policies designed to target smoking within the lower SES groups of ethnic minority groups may substantially reduce ethnic inequalities in smoking particularly among men in the Netherlands. However, among Ghanaian women, smoking prevention measures may be better focused on higher educated women.

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DECLARATION OF INTERESTS

None declared.

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Chapter 6 Overall discussion and implications of PhD research

6.1 Recap of aims

This PhD research achieved the following three aims:

- systematically reviewed the current smoking prevalence among adults in sub-Saharan Africa from 2007 to May 2016 and described the context of tobacco control strategies in those countries.
- compared the smoking prevalence of Ghanaians living in different locations and investigated the socio-demographic and migration-related factors associated with current smoking.
- assessed the ethnic differences in the prevalence of current smoking and smoking cessation and the contribution of socio-economic status, among six ethnic groups in the Netherlands.

6.2 Summary of chapters stating key findings

This thesis comprised of six chapters including an introduction and overall discussion. Chapters 2 to 5 comprised the main components of the thesis presented in the style of three research papers.

Chapter 1 presented an introduction to the main themes of the thesis, i.e. migration, smoking, and the relationship between the two. The rationale was explained and the aims were also delineated in this chapter.

Chapter 2 presented a systematic review of smoking in the sub-Saharan African region where Ghana is situated since this is the main population of interest. In this paper, a systematic review of smoking in sub-Saharan Africa for the period 2007 to 2016 was presented. This paper also

highlighted some of the key country-level measures implemented to prevent tobacco use in the African countries included in the systematic review. The main findings confirmed that smoking varied widely among countries suggesting cultural differences present across sub-Saharan Africa. However, a unanimous observation was that smoking was largely unacceptable among women than men. Although, smoking among men in some countries in SSA were comparably as high as in western countries. Anti-smoking policies did not seem to correlate to the prevalences observed in SSA. The lack of comprehensive policies present across SSA in the midst of the relatively lower smoking prevalences warranted the need for further stringent policies to be enforced to prevent an increase in smoking in SSA in the near future.

Chapter 3 provided a description of the epidemiology of smoking in Ghana, explaining some of the determinants of smoking and reasons for the low prevalence of smoking in Ghana overall.

The paper in Chapter 4 examined the smoking behaviour of Ghanaians in Ghana and Ghanaian migrants in three European cities using the RODAM data. The main aim of this paper was to explore whether smoking was influenced by location of residence, focusing on Ghana and Europe, given the variations observed in smoking between the sub-Saharan African and European regions. More particularly because of the low reported prevalence of smoking in Ghana and Ghanaians being one of the largest African ethnic minority group in Europe. The main findings showed that smoking was higher in the European Ghanaian population than in Ghana. It also investigated the factors that were associated with smoking among Ghanaian men. The findings suggested that the higher smoking prevalence among men was associated with socio-demographic factors such as lower education, being divorced or widowed, Islamic religion, infrequent attendance at religious services, living alone and assimilation in the context of cultural orientation.

Chapter 5 was a paper comparing Ghanaian migrants to other ethnic minority groups living in a European location (Amsterdam) with respect to their smoking prevalence and smoking cessation. The main intent of this chapter was to compare to other migrant populations and to

present a different perspective of the Ghanaian migrant group in Europe by putting it into context with other migrant populations of different ethnic minority populations. The main findings showed that Ghanaians were very different to other ethnic groups in Amsterdam, with much lower smoking rates. The differences in smoking among ethnic groups, however, was only partly explained by educational and occupational levels.

6.3 Strength and weaknesses of papers

Strengths and weaknesses of the systematic review paper

The strength of the systematic review paper was that it provided a recent update of the literature on smoking in SSA using estimates that were determined based on population-based studies conducted by researchers in the countries. This made the interpretation of the smoking estimates more generalizable to the country it represented. Wide age ranges and large sample sizes were included. However, the limitation was in the different recruitment methodologies used in the different studies included, and in the definition of current smokers. These variations made comparisons difficult.

Strengths and weaknesses of the RODAM paper

The recruitment process of the RODAM study achieved good response rates in Ghana, Amsterdam, and London but it was slightly lower in Berlin. Since prior research studies often failed to dissect African ethnic groups by country of origin,[226] the RODAM study removed this barrier by studying a relatively homogenous population from Ghana. This allowed the contribution of the Ghanaian ethnic group to be understood fully. The paper was limited in its ability to study the determinants of smoking among women due to small numbers of women smokers. The Ghanaian sample in London and Berlin may be also be less representative of the Ghanaian population living there since the recruitment of participants was centred around churches. The Christian religion discourages smoking, which could explain the lower prevalence observed among men in London.

Strengths and weaknesses of the HELIUS paper

The HELIUS study facilitated the comparison of smoking by ethnic group since the study comprised large sample sizes from five major ethnic minority groups including the local Dutch population living in Amsterdam. Each ethnic group was largely representative of the respective ethnic population living in Amsterdam. Like the other 2 papers, not being able to objectively validate smoking status may have underestimated the prevalence of smoking in each ethnic group. Also the cross-sectional nature of the study did not allow true smoking cessation to be confirmed, and self-reported statuses are subject to recall bias.

6.4 The Ghanaian perspective of smoking in Europe

Although the Ghanaian ethnic group has a much lower smoking rate than the European population, the factors that increase or lower the risk of smoking is similar to the factors that influence smoking in other ethnic groups as well. For instance, protective factors such as higher education, being married, practicing Christianity, frequent attendance at religious services, and living with children were also detected in other population research. This shows that Ghanaian migrants are susceptible to similar influences when it comes to smoking behaviour. What was interesting is the substantially higher prevalence of smoking among both Ghanaian men women in Europe compared to Ghana. The limited research on sub-Saharan African migrants which compared Ethiopian in the US migrants to natives in the home country found no significant difference in smoking risk between male Ethiopian migrants and men in Ethiopia but significantly more women Ethiopian migrants smoked than women in Ethiopia.[71] This inconsistency observed where both male and female Ghanaians smoked more in Europe compared to Ghana may be explained by the vast difference in cultural attitudes and stigma against smoking existing between Ghana and Europe which may be more dissimilar than that between Europe and another country in sub-Saharan Africa or a country in a different region in the world. Due to the fact that Ghana had such a uniquely low smoking prevalence, the smoking behaviour of migrants

in Europe may drastically differ to Ghana due to the different levels of exposure. An opposing finding however is seen in London where a lower smoking prevalence is reflected among Ghanaian migrants living there. This may be a reflection of the selection bias underestimating the true prevalence of smoking among Ghanaians in London compared to Berlin, and Amsterdam. The migrants who practice Christian faiths may be overrepresented in London and given the significant protective effect of the practice of Christian beliefs on smoking, the lower prevalence is justified. The lower prevalence in London may also be justified due to the sake of participants in the Christian community being more likely to give expected responses, so self-reporting of smoking may be underreported especially in the church setting. Another possible explanation may be that Ghana may be in an earlier stage of the tobacco epidemic than in Ethiopia who has a much higher male national smoking prevalence (18.3%),[227] than Ghana (7.1%),[126] therefore the prevalence of smoking among male Ghanaian migrants is still likely to increase as well as women.

The relationship between socio-economic status and smoking operates differently among Ghanaian women compared to women other ethnic groups, but the same patterns are observed among men in Amsterdam in all the ethnic groups studied. Higher educated Ghanaian women seem to be more likely to smoke than lower educated but the reverse was observed in higher educated women of Dutch, Turkish, Moroccan, African-Surinamese and South-Asian Surinamese. The finding suggests that the tobacco epidemic is still in its early stages in the Ghanaian community. Given that Ghanaian migrant women may have experienced a cultural shift in the attitudes and social norms operating against smoking between Ghana and Amsterdam, it may have triggered the uptake of smoking among the higher educated women first, a sign of the early stage of the tobacco epidemic, and following the trends of how tobacco use socially diffuses among women in communities.[228]

6.5 Principles of tobacco control and the effect on smoking behaviour

In the past, tobacco control interventions have focused on providing smoking cessation advice and pharmacotherapy to individual smokers in the clinical setting.[229] However, during the 1980's a shift to large-scale population-based approaches to control tobacco occurred since these were proven to be more efficient, less costly and had a greater impact. The most effective population-based approach to controlling tobacco is increasing tobacco prices along with an increase in excise taxes.[230] Studies have proven that increasing the price of cigarettes is associated with a decrease in cigarette sales,[231] increased cessation rates and prevent smoking initiation among young people. This relationship between cigarette price and consumption is well known by tobacco companies who have tried to prevent this effect by providing coupons and discounted prices to consumers with the aim of improving affordability and thereby increasing consumption especially among youth.[229] However, the lack of substitute products and the addiction of nicotine keeps smokers hooked on tobacco products despite increases in price.

Another effective population-based strategy for controlling prevalence of tobacco are smoke-free policies and laws.[232, 233] Smoke-free environments make smoking socially unacceptable, thereby having a positive effect on increasing smoking cessation and reducing smoking prevalence.

Placing restrictions on marketing of tobacco products and counter advertising is also effective in reducing tobacco consumption.[234, 235] Comprehensive bans on tobacco advertising promotion and sponsorships helps reduce the attractiveness of smoking. Counter advertising helps spread truthful facts about smoking, informing its users of the dangers of smoking to health.

In the systematic review of smoking in sub-Saharan Africa, some population-based tobacco control strategies were described. The most effective population-based tobacco control strategy, raised cigarette taxes was not present in most countries or present below the

recommended level of 70%. The effect of this lack of high cigarettes taxes across SSA can result in more affordable cigarette prices thereby hindering smoking cessation, preventing a reduction in the number of cigarettes smoked per day and may not deter younger people in sub-Saharan Africa from starting smoking.

With respect to the presence of comprehensive bans on tobacco, the systematic review of smoking in SSA found comprehensive bans were absent in several countries. This creates unwanted exposure to advertisements about tobacco products which puts vulnerable populations such as young people and women at risk of smoking initiation.

6.6 Implications for future research and policy

Implications for future research and policy from the systematic review paper

The findings from the research supported the need for increased monitoring and surveillance of smoking in SSA. Out of the 44 countries in sub-Saharan Africa, nationally representative high quality studies were obtained in only 17 countries over the last decade (2007 to 2016). The lack of credible data on tobacco use, makes monitoring difficult, and the burden of tobacco use can go undetected. Governments should indeed prioritize the surveillance of tobacco use through its inclusion in national surveys in order to measure its spread among their vulnerable populations.

Implications for future research and policy from the RODAM paper

The findings from the RODAM paper signalled the need for monitoring of smoking among migrant populations in developed countries. Regardless of whether a minority group originated from a country with a low smoking rate, it appeared that they were influenced by the wider smoking norms and more tolerant attitudes existing in the developed country and therefore were at risk of smoking. Policy makers should consider the impact of exposure to new environments on minority populations decisions to smoke. Minority migrant populations should be added to the persons vulnerable to taking up smoking list. Targeted promotional health educational messages should be designed with these groups in mind to prevent an onset of smoking when they settle in the developed country. Either through their embassy/home office, contact with GPs or in their local organisations.

Implications for future research and policy from the HELIUS paper

The findings from the HELIUS paper encouraged future research on smoking to be stratified by ethnicity and country of origin. The vast differences in smoking by ethnic group showed the strong impact of ethnicity and culture on smoking behaviour. Policy makers should consider the impact of ethnic origin in future smoking prevention initiatives in order to prevent the burden

of tobacco-related diseases being underestimated in populations today. Therefore, ensuring that ethnicity is captured in research studies can help identify at risk groups. Implementing comprehensive tobacco-control policies in all countries would strive to make smoking less accessible, less visible, less culturally acceptable and therefore less appealing to potential users.

Implications of RODAM and HELIUS findings

The findings of the research implied that interventions are required among women of ethnic minority groups in developed countries to prevent and reduce smoking. The fact that smoking was higher among women in Europe compared to women in their countries of origin which were developing countries, draws the need to focus on women from lower income developing countries when designing smoking interventions. Women are indeed a vulnerable group at risk of tobacco smoking. Coming from countries where smoking may be less acceptable and more stigmatized among women there to a country where smoking among women is normal could spark an upsurge among migrants, who relocate to Europe for a variety of reasons. Further research however may need to focus on the reasons for migration to determine whether women who migrate for particular reasons are more at risk of smoking than others. Migrant studies which use a cohort approach would be more beneficial in determining whether a change in smoking occurs and the particular peak period when smoking begins throughout the migration timeline. However, it is clear that cultural factors play a major part in smoking. Understanding how smoking is perceived in particular cultures would go a long way in determining whether this behaviour is more likely to occur in a particular group. A more practical approach to tackling smoking among the vulnerable groups would be to continue the drive to making smoking less culturally acceptable. This can be achieved through changing mind-sets and having less liberal attitudes towards smoking as in Ghana. Preventing the tobacco industry from being allowed to promote smoking to vulnerable groups and removing the social factor associated with smoking in some countries would help to change behaviour especially among vulnerable populations.

Overall conclusions/ Implications of the research to public health

Smoking among populations has become a public health epidemic in developed countries and its plight is spreading through developing countries in SSA. Protecting vulnerable groups from becoming smokers is an important public heath priority in order to prevent the burden of tobacco-related diseases in populations today. Knowing that even migrants from developing countries begin smoking and are more prone to smoking in a developed country after migration brings attention to the need for interventions targeted towards immigrant populations. In addition, it appears that migrants from low smoking countries smoke more and migrants from high smoking countries continue to smoke. Overall the greater public health implication would be to enforce tobacco-control policies in all countries, so that it strives to make smoking unappealing by continuing to prevent the uptake of smoking upon migrating to an area with higher smoking rates and to increase smoking cessation, thereby bringing the smoking epidemic closer to an end.

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Chapter 7 Appendices

7.1 List of Appendices

Appendix 2.1:

Copy of published systematic review paper

PLOS | ONE

RESEARCH ARTICLE

A Systematic Review of Tobacco Smoking Prevalence and Description of Tobacco Control Strategies in Sub-Saharan African Countries; 2007 to 2014

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Abstract

Objective

To systematically review current smoking prevalence among adults in sub-Saharan Africa from 2007 to May 2014 and to describe the context of tobacco control strategies in these countries.

Data Sources

Five databases, Medline, Embase, Africa-wide Information, Cinahl Plus, and Global Health were searched using a systematic search strategy. There were no language restrictions.

Study Selection

26 included studies measured current smoking prevalence in nationally representative adult populations in sub-Saharan African countries.

Data Extraction

Study details were independently extracted using a standard datasheet. Data on tobacco control policies, taxation and trends in prices were obtained from the Implementation Database of the WHO FCTC website.

Results

Studies represented 13 countries. Current smoking prevalence varied widely ranging from 1.8% in Zambia to 25.8% in Sierra Leone. The prevalence of smoking was consistently lower in women compared to men with the widest gender difference observed in Malawi (men 25.9%, women 2.9%). Rwanda had the highest prevalence of women smokers

no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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(12.6%) and Ghana had the lowest (0.2%). Rural, urban patterns were inconsistent. Most countries have implemented demand-reduction measures including bans on advertising, and taxation rates but to different extents.

Conclusion

Smoking prevalence varied widely across sub-Saharan Africa, even between similar country regions, but was always higher in men. High smoking rates were observed among countries in the eastern and southern regions of Africa, mainly among men in Ethiopia, Malawi, Rwanda, and Zambia and women in Rwanda and rural Zambia. Effective action to reduce smoking across sub-Saharan Africa, particularly targeting population groups at increased risk remains a pressing public health priority.

Background

The prevalence of smoking differs widely between populations across the world.[1, 2] Many factors are known to influence smoking prevalence and trends in prevalence, from individual level factors such as education level, to country-level factors such as national economic development and implementation of tobacco control policies.[3, 4] The highest prevalence of tobacco consumption has previously been found in high-income Western European countries, with a 37% prevalence among men and 25% among women.[1, 5] During the years 1990 to 2009, cigarette consumption in Western Europe declined by approximately 26%. Simultaneously during the same period, cigarette consumption in Africa and some middle Eastern countries increased by 57%.[1] Sub-Saharan Africa is considered to be in stage one of the tobacco epidemic continuum.[6] One characteristic of this first stage is a predominantly higher prevalence of smoking among men than among women. The estimated prevalence of smoking in sub-Saharan in 2010 was 14% in males and 2% in females, which supported this first stage criteria.[5] A previous systematic review published in 2006 on the prevalence of smoking among adult populations in sub-Saharan Africa was conducted using studies published before 2005.[7] In that review, men smoked more than women in all the sub-Saharan African countries represented. However, most of the studies in the review used study samples that were not representative of the national general populations, since only 6 national studies were amongst those included of which 4 were from South Africa and one each from Malawi and Zambia. The aim of this study was to systematically review the literature in order to provide contemporary estimates of the prevalence of smoking among adults in sub-Saharan Africa from January 2007 to May 2014. We also described country-level tobacco policies across sub-Saharan Africa to give some context and background about what is occurring to tackle smoking prevalence.

Materials and Methods

Search strategy for relevant articles

In May 2014, five databases of Medline, Embase, Africa-wide Information, Cinahl Plus and Global Health were searched using a strategy merging terms for sub-Saharan Africa and the countries in them, smoking, and terms for types of studies. The review protocol forms part of the PhD thesis of one of the authors (RB) but has not been separately published. The S1 Appendix provides details of the search strategy used. All of the references cited by the included studies were screened for other relevant articles.

Inclusion criteria

The titles and abstracts of the results generated from the searches were screened using the following inclusion criteria:

1. The participant recruitment strategy of each study must have involved sampling from a representative sample of the general population, and/or from a rural or urban area in a country in sub-Saharan Africa
2. The sample size must comprise more than 1000 participants
3. The research must have estimated the prevalence of current smoking in the sample
4. Data must have been collected during 2007 and May 2014

The searches were limited by date of publication from 2007 to May 2014, but not by language of publication. Research studies conducted in a sub-Saharan African population in another part of the world, or using unrepresentative population samples within Africa (e.g. only adolescents or older populations, employed workers, hospital patients or community-based unrepresentative samples) were excluded. (Refer to S2 Appendix which indicates the reasons why studies were excluded from the review).

Potentially relevant articles were obtained after screening titles and abstracts, and decisions on including studies were made after reading the full texts. Data were extracted following a standard protocol and using standard data collection forms and checklist by a single reviewer (RB) with uncertainties resolved by discussion with the co-authors.

Appraisal of study validity

To assess the quality of individual studies and to determine whether it was included, the following criteria were used.

1. Likely representativeness of the general population: whether nationwide sampling frames or more locally based populations were used; whether random population sampling, multistage sampling, or all participants were recruited from the entire sampling area.
2. In addition to a good representative sample, we looked at whether the study had either a large sample size and or a high response rate. If the response rate was not reported in the study, we assessed whether both the sample size and the recruitment method was sufficient to indicate the study was of good quality.

Rationale for inclusion criteria

We chose to apply the above mentioned inclusion criteria to minimize the presence of selection bias affecting the results obtained.[8] We ensured that the included studies addressed the question of interest and provided evidence on the prevalence of smoking in a sub-Saharan African area. We believed that the way in which participants were chosen to participate, and the participation rates can be a major source of selection bias and therefore these methods were assessed before a study was included. As a result only studies that ensured that the recruited individuals were representative of the target population and or the selection process involved a form of randomization were included. In combination with having a fairly random recruitment method, which should yield a representative sample, we decided that studies with a minimum sample size of 1000 would have a more precise estimate of current smoking in the target population due to less sampling error compared to a smaller sample size.

Search for preventative measures

In an attempt to explore some contextual factors which might be influencing the prevalence of current adult smoking among countries in sub-Saharan Africa, we set out to describe the preventative measures that were in place at the country level to reduce tobacco consumption. We examined documentary evidence of the implementation status of Articles 6 and 13, the last two components of the MPOWER policy package, which falls under the Demand Reduction measures of the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) Treaty. [9, 10] These include whether the country has enforced bans on tobacco advertising, promotion and sponsorship and whether taxes on tobacco has been raised. We also examined some components of Article 16 under the Supply reduction measures of the Treaty provisions, which requires bans to be placed on sales to and by minors. The information on preventative measures was obtained from the Implementation Database of the WHO FCTC website.[2, 10] For each included country, we extracted data, where available, on the date of adoption of the WHO FCTC and recorded the status of the following: whether tax policies to reduce tobacco consumption were present; what proportion of the retail price of cigarettes comprised taxes; and whether there has been an increasing or decreasing trend in tobacco prices. Also under the tobacco advertising and sponsorship article, we gathered data on whether smoking was banned in public places and if comprehensive bans on all tobacco advertising, promotion and sponsorship were present. Under the supply reduction measures, prohibition on the sale of tobacco products from vending machines and of individually packaged or packets of small cigarettes were examined.[10]

Responsibility of co-authors

All 4 authors were involved in the study design, and the writing of the paper. RB had the responsibility of screening the abstracts and full text articles, and selecting the articles for inclusion. LS, JA and KL provided advice on the review methods and were involved in any discussions to resolve uncertainties over study inclusion.

Results

Description of study populations and methods of measuring current smoking

26 papers were included in the review (Fig 1). These described 21 studies which represented research conducted in 13 countries of sub-Saharan Africa. The characteristics of study populations are presented in Table 1. Among these 13 countries, five were geographically located in the west (Ghana, Nigeria, Senegal, Sierra Leone, and Togo), one in the central region (Congo) and seven located in the eastern and southernmost regions of Africa (Ethiopia, Kenya, Malawi, Rwanda, Uganda, Zambia and South Africa). Estimates of the prevalence of current smoking obtained from the included studies represented the period 2007 to 2012, with sample sizes that ranged from 1,412 in Congo to 72,292 participants in Kenya.

Among the studies, current smoking among adults was determined using five broad criteria. Some researchers measured either 1) smoking of tobacco including all its products or 2) cigarettes only, while some assessed 3) the frequency of current smoking, that is, either daily or occasionally or 4) regularly during a specific time period prior to the study. 5) A few research studies measured the quantity of consumption within this time period.

From the 26 studies, age-specific smoking prevalences estimates were only presented in a total of four studies that were conducted in Ghana (2),[11, 12] Kenya[13] and Sierra Leone.

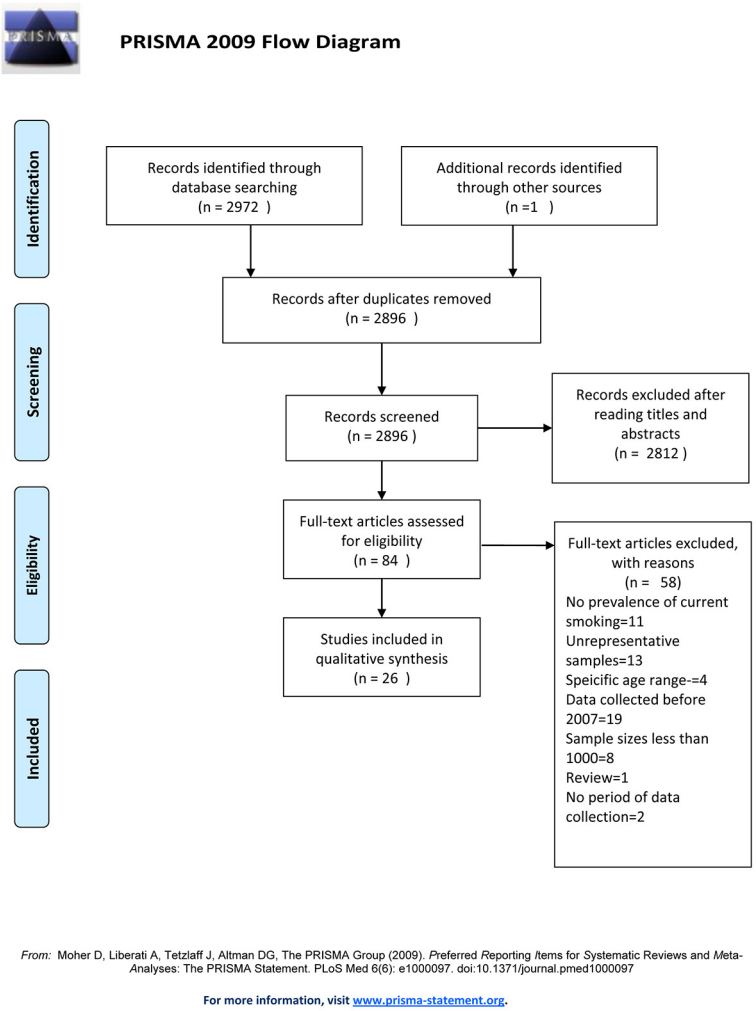

Fig 1. Flow Diagram of inclusion and exclusion of articles in systematic review.

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[14] From this limited data we observed that the prevalence of smoking increased as the age category increased then decreased slightly in the older age groups.

Quality of evidence

Research using a nationwide sampling frame were conducted in Ghana,[11] Malawi,[15] Nigeria,[16] Sierra Leone,[14] South Africa,[17] and Uganda.[18] These studies therefore provided the strongest evidence on the prevalence of current smoking since the sampling methodology was the most representative of the general population area of the country. These studies had large sample sizes (4,997 in Sierra Leone,[14] 5,206 in Malawi,[15] 6,678 in Uganda,[18] 9,484 in Ghana,[11] 11,638 in South Africa[17] and 34,070 in Nigeria).[16] The response rates were also high among these national studies, with the lowest response rates observed in the Ugandan (65.9%)[18] and South African (69%) studies.[17] (Refer to S3 Appendix for supplementary data on details of the sampling methodology used in each study). In contrast high response rates were obtained in the studies in Sierra Leone (91%),[14] Malawi (94.5%),[15] Nigeria (98.3%)[16] and Ghana (98.9%).[11]

Table 1. Characteristics of study populations of included studies.

Study ID	Country, year of data collection, reference	Age range	Median (IQR) Age	Mean (SD)	Total sample size	Response Rates %	Definition of current smoking as measured in the study
1	Congo, 2010,[29]	5–83	-	29 (16)	1412	93.4	Active smoking
2	Ethiopia, 2008–09,[26]	15–64	-	-	5500	81.3	Current smokerNo/Yes
3	Ghana, 2008,[11]	15–49	-	-	9484	98.9	Currently consumed cigarettes
4	Ghana, 2007–08,[12]	14–105	31	-	6258	88.0	Smokes at least 100 cigarettes in his or her lifetime and smokes nowadays
5	Kenya, March to July 2010,[30]	>18	35 (26,50)	-	4037	93.0	Tobacco smoking- Currently daily (within the last 30 days)
							Tobacco smoking- Currently but not daily (within the last 30 days)
6	Kenya, 2010,[19]	>18	-	33.4 (11.6)	2061	-	Current cigarette smokers
7	Kenya, 2011,[13]	>18	-	-	72292	-	Currently smoked at least 100 cigarettes and smoking at the time of the interview
							Smoked daily
8	Malawi, 2009,[15]	25–64	-	-	5206	94.5	Tobacco smokers
9	Nigeria, 2008,[16]	15–59	-	-	48871	98.3	Use of smoking tobacco- cigarette, pipe or other
10	Nigeria, 2007,[25]	25–64	-	43.8 (13.7)	1458	-	Prevalence of tobacco smoking
11	Rwanda, 2008–2009, [27]	15–80	-	38.3	1824	97.7	Currently smoking at least one cigarette per day
	(Huye- rural)	-	-	-	788	-	
	(Kigali- urban)	-	-	-	1036	-	
12	Senegal, 2010,[23]	>15	-	43.4 (17.8)	1424	-	Tobacco smokers- active smoking
13	Sierra Leone, 2009,[14]	25–64	-	-	4997	91.0	Current tobacco use (smoke and smokeless)
14	South Africa, 2008,[17]	>15	-	40 (16.7)	16800	69.0	Non-smoker or smoker
15	Togo, October 2009 to January 2010,[20]	>18	-	45 (10)	2000	-	Consumed at least one cigarette per day
16	Uganda, December 2008 to November 2009, [31]	>13	-	-	6663	65.6	Current cigarette smoker of both manufactured and local cigarettes
17	Uganda, 2011,[44]	>13	-	34.4	6867	93.9	Current daily smoking
18	Uganda, July to September 2012,[22]	>18	-	36.5 (15.2)	4142	-	Currently consume tobacco
19	Zambia, December 2008 to 2009,[21]	>25	-	-	2093 (total)	-	Current smoking- do you currently smoke any tobacco products such as cigarettes, cigars or pipes
	(Kasama- rural)	-	-	-	1198	-	
	(Kaoma- rural)	-	-	-	895	-	
20	Zambia, 2011,[28]	>25	-	-	1627	-	Current smoking- do you currently smoke any tobacco products such as cigarettes, cigars, or pipes
21	Zambia, 2008,[24]	>25	-	33.4 (11.6)	1928	-	Currently smoked cigarettes

SD- Standard deviation; IQR-Interquartile range;-Data not available

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Other studies sampled from sub-regions of the population so the prevalence was less representative of the entire national population. However, the sampling methodology used ensured that the samples were representative of the area and that area was similar in characteristics to the general population. All studies used either multi-stage sampling strategies to ensure

random selection of participants or census type surveys where all residents in areas were eligible to participate. In addition all studies recruited participants from a wide age range, apart from a few exceptions, most were from over 15 and 25 years up to age 64 which meant that most of the results were generalizable to not just a specific age group. Adequate sample sizes and good response rates were also observed among these sub-national samples.

Although response rates were not known for 9 studies, the methodology employed was of a high standard and the final sample size was large enough to justify the study of good quality to be included.[13, 19–25]

Main findings

The prevalence of smoking varied immensely among countries in sub-Saharan Africa ranging from 1.8% in Zambia to 25.8% in Sierra Leone (Table 2). Similarly, the state of implementation of tobacco control policies varied across the region (Table 3). The highest smoking prevalences in SSA were reported in South Africa, Sierra Leone and Zambia. In general, smoking prevalences were higher in national and sub-national studies conducted in Malawi, Nigeria, Rwanda, Sierra Leone, and South Africa compared to prevalences in Ghana, Senegal, Togo and Uganda.

Prevalence of current smoking by gender

The prevalence of smoking was consistently higher in men compared to women in all studies.[11, 12, 15, 16, 20, 22, 23, 26–28] Less than 5% of women reported currently smoking in all the studies included with the exception of Rwanda where more than 12% of women currently smoked.[27] This parallels an even higher prevalence of smoking among men (20.9%) in Rwanda.

Comparison of current smoking prevalence between urban and rural locations

We obtained estimates of the prevalence of current smoking in both urban and rural areas within 8 countries; Congo,[29] Ghana,[11, 12] Ethiopia,[26] Kenya,[13, 19] Malawi,[15] Nigeria,[16] Rwanda[27] and Zambia.[24, 28] (Tables 2 and 4).

The greatest difference in current smoking prevalence between urban and rural areas was observed in Zambia. Smoking was 22.4% in rural Zambia,[21] compared to 6.8% in urban Zambia[24]. For Congo,[29] Ghana,[11, 12] Ethiopia,[26] Kenya,[13, 19] Malawi,[15] Nigeria, [16] Rwanda,[27] the difference in smoking between urban and rural areas were less marked. Rwanda and Zambia seemed to have the greatest variation in female smoking between urban and rural areas although with completely opposite patterns. In Zambia, more women smoked in rural areas compared to urban areas (10.8[28] vs 1.5[24]), yet in direct contrast a significantly higher proportion of Rwandan women smoked in urban locations (17 vs 7) than rural areas. The differences in smoking among men varied the most when men in urban and rural areas of residence for Ethiopia (21.6 rural vs 10.3 urban), Kenya (22 urban vs 11.2 rural) and Zambia (39.6 rural vs 17.5 urban) were compared.

Consistency of findings and time trends

For five countries (Ghana, Kenya, Nigeria, Uganda and Zambia), at least two nationally representative population-based studies were conducted during 2007 to 2014. We observed variations in the smoking prevalences reported in studies conducted during the same year or time period and similar area e.g. a rural or urban area. For example, two studies conducted in urban areas in Kenya during 2010 estimated very different smoking prevalences 4%[30] and 13%.[19] Two very distinct rural smoking estimates were seen in rural Zambia as well (22.4% vs 10.8%).[21]

Table 2. Prevalence (95% CI) of current smoking among adults in sub-Saharan African countries by rural urban location or nationwide.

		BOTH MEN AND WOMEN Prevalence (95% CI)		
STUDY ID	COUNTRY	In Urban area	In Rural area	Overall nationwide prevalence
1	Congo	21.6	15.4	19.5
2	Ethiopia	-	-	-
3	Ghana	-	-	-
4	Ghana	-	-	(U) 3.4 (3.0, 3.9)
	Ghana	-	-	(A") 3.8 (3.1, 4.4)
	Ghana	-	-	(A*) 4.3 (3.6, 5.0)
5	Kenya	4.09	-	-
	Kenya	1.24✓	-	-
6	Kenya	13.1	-	-
7	Kenya	-	6.3	-
	Kenya	-	5.7π	-
8	Malawi	6.6 (4.7, 8.5)	10.9 (10.0, 1.8)	14.1
9	Nigeria	(WP) 2.8 (2.4, 3.1)	(WP) 2.7 (2.4, 3.0)	(WP) 2.7
10	Nigeria	-	-	14.6
11	Rwanda	*18.2	*14.6	16.7
12	Senegal	-	-	5.8 (4.7, 7.2)
13	Sierra Leone	-	-	25.8 (23.4, 28.2)
14	South Africa	-	-	22
15	Togo	-	-	9.3
16	Uganda	-	2.2	-
17	Uganda	-	6.5 (5.8,7.1)	-
18	Uganda	-	-	6.4
19	Zambia	-	22.4	-
	Zambia	-	10.8	-
20	Zambia	-	-	1.8
21	Zambia	6.8	-	-

95% CI- 95% confidence interval; (U): Unadjusted

(A"): Adjusted for male under-response

(A*): Adjusted for male under-representation in the study sample, by population-based weighting using national survey data; (WP): weighted prevalence

*Not presented in paper, but enough data was presented for prevalence to be calculated manually.

π Tobacco smoking currently but not daily (within the last 30 days)

✓smoked daily;—Data not available from study

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However, where cross-sectional studies have been conducted over successive years in the same type of area, both increases and declines in current self-reported smoking prevalence were observed. For Nigeria, a low prevalence of 2.7% in current smoking was reported in 2008 [16] compared to 14.6% reported one year previously (2007).[25] the smoking prevalence previously reported in rural Uganda during 2008–2009 (2.2%)[31] increased slightly to 6% in 2011.[17]

Tobacco control strategies present among countries

All countries included in the review except for Malawi are a signatory to the treaty and have ratified or obtained accession to the WHO's Framework Convention on Tobacco Control.[32] Ethiopia took the longest time (10 years) to ratify the convention after becoming a signatory.

Table 3. Status of the implementation of selected articles under the supply and demand reduction measures, Treaty Provisions of the WHO FCTC.

		Supply reduction measures		Demand reduction measures				
		Sales to and by minors (Article 16)		Tobacco advertising promotion and sponsorship (Article 13)		Price and tax measures to reduce the demand of tobacco component of (Article 6)		
Country	Date of WHO FCTC ratification	Sale of tobacco products from vending machines prohibited	Sale of cigarettes individually or in small packets prohibited	Tobacco smoking banned in public places	Comprehensive ban on all tobacco, advertising promotion and sponsorship	Trends in prices	Tax policies to reduce tobacco consumption	Proportion of the retail price consisting of taxes
Congo	6 Feb 2007	**No**	**No**	Yes	Yes	Increased	Yes	32.0
Ethiopia	25 March 2014	No data	No data	No data	No data	No data	No data	No data
Ghana	29 November 2004	Yes	Yes	Yes	Yes	Constant for 2 years	Yes	88.0
Kenya	25 June 2004	Yes	Yes	Yes	Yes	Constant	Yes	52.0
Malawi	Not ratified	No data	No data	No data	No data	No data	No data	No data
Nigeria	28 June 2004	Yes	Yes	Yes	Yes	Increasing	Yes	Not answered
Rwanda	19 October 2005	Not answered	Not answered	Not answered	Not answered	No answer	Not answered	Not answered
Senegal	27 Jan 2005	No	No	Yes	Yes	Decline	Yes	70.9
Sierra Leone	22 May 2009	No	No	Yes	No	Not answered	No	Not answered
South Africa	19 April 2005	No	No	Yes	Yes	Decline	Yes	Not answered, 52.0 (2012)
Togo	15 Nov 2005	Yes	Yes	Yes	Yes	Stable	Yes	45.0
Uganda	20 June 2007	No	No	Yes	No	Stable for 2 years	Yes	40.3
Zambia	23 May 2008	No data	No data	No data	No data	No data	No data	No data

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All other countries took less than 3 years to formally approve the treaty after becoming signatories. Among the 13 countries, according to the results from countries' status of the implementation of the policies under the WHO FCTC, only policies that are considered to be complete and not in draft form were reported on. Data were available for 9 countries (Congo, Ghana, Kenya, Nigeria, Senegal, Sierra Leone, South Africa, Togo, and Uganda) either because of the lack of the country's authorities submitting a report or not answering a particular survey question (Table 3). Of these countries, 7 had comprehensive bans on all tobacco advertising promotion and sponsorship, but Sierra Leone and Uganda did not. All 9 countries had implemented bans on smoking tobacco in public places. All except for Sierra Leone had some taxation policies in place to reduce tobacco consumption. We noticed more variation in the percentage tax on the most popular price category of tobacco product among the countries. As of 2014 according to results from the survey, most of the countries for which data was available had set tobacco taxes below 70% except for Ghana (88%) and Senegal (70.9%). Recent trends in cigarette price have been increasing in Congo and Nigeria, but have declined in Senegal and South Africa. However they have been constant in Ghana, Kenya, Togo and Uganda for approximately 2 years.

Table 4. Prevalence (95% CI) of current smoking by gender and urban and rural locations where available.

		MEN Prevalence (95% CI)			WOMEN Prevalence (95% CI)		
STUDY ID	COUNTRY	In Urban area	In Rural area	Overall prevalence	Overall prevalence	In Urban area	In Rural area
1	Congo	-	-	-	-	-	-
2	Ethiopia	10.3	21.6	18.3	1.0	0.7	1.1
3	Ghana	9.8	5.3	7.1	0.2	0.6	0.2
4	Ghana	3.4	3.1	8.9 (7.3, 10.5)	0.3 (0.1, 0.4)	0.22	0.13
5	Kenya	9.53	-	-	-	0.7	-
	Kenya	2.50✓	-	-	-	0.45✓	-
6	Kenya	22	-	-	-	3.8	-
7	Kenya	-	-	11.2	2.6	-	-
	Kenya	-	-	10.2π	2.3π	-	-
8	Malawi	-	-	25.9 (23.3, 28.5)	2.9 (2.1, 3.8)	-	-
9	Nigeria	-	-	(WP) 8.2 (7.6, 8.9)	(WP) 0.1 (0.1, 0.2)	-	-
10	Nigeria	-	-	-	-	-	-
11	Rwanda	*19.5	*22.8	20.9	12.6	*17	*7.0
12	Senegal	-	-	18.4	0.2	-	-
13	Sierra Leone	-	-	-	-	-	-
14	South Africa	-	-	-	-	-	-
15	Togo	-	-	20.2	3.0	-	-
16	Uganda	-	-	13.7	0.9	-	-
17	Uganda	13.1 (11.7,14.5)	-	-	-	-	1.3 (9.5,16.8)
18	Uganda	-	-	14.6	2.0	-	-
19	Zambia	-	39.6	-	-	-	10.8
	Zambia	-	40.4	-	-	-	7.2
20	Zambia	-	-	18.1	8.7	-	-
21	Zambia	17.5	-	-	-	1.5	-

95% CI- 95% confidence interval; (WP): weighted prevalence

*Not presented in paper, but enough data was presented for prevalence to be calculated manually.

π Tobacco smoking currently but not daily (within the last 30 days)

✓smoked daily;—Data not available from study

doi:10.1371/journal.pone.0132401.t004

Discussion

Summary of main findings on current smoking prevalence

We observed a wide range of current smoking prevalence among the 13 sub-Saharan African countries in the review. This highlights the presence of wide gender diversity in smoking prevalence that is much more prominent in sub-Saharan Africa and other developing countries than in developed countries.[1] The low observed prevalence of smoking among women in sub-Saharan Africa may be due to the presence of strong social norms and taboos which discourage women to smoke.[33, 34] In the same way these social norms may depict smoking among women as inappropriate, smoking among men in some societies is viewed as acceptable, and as a symbol of status and social power. There may also be a growing parity between the prevalence of smoking among men in a few sub-Saharan African countries and those in Western societies reflecting global patterns which shows an increasing similarity in the prevalence of smoking among men in low, middle and high income regions of the world.[35] The prevalence of smoking differed according to location of residence among adults in the same country. We observed

that more adults residing in urban areas smoked compared to rural areas for some countries. This may be indicative that factors related to urbanization, including economic factors, are having an impact on individuals' ability to have greater access to cigarettes in some African societies.[35] However, we do not know what the underlying characteristics of the urban residents are, for example, whether it is due to higher socioeconomic status which may explain the higher smoking prevalence observed, or simply greater access. Some studies reported diverse prevalence ranges for the same geographical area i.e. rural or urban, which might even illustrate different smoking norms are present among different areas within a country.

The differences in reported smoking prevalence may be a reflection of the different sampling strategies used in the different studies. The differences in smoking observed between studies in Nigeria may be due to differences in the age groups and sample size of the populations studied. The 14.6% prevalence was from a slightly older population aged 25–64 using a sample selected from one region in Nigeria, not using a nation-wide sampling frame and also using a much smaller sample size (1458) compared to the younger 15–59 population where the 2.7% prevalence was observed from a sample comprising 48871 participants. It is possible that the higher prevalence observed in Nigeria may be specific to that region and less representative of the wider Nigerian population. It may also be due to inconsistencies in measuring current smoking which we realized varied greatly across studies. Our attempts to compare the different smoking prevalences are limited by the different sampling procedures and methods of measuring current smoking.

Comparison to previous findings

We compared our findings to a systematic review for the period 2000–2006.[36] In comparing the current review period (2007–2014) to the previous review period, we looked for studies that reported overall prevalence of smoking for an area representative of the entire country and not just a rural or urban area and separately by gender. Five countries also had an estimate reported in the previous period of 2000–2006. The comparisons are shown in Figs 2 and 3.

The patterns observed from comparing smoking measured during the periods 2000–06 and 2007–14 varied quite markedly by country and by gender. Estimated smoking prevalence was higher in the most recent review among both men and women in Ethiopia, Rwanda and Zambia (Figs 2 and 3). In contrast, smoking prevalence was lower in studies in the recent review among both men and women in Ghana, Nigeria and Uganda. In Kenya smoking prevalence among women was higher but among men was lower in the latest review while the opposite pattern was seen in Malawi. These descriptive patterns are interesting but we did not conduct

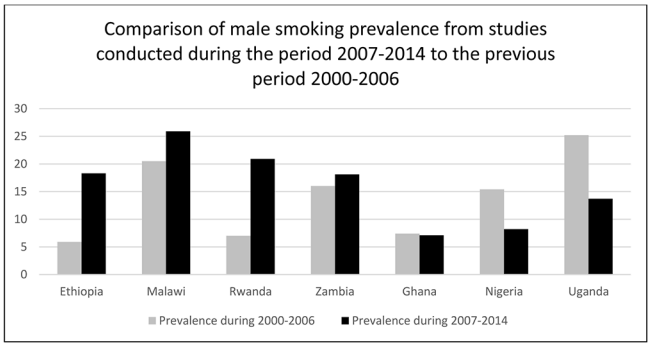

Fig 2. Reported smoking prevalence during 2000–2006 and 2007–2014 for men in 7 countries in sub-Saharan Africa that were included in the review.

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further analysis as different methodologies were used in the two periods and the populations studied also differed.

Description of the tobacco control measures present in 13 sub-Saharan African countries

The tobacco industry has been successful in expanding its markets to low and middle-income countries by capitalising on economic growth, changing social norms and population demographics in low income regions.[1] Africa has lower rates of tobacco taxation, weaker smoke-free policies and less stringent tobacco advertising restrictions in comparison to higher income countries.[9, 37] Tobacco companies are known to be attracted to weak policy environments and execute stronger tactics which oppose governments' fight for smoke free environments.[38] From the included studies, very high prevalences of smoking among men was observed in Malawi (25.9%) who is yet to ratify the WHO FCTC convention, and in rural Ethiopia (21.6%) who has ratified the convention very late in 2014, since it was created under the WHO in response to the global tobacco epidemic as a strategy to reduce the demand and supply of tobacco in countries. Malawi's adoption of the WHO FCTC would help in implementing methods to regulate the demand and supply of tobacco which will involve both economic and non-economic measures to be executed and help reduce the high smoking rates among men in the country. Further to this, we noticed that Ghana, Nigeria, Togo and Senegal adopted the WHO FCTC earlier and from the data we observed that they have lower smoking rates than countries who signed the convention much later such as Sierra Leone. There can be many explanations for such a relationship, but earlier adoption of the WHO FCTC can allow governments the structure to be able to enforce stronger tobacco control policy environments.

Advertising is known to increase tobacco consumption by increasing sales and may even trigger potential users to start smoking.[39] Research conducted among 22 Organization for Economic Cooperation and Development (OECD) countries concluded that the presence of comprehensive bans are better able to reduce consumption than limited bans. In the absence of comprehensive bans in Sierra Leone and Uganda, a considerable proportion of men smoked in Uganda (13.7%) including rural areas (14.0%) and among adults in the population of Sierra Leone (25.8%) have been documented. The absence of robust tobacco control policies might be influencing the high smoking rates in these countries. However, this is not a simple relationship. There is likely to be a wide range of factors influencing whether adults smoke in sub-Saharan Africa, which include cultural and religious factors that determine the social acceptability of smoking, and the effectiveness of the implementation of tobacco control polices.

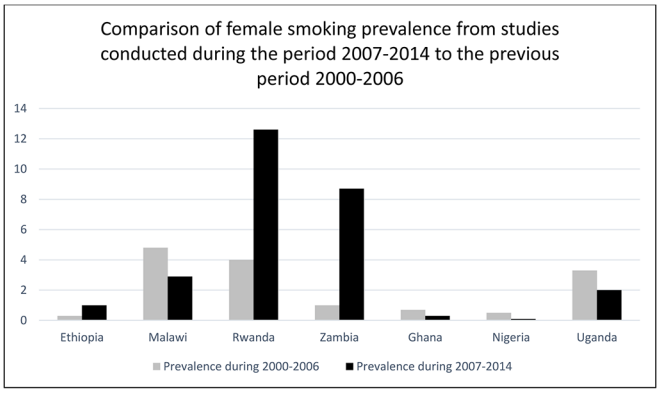

Fig 3. Reported smoking prevalence during 2000–2006 and 2007–2014 for women in 7 countries in sub-Saharan Africa that were included in the review.

doi:10.1371/journal.pone.0132401.g003

With respect to taxes, the literature has shown that tobacco taxes when raised to increase prices can reduce and stop consumption among current users and or prevent consumption among potential users, significantly impacting young persons and poorer users.[40, 41] It is recommended that tobacco excise taxes be set above 70% of the retail price of the tobacco product to have a significant impact on increasing prices and thereby reducing consumption. The data reported here do not allow us to draw any conclusions about the effectiveness of control measures. For example, a government concerned about high levels of existing smoking might introduce stricter controls whereas in areas with lower smoking, tobacco policies may receive less attention. The one clear conclusion is that tobacco control policies vary widely in different African countries, with no clear correlation with smoking prevalence.

Strengths and limitations

We believe that the included studies give good estimates of current smoking prevalence in the respective countries, and rural or urban sub-national areas over the last seven years (2007 to May 2014). We were unable to make any analysis of the association between preventive measures and smoking prevalence due to several methodological and data limitations. Most importantly is that the date the prevalence of current smoking was measured may precede the implementation of the respective tobacco control measures. We know that the measures would have been implemented as of 2014 but some of the prevalences reported may not have been impacted by the presence of these tobacco control measures if the measures were implemented after the study was done. Any possible associations are subject to a number of other confounding factors at the individual and community level.

This review may also be limited in the strength of comparisons made between the prevalence of smoking between urban and rural areas and across countries, since the research varied in how smoking was measured, how representative samples were selected, and the period in which the data were collected. We only looked at data within the broad period 2007 to 2012 and not specifically by year, so we are unable to deduce whether an increasing or decreasing trend in current smoking was present.

Another bias amongst the studies may be in the measurement of current smoking. All included studies assessed current smoking from self-reported statuses. Past research observed underreporting among patients who had their current smoking status confirmed via taking measurements of their carbon monoxide level and concentration of serum cotinine. Approximately 50% of current smokers self-reported to be non-smokers.[42] Furthermore, smoking in certain countries in Africa seems to be stigmatised especially among women.[43] There may be a possibility that the prevalence may be underreported for example in some countries with unusually low prevalence such as Ghana.

Implications for Policy

In spite of the limitations of the data, this study has important implications for public health research and policy in Africa. It shows that smoking levels are still high in the majority of sub-Saharan African countries for which data are available. There is also some evidence to suggest smoking prevalence may be increasing in some areas, especially among women. In addition, we found that the level of implementation of tobacco control measures varies widely for the countries in the review, although due to data limitations we could not make any analysis of the effect of prevention policy, not the effects of policy gaps. Health policy makers would benefit from more reliable and complete data on smoking prevalence trends for all countries in sub-Saharan Africa including within country patterns of smoking by age, gender and ideally comparing rural-urban environments. Data on smoking prevalence and also better evidence of the

effectiveness of tobacco control policies in Africa are needed to demonstrate that smoking should, and can, be addressed as a major population health priority in Africa. The continued influx of international aid for infectious diseases, such as malaria and HIV/AIDS, has caused distortions within health systems and health policy priorities, and continues to draw resources away from tackling non-communicable disease, and the single biggest risk factor, smoking.

Conclusion

This shows that smoking in some countries of sub-Saharan Africa is increasing. The patterns varied across the region, within sub-regions and by rural urban location within countries. Gender seems to be the strongest determinant of tobacco smoking among adults, with men smoking more than women in all countries. The implementation of tobacco control policies was also found to vary widely, in the study countries. More research is needed on the implementation and effectiveness of tobacco control policies across all countries in sub-Saharan Africa. Effective action to reduce tobacco smoking and to particularly stop the increased uptake of smoking among women must become a public health priority for sub-Saharan Africa to reduce the burden of disease.

Supporting Information

S1 Checklist. PRISMA 2009 Checklist.
(DOC)

S1 Appendix. Example search strategy.
(DOCX)

S2 Appendix. Reasons for excluding studies from systematic review.
(DOCX)

S3 Appendix. Details of the sampling methodology and measurement of current smoking used in each study.
(DOCX)

Author Contributions

Conceived and designed the experiments: LS RB JA KL. Performed the experiments: RB. Analyzed the data: RB. Contributed reagents/materials/analysis tools: LS RB JA KL. Wrote the paper: RB LS JA KL.

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Appendix 2.2.
Search strategy used for the systematic review of tobacco smoking prevalence and description of tobacco control strategies in sub-Saharan African countries; 2007 to 2014

The search strategy involved a combination of three different concepts:

1. Sub-Saharan Africa **AND**
2. Smoking **AND**
3. Types of studies

The following search strategy was used in most of the databases with slight adaptations for databases using different interfaces and thus required the use of different subject headings.

Table 7.1 Search strategy used in the OvidSP databases

Search no.	Search term
1	exp “Africa south of the Sahara”/
2	sub-Saharan Africa
3	subsaharan Africa
4	Black Africa
5	Africa south of the Sahara
6	Exp “Democratic Republic of the Congo”/
7	Angola or Benin or Botswana or Burkina Faso or Burundi or Cameroon or Cape Verde or Central African Republic or CHAD or Comoros or Congo or Congo Democratic Republic or Djibouti or Equatorial Guinea or Eritrea or Ethiopia or Gabon or Gambia or Ghana or Guinea or Guinea-Bissau or Cote d'Ivoire or Ivory Coast or Kenya or Lesotho or Liberia or Madagascar or Malawi or Mali or Mozambique or Namibia or Niger or Nigeria or (Sao tome and Principe) or Rwanda or Senegal or Seychelles or Sierra Leone or Somalia or South Africa or South Sudan or Sudan or Swaziland or Tanzania or Togo or Uganda or Zambia or Zimbabwe
8	**1 -7**
	Search terms for smoking
9	Smoking
10	Smok* or tobacco* or cigar*
11	Tobacco consumption
12	Tobacco/
13	Pipe adj2 smok*
14	Bidi
15	Kretek
16	prevalence ADJ4 tobacco
17	prevalence ADJ4 smoking
18	**9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17**

Search no.	Search term
	Search terms for types of studies
	Search filter for type of studies that may have prevalence
19	Exp Prevalence/
20	Prevalence
	Search filter for cross-sectional studies (Ovid Medline)
21	exp Cross-Sectional Studies/ or cross-sectional.ti,ab. or "prevalence study".ti,ab.
	Search filter for cohort studies (Ovid Medline)
22	cohort.ti,ab. or exp Cohort Studies/ or longitudinal.ti,ab. or prospective.ti,ab. or retrospective.ti,ab.
	Search filter for epidemiologic studies (Ovid Medline)
23	Epidemiologic Studies/
	Combining the searches
24	**19 or 20 or 21 or 22 or 23**
25	**8 AND 18 AND 24**
26	**Limit 25 to the studies published from the years 2007 to 2014 (May)**

Appendix 2.3
Reasons for excluding studies from systematic review for the article ‘A systematic review of tobacco smoking prevalence and description of tobacco control strategies in sub-Saharan African countries; 2007 to 2014’.

Table 7.2 Reasons why articles were excluded from the systematic review

Reference No.	Reason for exclusion
[236]	Prevalence of current smoking not reported
[237]	Prevalence of current smoking not reported in representative sample
[238]	Current smoking prevalence not reported Small sample size less than 1000 participants- (805)
[239]	Current smoking prevalence not reported Community based-Small sample size less than 1000 participants, (444)
[240]	Prevalence of current smoking combined with ex- smoking
[241]	Prevalence of current smoking not reported, only ever smoking and use of chewing tobacco and snuff
[242]	Prevalence of current smoking not reported
[243]	Prevalence of current smoking not reported, Data collection period before 2007 (2005)
[244]	Prevalence of current smoking not reported
[245]	Small sample size (419) longitudinal study, no prevalence of current smoking reported
[246]	No prevalence of current smoking
[247]	Unrepresentative community-based sample 21.5% response rate (207 participants)
[248]	Community-based Small sample size 407 participants
[249]	Community based Sample size less than 1000- 611 participants
[250]	The majority of the sample represented adults over 50 years (4770) and a small number between ages 18-49 (803)
[251]	Community based- sample sizes of urban and rural areas less than 1000
[155]	Not in sub-Saharan Africa
[252]	Adults over 40 years
[253]	Semi-urban area
[254]	Aged 35 and above
[255]	Unrepresentative
[256]	Unrepresentative community-based survey
[257]	Unrepresentative community-based survey
[258]	Aged 51 and older
[161]	Aged 50 and older
[259]	Unrepresentative community-based survey
[260]	Unrepresentative community-based survey
[261]	Unrepresentative community-based survey
[262]	Data collection period before 2007, (2004,2005)
[263]	Data collected before 2007, (2003)
[264]	Data collected before 2007 (2004)
[265]	Data collected before 2007 (2006)
[266]	Data collected before 2007 (2006)
[267]	Data collection before 2007- (2002-2004)
[268]	Data collection period before 2007 (2005)
[269]	Data collection period before 2007 (2005)
[270]	Data collection period before 2007 (2006)
[271]	Data collection period before 2007 (2006)
[272]	Data collection period before 2007 (2002-2004)
[273]	Data collection period before 2007 (1996-1998)
[274]	Data collected before 2007 (2002-2003)
[275]	Sample size less than 1000 (548)
[276]	Study sample less than 1000 participants (658)
[277]	Sample size less than 1000 (469)

Reference No.	Reason for exclusion
[278]	Sample size less than 1000 (699)
[279]	Sample size less than 1000 (899)
[280]	Sample size less than 1000 (200)
[281]	Sample size less than 1000 participants
[282]	Sample size less than 1000 participants (886)
[283]	Data collection period before 2007 (2005-2006)
[284]	Study period before 2007 (2004)
[285]	Data collection period before 2007 (2002-2005)
[286]	Data collection period before 2007 (2005)
[287]	Data collection period before 2007 (2003)
[288]	Data collection period before 2007 (2002), sample size less than 1000 (200)
[289]	No full text
[290]	Period of data collection not reported
[291]	Review

Appendix 2.3.1:
Articles that were excluded from systematic review with reasons [2014 to 2016 period]

- Sharp (2015)[292]- no prevalence of smoking reported
- Nakibuuka (2015)[293]- no prevalence of smoking reported
- Joshi (2014)[294]- same study already included
- Mosha (2014)[295]- sample size less than 1000
- Kavishe (2015)[158]- sample size less than 1000
- Stanifer (2015)[296]- sample size less than 1000
- Kaze (2015)[297]- sample size less than 1000
- Uguru (2015)[298]- unrepresentative sample (only men)

Appendix 2.4.
Details of the sampling methodology and measurement of current smoking used in each study for the systematic review

Table 7.3 Details of the sampling methodology and measurement of current smoking used in each study [2007-2014]

First Author [year of publication],	Country/ area representative of	Sampling strategy	Actual sample size, N	How smoking was defined in the study
Nyembue, T.D.	Congo, Kinshasa sub-national, rural and urban	Households were sampled in four stages. In the first stage, eight health zones were randomly selected from the 35 health zones in Kinshasa. The second stage involved the random selection of 2 health areas in each health zone. The third stage randomly chose three streets from among all the listed streets within each health area. Fourthly, inhabited parcels were randomly selected from the list of whole parcels. One household was randomly chosen in instances where more than one household was present on a parcel. Individuals met the inclusion criteria if they were older than 5 years and lived in Kinshasa for more than 1 year. One individual was randomly recruited to participate from among those who met the inclusion criteria in the household. The number of participants was selected proportionately according to the size of the health zone.	1412	Active smoking
Alemseged, F [2012]	Ethiopia, sub-national, rural and urban	Residents aged 15 to 64 years living in the 10 selected administrative areas under research in Ethiopia. The population was stratified by sex, age and rural urban residential area	5500	Current smoker Yes/No

First Author [year of publication],	Country/ area representative of	Sampling strategy	Actual sample size, N	How smoking was defined in the study
John, R.M. [2012]	Ghana, national, urban and rural	The Demographic and Health Survey conducted in 2008 in Ghana sampled households which were representative of Ghana. This was done using a two-stage cluster design. 11913 households were given a general questionnaire and half of the households were given additional questions for men and women.	Total 9484 4916 men 4568 women	<u>Smoking was defined in 2 ways:</u> 1. Currently consumed cigarettes 2. Currently consumed cigarettes, cigars, pipe tobacco, chewing tobacco, and or snuff
Owusu-Dabo, E. [2009]	Ghana, sub-national urban and rural	The study was conducted in the Ashanti region of Ghana which is located in the central area of Ghana and is the most densely populated among the 10 regions in Ghana and most representative of the national population. All Ashanti enumeration areas listed in the 2000 census comprised the sampling frame. The list was stratified according to urban rural location and a random sample of 15 EAs was selected from each area. Field workers from Ghana Statistical office visited each enumeration area to select 20% of the houses in the area for the sample. An enumeration area typically contains approximately 100 houses, the field workers marked with chalk every fifth house as they walked the route. Institutionalised individuals were excluded	6258	Smokes at least 100 cigarettes in his or her lifetime and smokes nowadays

First Author [year of publication],	Country/ area representative of	Sampling strategy	Actual sample size, N	How smoking was defined in the study
Bloomfield, G.S. [2013]	Kenya/ sub-national- peri-urban	The study was conducted in the Wemuye HDSS site. The area was stratified using random sampling by sub-location and village using probability proportional to size. Individuals were randomly selected from male and female clusters in each sub-location and village.	4037	Tobacco used currently daily- within the last 30 days
Ayah, R. [2013]	Kenya, sub-national Urban slum of Nairobi (the capital of Kenya)	Urban slum in Nairobi Kenya called Kibera. The sample was drawn from a list of villages in this area. Clusters were sampled based on probability proportional to size of the village. The design effect of 2 was used to adjust for the degree of clustering among the participants. 80 clusters each containing about 10 households were selected. 25 participants per cluster were selected. The nearest health center, church or school was used as the starting point from which recruitment of households began. Households were selected through a random walk from the starting point. The next consecutive household was also selected from the recruited ones until the sample size was reached. All adults over 18 years living in the area for more than 3 months were invited to participate in the study. All pregnant women were excluded. Two visits were made to each household in an attempt to recruit residents absent at the time of first visit.	2061	Current cigarette smokers

First Author [year of publication],	Country/ area representative of	Sampling strategy	Actual sample size, N	How smoking was defined in the study
Lo, T..Q. [2013]	Kenya/sub-national rural western Kenya	The study was conducted in the Rarieda, Wagai, Yala and Karemo District of rural western Kenya. The Health and Demographic Surveillance System is a longitudinal based database of demographic and health census data. Household interviews were conducted in during the second round of the HDSS survey. Senior adult members of the household were used as proxy respondents to answer questions on smoking behaviour for absent individuals	72292	Smoking was defined in 2 ways: 1. Currently smoked at least 100 cigarettes and smoking at the time of the interview 2. Smoked daily
Msyamboza, K.P. [2011]	Malawi, national, urban and rural	The sampling frame was the list of enumeration areas in Malawi. 144 Enumeration areas were randomly selected from the list of EAs in Malawi. 40 households were then selected from each EA using a systematic sampling method. The sampling interval for selecting households within the EA was determined by dividing the total number of houses in each EA by 40. The Kish Method was then used to select one eligible participant from each household. Households were not replaced if no eligible participants were available in selected households.	5206	Tobacco smokers
Tafawa, A.O. [2012]	Nigeria, national urban and rural	The 2006 Population and Housing Census of the Federal Republic of Nigeria was used as the sampling frame for the Nigeria Demographic and Health Survey. Enumeration areas that provided 888 clusters were stratified by urban and rural areas to allow oversampling of urban	34070	Use of smoking tobacco- cigarette, pipe or other

First Author [year of publication],	Country/ area representative of	Sampling strategy	Actual sample size, N	How smoking was defined in the study
		areas before selection of households. All women, ages 15–49, who were either permanent residents or overnight visitors in all selected households and all males, ages 15–59, who were either permanent residents or overnight visitors in half of the selected households were eligible to participate. Two NDHS 2008 questionnaires were merged to create the data set for this study		
Ulasi, I. [2010]	Nigeria, sub-national	Two thirds of the study population was selected from the semi-urban area and the remaining third from the rural community to achieve proportional representation. A minimum target sample size of 2000 adults aged 25 to 64 stratified by sex and 10 year age group. To compensate for non-response, or attrition, the number was projected to 2200.	1458	Tobacco smoking
Musafiri, S. [2011]	Rwanda sub-national urban and rural in the capital Kigali urban, and a rural area Huye District	Nyarugenge district is divided into 10 administrative sectors and Huye district has 14 administrative sectors. Each sector has a population register regularly updated. Using population registers systematic sampling was used to obtain probabilistic samples that are representative of the total population. The sample size was estimated at 2138 subjects aged 15 to 80 years (1184 in Kigali and 954 in Huye district). Participants were invited in Health centers where a structured interview was conducted by well-trained health	1920	Currently smoking at least one cigarette per day

First Author [year of publication],	Country/ area representative of	Sampling strategy	Actual sample size, N	How smoking was defined in the study
		workers. Three health centers were available in Kigali and three others in Huye district. Inclusion criteria were age >15 years, living in Kigali town or Huye District and being competent and willing to sign the informed consent form after being given all the details about the study.		
Pessinaba, S. [2013]	Senegal	A cross-sectional study selected participants using a stratified cluster systematic random sampling method. Conducted in May 2010 in a Senegalese population resident in city of Saint Louis aged 15 years and older. Consent was received. Pregnant women were excluded.	1424	Active smoking
Samai, M. [2011]	Sierra Leone, national	Cross sectional population based survey, all individuals were resident in the study area and willing to participate. The multi-stage cluster sampling strategy was used in this study. The CSs as demarcated by Statistics Sierra Leone (SSL) were used as the primary sampling unit (PSU). 100 CSs were selected using the probability proportionate to size (PPS) sampling method. Five hundred and fifty EAs were selected from within the selected CSs by the PPS sampling method. In the third stage, ten households were randomly selected from each selected EA. One eligible respondent was selected	4997	Current tobacco use (smoke and smokeless)
Alaba, O. [2013]	South Africa/ national	Participants were recruited as part of the first wave of the 2008 South African National Income Dynamics Study (NIDS). The sampling strategy utilised a stratified 2-stage cluster	11,638	Non-smoker or smoker

First Author [year of publication],	Country/ area representative of	Sampling strategy	Actual sample size, N	How smoking was defined in the study
		sample to select households. 53 district councils (DC) of South Africa formed the master sample. From within each strata, 400 Primary Sampling Units (PSU) were randomly selected according to the SC PSU allocation. 8 non-overlapping clusters of dwelling units were systematically selected from within in PSU. A household and adult questionnaires were administered		
Baragou, S. [2012]	Togo/ sub-national	The study was conducted in the town of Lome. 34 households were selected each from 30 clusters to give a total of 1000 households. From each household, one male and one female over 18 years was recruited giving a total of 68 individuals per cluster. Consent was obtained after the study objectives were explained The sample size of 2000 was calculated to detect a 20% prevalence of hypertension with 80% power at the 0.05 level	2000	Consumed at least one cigarette per day
Kinyanda, E. [2011]	Uganda, sub-national rural	Annual household survey in Southwest Uganda, all household village residents >13 years were eligible to participate	6678 total 2719 males 3959 females	Current cigarette smoker including both manufactured and local cigarettes

First Author [year of publication],	Country/ area representative of	Sampling strategy	Actual sample size, N	How smoking was defined in the study
Murphy, D. [2013]	Uganda/sub-national, rural	All residents older than 13 years of age who lived in one half of the rural sub-county. Equal proportions of males and females were sampled.	6867	Current daily smoking
Nuwaha, F. [2013]	Uganda/ sub-national	First 111 villages were randomly selected and stratified by urban or rural residence using the 20002 Uganda Bureau of Statistics. 30 households were selected from each village and Adults Older than 15 years excluding pregnant women who lived in urban and rural communities of Buikwe and Mokono districts in Uganda were recruited after informed consent was obtained.	4142	Currently consume tobacco
Mulenga, D. [2013]	Zambia/sub-national rural	In the multi-stage sampling procedure, wards were first selected from each constituency. Then standard enumeration areas were selected proportional to the ward size. Households were then systematically sampled from within each standard enumeration area. From within households, all adults older than 25 years were eligible to participate.	2093	Current smoking- do you currently smoke any tobacco products such as cigarettes, cigars or pipes
Zyaambo, C. [2013]	Zambia/sub-national	The mining town of Kitwe in Zambia was first divided into high cost (2) and low cost residential areas (3). One high cost and two lost cost residential areas were randomly selected. The selected areas where then divided into wards where one ward was randomly selected from each constituency. Each selected ward was further divided into Census Supervisory	1627	Current smoking- do you currently smoke any tobacco products such as cigarettes, cigars, or pipes

First Author [year of publication],	Country/ area representative of	Sampling strategy	Actual sample size, N	How smoking was defined in the study
		areas where 6 were chosen from the two low cost and four selected from among the high cost residential area. 10 Standard enumeration areas were then selected using probability proportional to size, selecting one each from the selected census supervisory areas. Households were systematically sampled from the chosen standard enumeration areas to ensure a wide coverage among the standard enumeration areas. All adults above 25 years were eligible to participate		
Siziya, S. [2011]	Zambia, sub-national urban district called Lusaka	Lusaka district was conveniently selected since it was the most urbanised district in Zambia. The hypothesis that that prevalence rates for non-communicable diseases and their risk factors would be highest in urbanized areas. A district was first administratively divided into constituencies, then into wards, Census Standard Areas (CSAs) and finally into Standard Enumeration Areas (SEAs). Lusaka district had 7 constituencies out of which 5 were randomly selected. From each selected constituency, one ward was selected stratified by type of residential area (low, medium and high density areas). CSAs were not considered in our sampling. The number of Standard Enumeration Areas (SEAs) selected in each ward was proportional to its population size. The number of SEAs varied from 15 to 45, and a 1 in 4 systematic random sampling technique was used to select SEAs, except in one ward in which a 1 in 3 systematic method was used.	1928	<u>Smoking was defined in 2 ways:</u> 1. Currently smoked cigarettes 2. Do you currently smoke any tobacco products, such as cigarettes, cigars or pipes?

First Author [year of publication],	Country/ area representative of	Sampling strategy	Actual sample size, N	How smoking was defined in the study
		Households were systematically sampled to widely cover the selected SEAs. Finally, all persons of age 25 years or older were requested to participate in the survey.		

Table 7.5 Details of the sampling methodology and measurement of current smoking used in each study [2014-2016]

First Author (Year of publication)	Country/ area representative of	Sampling strategy	Actual sample size	How smoking was defined in the study
Houehanou, YCN (2015)	Benin/national	Participants were recruited for the Benin Steps Survey, using a five-stage sampling frame. Out of 546 districts, 60 were randomly selected using probability proportional to the size of the population. Out of these 60 districts, half of the neighbourhood and villages in each district were randomly selected. Out of these neighbourhoods and villages retained, dwellings, households and participants were selected. The centre of the village/neighbourhood was chosen as the starting point and the direction for recruitment was chosen randomly. Within households, participants were selected using the Kish method.	6960	Daily tobacco smoking during previous 12 months
Pefura-Yone, EW (2015)	Cameroon/ Urban	7 districts of Yauounde were sampled using a multilevel stratified random strategy.16 enumeration areas were randomly selected from the list of enumeration areas in Yaounde, using a 2-3 EA per district ratio. One household was then selected from 2. 70 to 110 households were selected per EA. Within each household, all adults older than 19 years were selected.	2304	Current smokers: smoked at least one cigarette per day for at least one year; smoked at least 20 cigarettes in their lifetime and was still smoking.
Lakew, Y (2015)	Ethiopia/ national	The Ethiopian Demographic Health Survey from 2011 was used. Participants were selected using a two-stage stratified two-stage cluster sampling method. A list of 624 enumeration areas formed the sampling frame, this was stratified by urban rural area. There	30625	Used any form of tobacco. Do you currently smoke cigarettes? What type of other tobacco do you currently smoke or use like pipe, chewing

First Author (Year of publication)	Country/ area representative of	Sampling strategy	Actual sample size	How smoking was defined in the study
		were 187 urban and 437 rural areas. 16702 households were selected from 11 administrative regions.		tobacco (yes/no), snuff (yes/no), shisha (yes/no), gaya (yes/no) and any other types of tobacco (yes/no). If respondents did not use any tobacco, these were classified as non-tobacco users. If a respondent was a user of tobacco if they used one or more of the tobacco types.
Blecher, E (2014)	Madagascar/national	The nationally representative Madagascar Demographic Health Survey (DHS) from 2008-2009 was used. Households were selected stratified by rural (14,432) and urban (4768) areas. Within each household, women aged 15-49 were selected while in half of the households 15-59.	25961	Current smokers of cigarettes or pipe tobacco
Reddy, P (2015)	South Africa/ national	The first South Africa National Health and Nutrition Examination Survey (SANHANES-1). The list of enumeration areas formed the sampling frame, from which 500 were randomly selected. 10,000 households were then selected using a multi-stage disproportionate cluster sampling method.	15401	Current tobacco smokers Currently smoked tobacco daily or less than daily Current smokers of other tobacco products on a daily or less than daily basis (hand-rolled cigarettes, pipes, cigars, cheroots, cigarillos, hookah, hubbly bubbly, water-pipe sessions, electronic cigarettes, snuff, chewing tobacco, smokeless tobacco.

First Author (Year of publication)	Country/ area representative of	Sampling strategy	Actual sample size	How smoking was defined in the study
Bazil, K (2015)	United Republic of Tanzania/urban, rural	A cross-sectional population survey was used. A five stage multi-sampling procedure was used. A municipal area, two district towns and rural areas were selected. Within each stratum, the lowest administrative local authority was sampled using probability proportional to the number of households. Households were then randomly sampled within the area. If households were located within 5 km of a health facility it was eligible to be sampled. Within each household, verbal consent was obtained from the head of the household who then provided a list of members, from which all adults over 18 years were invited to participate.	1095	Current smoking

Appendix 3.0.

Details of the RODAM Study design not included in paper

The **R**esearch on **O**besity and **D**iabetes among **A**frican **M**igrants (**RODAM**) study is a cross-sectional survey of three main groups of adult Ghanaians aged 25 or older.[178]

1. Ghanaian-born adults who have lived for at least one consecutive year in a rural area in Ghana, or an urban environment in Ghana;
2. Ghanaian-born adults who have migrated and lived for at least one consecutive year in the European cities of London, Amsterdam or Berlin.
3. Adults of Ghanaian descent i.e. who have Ghanaian-born parents or grand-parents, who were not born in Ghana but are at least over the age of 25 years and have lived in London, Amsterdam or Berlin for at least one consecutive year.

Background and rationale of the RODAM study

The RODAM study was designed to investigate the reasons underlying the observed higher prevalence of Obesity and Type 2 Diabetes among migrants of African origin in Europe compared to the local European populations.[178] It's main aim was to understand the complex relationship between environmental and genetic factors which may contribute to the higher prevalence of obesity and Type 2 Diabetes among sub-Saharan African migrants in different locations. This was achieved by conducting a multicentre cross-sectional study among Ghanaians living in rural and urban Ghana and three European locations. Standardised data on genetic and non-genetic factors, health outcomes, and lifestyle factors were collected.

Ethics and informed consent

The respective ethics committees at all study locations in Germany, the UK, the Netherlands and Ghana have granted approval for the RODAM study protocols, including the written information and consent forms, based on the standard ethical principles outlined in the World Medical Association (WMA) Declaration of Helsinki.

A copy of participants' information leaflet and consent form are provided in Appendix 3.1. Appendix 3.2 shows the ethical approval granted by The Observational and Interventions Research Ethics Committee of the London School of Hygiene & Tropical Medicine on the 12th July 2012, for the research proposal submitted for the RODAM study.

Description of target population and data collected for RODAM

Data were obtained from the multicentre RODAM study.[178] Teams of researchers have attempted to collect data on nationally representative samples of adult Ghanaian populations living in London, Amsterdam and Berlin and from residents of urban and rural areas in the Ashanti region of Ghana. All consenting participants resided for at least one consecutive year in each study location. From the eligible participants, data on their general health lifestyles, dietary habits, history of diseases, medication usage, smoking habits, psychological factors, migration-related factors and other socio-demographic characteristics were collected. Anthropometric measurements, blood and urine samples were collected for biochemical analysis.

Desired sample size and power calculations

RODAM researchers calculated that a sample size of approximately 1,230 was sufficient for detecting a 5% difference in the prevalence of Type 2 diabetes and obesity, the main aims of the RODAM study with 90% power and 95% confidence.[178] Field workers strived to recruit a total sample of 6,250 participants 1,250 at each location.

From the targeted sample size for the RODAM study, the sample size required to detect a minimum 5% difference in the prevalence of smoking between either rural or urban Ghana and one of the European locations with at least 1) 80% statistical power or 2) 90% statistical power, at the 0.05 level was calculated (Table 7.6).

Table 7.6 Projected power and sample size calculations

	Significance level	Power	Total sample size	Sample size in group 1	Sample size in group 2	Proportion 1	Proportion 2
1	0.05	80%	730	**365**	**365**	0.03	0.08
2	0.05	90%	948	**474**	**474**	0.03	0.08

Sampling strategy

Recruitment strategy for Ghanaians residing in rural and urban Ghana

The list of enumeration areas (EAs) used in the 2010 census from the Ashanti region formed the sampling frame for selecting participants in Ghana.[178] The Ashanti region is the most densely populated of all the regions in Ghana (approximately 4.7 million residents representing 19% of Ghana's population), comprising of more than 2000 urban and 1000 rural areas.[299] The EAs were stratified according to urban and rural areas and weighted.

The Kumasi and Obuasi cities represented the urban stratification since they contained the highest number of urban areas in the Ashanti region (Refer to Figure 7.1 for location of Kumasi and Obuasi in Ghana).[178] From the Kumasi city, a weighted random sample of 10 EAs were randomly selected. Five (5) were selected from Obuasi.

The rural stratification contained all districts with a high proportion of rural areas. A weighted random sample of 15 rural EAs were then selected. Letters were sent to authority figures in selected communities from each enumeration area providing notification about the commencement of the study. Trained field workers recruited participants from the rural areas by rotating through the rural villages and setting up mini-clinics for short durations of 1 or 2 weeks which varied according to the response of participants. Enumerators then presented details of the study to eligible members of households to achieve informed consent from participants. Consenting participants >25 years in the village visited the clinic to be interviewed and participated in a physical examination according to the RODAM study protocol.[178] Participants in the urban study areas were contacted via telephone or a house visit and invited to visit the RODAM location set up at a designated private space at a hospital or clinic in Kumasi or Obuasi to participate in the RODAM study.

Source: www.mapsoftheworld.com

Figure 7.7.1 Map of the Ashanti and other 9 regions in Ghana

Recruitment strategy for Ghanaians residing in London

The Office for National Statistics estimated that there were approximately 93,000 Ghanaians living in the UK in 2012, with the highest density in the London boroughs of Brent, Croydon, Hackney, Haringey, Lambeth, Lewisham, Newham, Southwark (Figure 7.2).[178, 300] The Ghanaian embassy and the Association of Ghanaian churches provided a list of Ghanaian organisations and churches located in London.[178] These were used as the sampling frame for selecting participants due to the absence of a population register of London Ghanaian residents. The London boroughs with the highest concentrations of Ghanaian organisations and churches were purposefully selected to be sampled. The leaders of these organisations were approached to recruit members from these organisations for the study. If member lists were available, a random number of participants were selected and invited to participate based on probability proportional to size. Included participants had to be older than 25 years. Physical examination and interviews took place in local health centres, churches or community centres in the area.

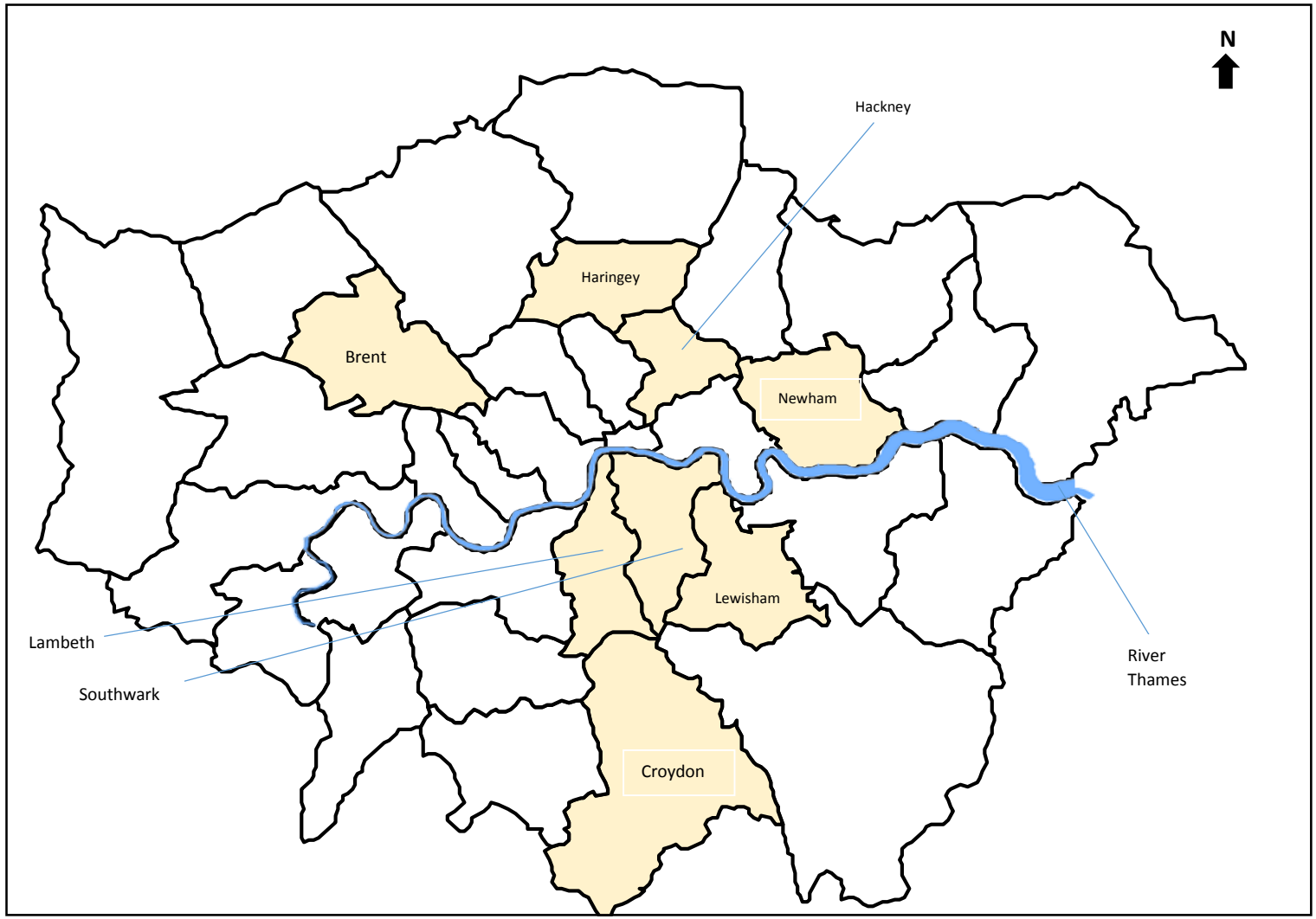


Figure 7.7.2 Map of London showing the boroughs with the highest population density of Ghanaians from which participants were sampled for the RODAM study

Source "Contains Ordnance Survey data © Crown copyright and database rights."

Map created using the standard borough thematic mapping template for London boroughs-

Source: www.data.london.gov.uk/dataset/excel-mapping-template-for-london-boroughs-and-wards

Recruitment strategy for Ghanaians residing in Amsterdam

In 2012, approximately 22,000 Ghanaians lived in the Netherlands most of whom resided in Amsterdam Southeast.[301] The list of Ghanaian nationals older than 25 years registered on the Amsterdam Municipal Health registration was used as the sampling frame for Amsterdam.[178] Ghanaian residents were identified according to the Dutch standard indicator for ethnic origin which classified one's ethnic origin based on information on the country of birth of each individual and their parents. Study details, a response card, a consent form and a written invitation were mailed to all eligible participants. Participants agreeing to participate received written confirmation with the date and time of their appointment to participate in the interview and physical examination at a health centre or if preferred a paper or electronic copy of the study questionnaires were mailed to their address.

Recruitment strategy for Ghanaians residing in Berlin

As of 2006, an estimated 20,000 Ghanaians lived in Germany, with the majority living in the Federal states of North Rhine-Westphalia (23.8%), Hamburg (22.7%), Hesse (9.8%), and Berlin (9.2%).[302] The targeted population of Ghanaian migrants in Berlin were sampled from a list of Ghanaian citizens supplied by the registration office.[178] A number of Ghanaian organizations and churches present in local boroughs with high density Ghanaian populations were purposefully sampled. Key leaders of these organisations were contacted to gain support and encourage member participation. Member lists if available were requested. A combined list of Ghanaian nationals was created from the obtained lists above and participants were randomly selected and invited to participate based on probability proportional to size of defined clusters. Written invitations with study details and response cards were mailed to selected participants. Those aged 25 years and above who positively responded were phoned to schedule an appointment for the completion of the RODAM questionnaire.

Description of variables measured at data collection in the RODAM Study

Anthropometric, biochemical and questionnaire data on general lifestyle and dietary practices were collected in completion from most RODAM participants.[178] Anthropometric measurements included physical measurements of participants' height, weight, waist and hip circumference, sitting height, sitting blood pressure, ankle brachial index (ABI) test of peripheral artery disease, and bioelectrical impedance analysis (BIA) to assess body composition. Biochemical measurements included taking morning urine samples for urine analysis to determine the presence of glucose, cholesterol, protein, ketones, leucocytes, pH, erythrocytes, and nitrites. Venous blood samples were collected as samples of EDTA whole blood, heparin plasma and serum were obtained after centrifuging.

The interviews and self-administered questionnaires retrieved a range of data on socio-demographic characteristics, perceptions of one's general health, body weight, perceptions and satisfaction with body shape, reproductive health, personal and family history of diseases, current symptomology and management of diseases, medication profiles, country of birth of participant and parents, culture, religion, use of language, lifestyle habits like smoking, physical activity, education and employment level, household income, ability to deal with everyday problems, recent experiences, evaluation of recent well-being, satisfaction with social contacts. Participants were also asked about their frequency of consumption of a wide range of listed foods and beverages including alcohol.

Reasons for estimating prevalence ratios

Poisson regression with robust variance estimator was used to estimate prevalence ratios for this cross-sectional study for the following reasons:[210, 303]

1. It is easier to relate to than odds ratios.
2. In the event that a variable is adjusted for that is not a confounder, the crude estimate will not change.

Explanatory factors

Based on the data available in our study, and using the model below which depicts the relationship between several factors and smoking outcomes, the following explanatory factors and possible confounders were investigated in the study:

- *Age*
- *Marital status*
- *Religion*
- *Frequency of attending religious services*
- *Socio-economic indicators*
  - *Educational level*
  - *Employment status*
  - *Type of profession*
  - *Occupation type*
- *Generation status*
- *Duration of residence in host country of first generation migrant*
- *Age at first migration to European city of first generation migrant*
- *Period when started smoking*

Based on the data available in our study, the relationship between smoking and the following factors were investigated (Figure 7.3)

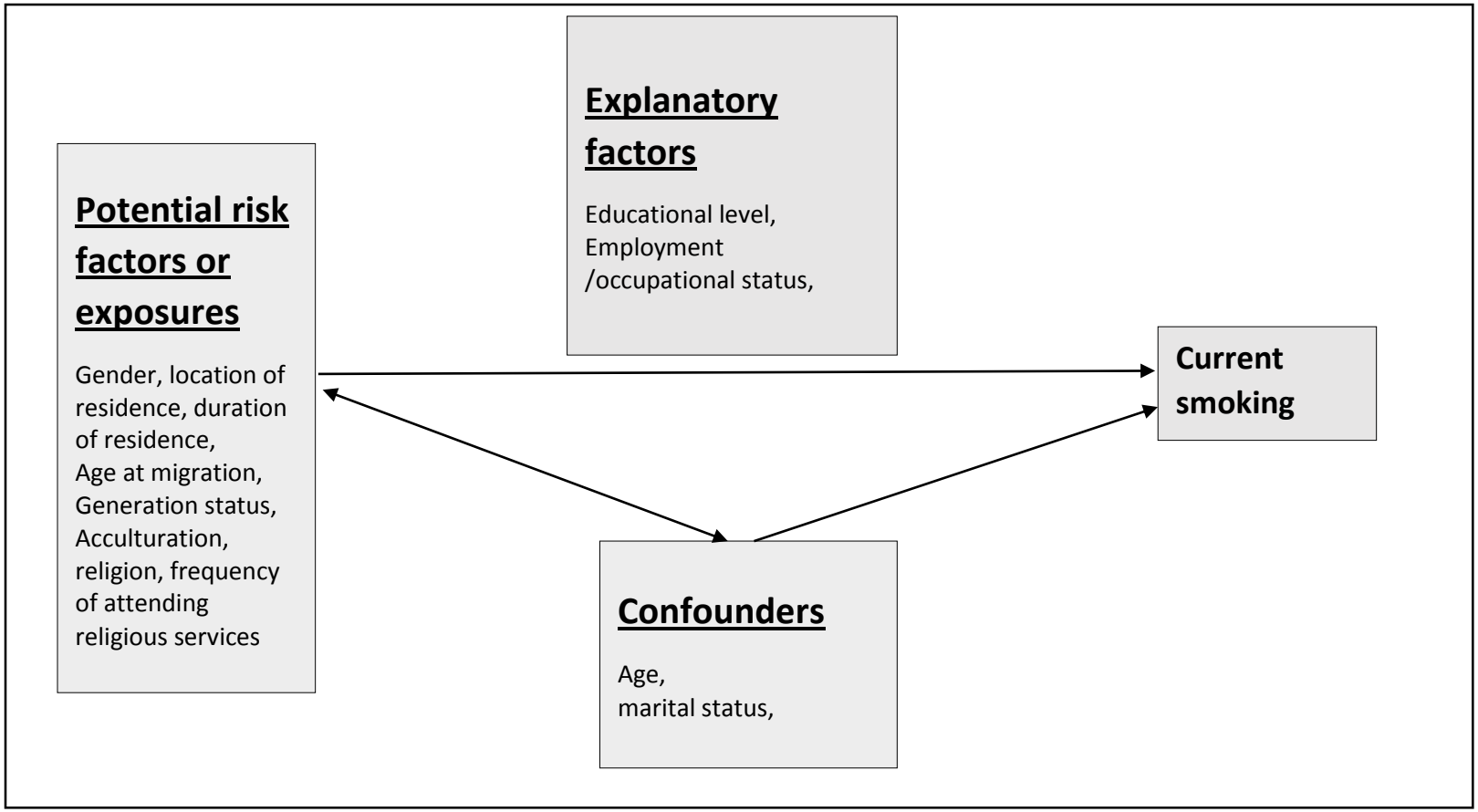


Figure 7.7.3 Diagram showing the relationship between exposures confounders and explanatory factors investigated for current smoking

Appendix 3.1.

RODAM participant information sheet and consent form

RODAM information sheet

Research on Disease among African Migrants

RODAM is a collaborative project between researchers based in 3 European countries (UK, Netherlands and Germany) and in Ghana. It aims to study the health of Ghanaians living in these European countries and in Ghana in order to understand certain disease patterns among this group of people and to identify ways in which diagnosis and treatment can be improved when these conditions occur.

What is the purpose of the study?
Research has shown that cardiovascular disease and risk factors such as hypertension have increased significantly in the past twenty years worldwide. These conditions not only have huge consequences on health care costs and quality of life, but they also lead to other disease conditions that increase human suffering considerably.

Another problem is that ethnic minority and migrant populations in Europe have been shown to be affected more often by certain conditions and often at younger ages. These conditions are also more likely to lead to health complications in these migrant populations. It is therefore important to understand why certain health problems occur more often in such migrant populations and to determine whether it is a result of the environment in which people migrate to, their beliefs and behaviour, or whether there are genetic reasons for these observations.

It is hoped that a better understanding of the processes that lead to these diseases will guide health systems to provide appropriate services and treatment to prevent ill health in ethnic minority groups.

What does the study involve?
The study aims to recruit 1250 Ghanaians aged between 25 and 70 years who have lived in London for at least one year continuously. The idea is to approach identifiable Ghanaian groups or organisations in London and invite a set number of people from each of these groups to take part. Participants will have to agree to be a part of this study by signing a consent form after they have received detailed information and have asked any questions on the study. They will be asked a number of questions on their social and demographic life such as age, marital status and education. They will also be asked specific questions on their past and present health, diet, physical activity and family medical histories. They will then be invited to a defined place such as a health centre, church hall or community centre and have measurements of their weight and height done as well as blood pressure and other non invasive procedures done. Urine samples will be obtained. They will finally have about 20 mls of blood taken in 6 small tubes (about two table spoons in all) to determine their blood sugar, cholesterol, kidney function and other cardiovascular markers. They will be sent copies of their results as soon as these are available and offered guidance on what to do should there be any problems detected. Completing the questionnaire will take about one hour and we estimate that another hour will be required for the measurements.

Why are we contacting you?

We have contacted you because we think you or the organisation you represent can be particularly helpful in assisting us achieve this aim of inviting Ghanaians living in London to take part in this study.

How can you be of help to RODAM?
We are asking that you help us in recruiting the required number of Ghanaians in London by passing the information on to as many Ghanaian organisations and helping us to invite and encourage individuals to take part in the study. If you have a list of Ghanaian members in your group or organisation, it will be extremely helpful if you can invite a random number of these to take part in the study. We will also like to be given about 10 minutes to explain the study to your members at one of your meetings. This will be pre-arranged with you. We can provide suggestions on how to invite a random number of people to participate in the study. We intend to recruit participants over a one year period between September 2012 and August 2013.

Are there any risks to participants?
We do not expect any risks to occur except that they may have to commit about two hours of their time to the study. On the day the measurements are taken, we will request that participants do not take any food in the morning as we require a fasting blood sample to be taken. This will be done in the morning to minimise discomfort. The taking of blood may cause slight discomfort but we will try to minimise these considerably, by using very experienced staff. All information obtained from participants will be treated with strict confidentiality.

Are there any benefits for participants?
The study gives participants an opportunity to have an idea of their cardiovascular risk and to receive some health education. The findings will ultimately help in improving the management of these health conditions among Ghanaians and other Africans. We can also organise free health talks, preferably after the study to organisations that are involved in recruiting participants should they wish to have more health education.

CONSENT FORM
RODAM

I have read and understand the information booklet about the RODAM study and have had the opportunity to ask questions.

I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected.

I understand that members of the research team will ask personal details and information on my lifestyle and past and present health status.

I agree to the researchers measuring my height, weight, blood pressure and taking blood and urine samples from me for cardiovascular health studies.

I agree to take part in the above research.

Name of participant _____

Signature _____ Date _____

Name of person taking consent _____

Signature _____ Date _____

Appendix 3.2.

Copy of ethics approval granted for the RODAM study by the Observational /Interventions Research Ethics Committee of the London School of Hygiene and Tropical Medicine

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
United Kingdom
Switchboard: +44 (0)20 7636 8636

www.lshtm.ac.uk

Observational / Interventions Research Ethics Committee

Liam Smeeth
Professor of Clinical Epidemiology
NCDE/EPH
LSHTM

12 July 2012

Dear Professor Smeeth,

Study Title: **Type 2 diabetes and obesity among sub-Saharan African native and migrant populations: dissection of environment and endogenous predisposition (RODAM)**
LSHTM ethics ref: **6208**

Thank you for your letter of 5 July 2012, responding to the Observational Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval having been received, where relevant.

Approved documents

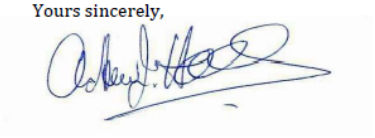
The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
LSHTM ethics application	n/a	18/5/2012
Protocol		18/5/2012
Information Sheet		05/07/2012
Consent form		21/06/2012

After ethical review

Any subsequent changes to the application must be submitted to the Committee via an E2 amendment form. All studies are also required to notify the ethics committee of any serious adverse events which occur during the project via form E4. At the end of the study, please notify the committee via form E5.

Yours sincerely,



Professor Andrew J Hall
Chair
ethics@lshtm.ac.uk
http://intra.lshtm.ac.uk/management/committees/ethics/

Appendix 3.3.

Extract of RODAM Questionnaire items used in data analysis

An extract of the RODAM questionnaire items that were used in the research paper are detailed in the table below. Trained interviewers administered the questionnaires to participants, or if preferred, the questionnaire was self-administered completed online or in paper format.

Question	Response options provided
What is your sex?	-Male -Female
How old are you?	_____years old
What is your relationship status?	-Married/registered partnership -Cohabitating (living together) -Unmarried (never married) -Divorced or separated -Widow/widower
Including yourself, how many people are there in your household? This includes children who live with you only some of the time.	_____person(s) If your answer is '1' (you live alone), go to next question
Who do you live with right now? Include children who live with you only some of the time. Please give an answer for every statement. -I live with my partner -I live with a child/children 3 years old or younger -I live with child/children 4 years old or older -I live my parent(s) -I live with my mother-and/or father-in-law -I live in a nursing or care home or other institution -I live with an adult/adults other than those mentioned above	-No -Yes
Do you practice a specific religion right now?	-No -Yes
Which religion is this?	-Roman Catholic -Orthodox Christian -Protestant -Reformed Christian -Pentecostal -Islam
How often have you attended a religious service in the past 6 months (in a church, mosque, synagogue, etc)?	-Once a week or more -Once every 2 weeks -Once a month -Less than once a month -Never
What year did you come to live in the UK?	Year _____
There are many different cultures in the UK. Culture can play a part in your health. RODAM would like to get some insight into this. Could you please indicate to what extent the following statements apply to you? -I feel English -I feel Ghanaian	-totally disagree -disagree -neutral -agree -totally agree
-I have English friends -I have Ghanaian friends	-none -a few -quite a few -many -very many
-I spend my free time with English people -I spend my free time with Ghanaian people	-always -often -sometimes

Question	Response options provided
	-hardly ever -never
-I share most of my beliefs and values with English people -I have a lot in common with English people -I feel comfortable with English people -English people understand me -I feel proud to be part of English culture -I know how things are done in English culture and I feel I can do them easily -I understand English people -In English culture, I know what's expected of a person in various situations - I know a lot about English culture (for example, its history, traditions and customs)	-totally disagree -disagree -neutral -agree -totally agree
-I share most of my beliefs and values with Ghanaian people -I have a lot in common with Ghanaian people -I feel comfortable with Ghanaian people -Ghanaian people understand me -I feel proud to be part of Ghanaian culture -I know how things are done in Ghanaian culture and I feel I can do them easily -I understand Ghanaian people -In Ghanaian culture, I know what's expected of a person in various situations - I know a lot about Ghanaian culture (for example, its history, traditions and customs)	-totally disagree -disagree -neutral -agree -totally agree
Do you smoke at all?	-Yes -No, I've never smoked -No, but I used to smoke
How long did you smoke?	____years and ____months
How long has it been since you quit?	____years and ____months
What did you smoke and how much?	-about __cigarettes from a pack or hand-rolled a day Enter 1 if you smoked less than 1 cigarette a day
How many years have you smoked? Please estimate if not sure	_____years
What do you smoke and how much do you smoke on average?	-about __cigarettes from a pack or hand-rolled a day Enter 1 if you smoked less than 1 cigarette a day
What is the highest level of education you have completed and for which you received a diploma, in Ghana or elsewhere? (Example taken from a questionnaire given to a Ghanaian participant in the UK)	-None (have had no formal education, did not finish education, or finished it in another country) -Primary school -Lower (junior) secondary education -Higher (senior) secondary education -Vocational education e.g. catering, secretarial, administrative training -teacher training -nursing -Technical college (e.g. carpenter, mechanic) -University -Other, namely _____
Employment Which situation most applies to you?	-I have a paid job, and work 32 or more hours a week

Question	Response options provided
	-I have a paid job and work between 20 and 32 hours a week -I have a paid job and work between 12 and 20 hours a week -I have a paid job and work less than 12 hours a week -I am retired - I am unemployed and looking for work (registered at the job centre) - I am unable to work -I get social benefits -I am a full-time homemaker (male or female -I am a student

Appendix 4.1.
HELIUS methods and selected questionnaire items

Description of HELIUS methods

The **HE**althy **LI**fe in an **U**rban **S**etting **(HELIUS)** study was approved by the Institutional Review Board ethics committee of the **A**cademic **M**edical **C**entre **(AMC)** at the University of Amsterdam. All participants gave written informed consent to participating in the study and for the use of their data.

The HELIUS study has recruited representative samples from five of the largest ethnic minority groups living in Amsterdam, namely Turkish, Moroccan, African-Surinamese and South-Asian Surinamese as well as Dutch.

The different ethnic groups were defined through confirmation of their birth-country and that of at least one parent. Therefore, someone of Turkish ethnicity was born in Turkey and at least one parent born in Turkey. A Ghanaian was born in Ghana and at least one parent born in Ghana. Moroccans were born in Morocco and at least one parent born in Morocco. African Surinamese and South-Asian Surinamese were born in Suriname but of African and South-Asian descent respectively and at least one parent born in Suriname of the respective ethnicity.

The **M**unicipality **R**egistry of **A**msterdam **(MRA)** was used as the sampling frame. From this list, participants from the named ethnicities were selected using the above mentioned criteria. Data collectors strived to randomly select a total of 5,000 participants within each ethnic strata, who were within the 18-70 age group.

For each participant recruited from the MRA, up to 3 additional relatives were also invited to participate. Either, the participants' both parents and one sibling or, in the absence of parents, two children over the age of 18 years were invited to participate and the partner. Data collection occurred during 2011 and 2015.

Extract of HELIUS Questionnaire items used in data analysis

A copy of the HELIUS questionnaire items that was used in the research paper are detailed in the table below. Trained interviewers matched by ethnicity and original language of the participant administered the questionnaires to participants. If preferred, the questionnaire was translated to the preferred language either Dutch, English, Turkish, Moroccan, or local Ghanaian language of the participant.

Question	Response options provided
What is your sex?	-Male -Female
How old are you?	_____years old
What is your marital status?	-Married/registered partnership -Cohabitating (living together) -Unmarried (never married) -Divorced or separated -Widow/widower
What is your country of birth?	-The Netherlands -Ghana -Other, namely
What is your mother's country of birth?	-The Netherlands -Suriname -Turkey -Morocco -Ghana -I don't know -Other, namely
What is your father's country of birth?	-The Netherlands -Suriname -Turkey -Morocco -Ghana -I don't know -Other, namely
Do you smoke at all?	-Yes -No, I've never smoked -No, but I used to smoke
How long did you smoke?	____years and ____months
How long has it been since you quit?	____years and ____months
What did you smoke and how much?	-about __cigarettes from a pack or hand-rolled a day Enter 1 if you smoked less than 1 cigarette a day
How many years have you smoked? Please estimate if not sure	_____years
What do you smoke and how much do you smoke on average?	-about __cigarettes from a pack or hand-rolled a day Enter 1 if you smoked less than 1 cigarette a day

Question	Response options provided
What is the highest level of education you have completed? (Example taken from a questionnaire given to a Ghanaian participant)	-None (have had no formal education, did not finish education) -Primary education -Lower, secondary education -Higher secondary education -Vocational education e.g. catering, secretarial, administrative training -teacher training -nursing -Technical college (e.g. carpenter, mechanic) -University -Other, namely _____
Employment Which situation most applies to you?	-I have a paid job, and work 32 or more hours a week -I have a paid job and work between 20 and 32 hours a week -I have a paid job and work between 12 and 20 hours a week -I have a paid job and work less than 12 hours a week -I am retired - I am unemployed and looking for work (registered at the job centre) - I am unable to work (receive benefits such as WAO, AAW, WAZ, WAJONG, WIA) -I get social benefits -I am a full-time homemaker (male or female -I am a student

WAJONG- Disablement Assistance Act for Handicapped Young Persons (disabled before the age of 18); WIA- occupational disability benefit if ill for more than 2 years and 35% or more work disabled since January 1 2006; WAO-partially incapacitated persons; WAZ- self-employed persons' disablement benefits act who were occupationally disabled from August 2005: the self-employed person is more than 255 occupationally disabled, younger than 65 years, part of their income was earned as a self-employed person when they got ill; AAW- general disablement pensions act