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A population based epidemiological study on the prevalence and risk factors of cardiovascular diseases in The Gambia

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Declaration

I, Bai Cham, 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.

List of abbreviations

AHA	American Heart Association
BMI	Body mass index
CRR	Central River Region
CVDs	Cardiovascular diseases
DALYs	Disability-adjusted life years
DBP	Diastolic blood pressure
EAs	Enumeration areas
FAO	Food and Agricultural Organisation
FBG	Fasting blood glucose
GDP	Gross Domestic Product
GPAQ	Global Physical Activity Questionnaire
IHME	Institute for Health Metrics and Evaluation
IMF	International Monetary Fund
KM	Kanifing Municipality
LE	Life Expectancy
LGA	Local government areas
LMICs	Low and middle-income countries
LRR	Lower River Region
METS	Metabolic equivalents
NBR	North Bank Region
NCDs	Non-communicable diseases
NGOs	Non-Governmental Organisations
OOP	Out of pocket payment
PDAs	Personal Digital Assistants
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
SBP	Systolic blood pressure
SDGs	Sustainable Development Goals
SSA	Sub-Saharan Africa

UN	United Nations
UNDP	United Nations Development Program
URR	Upper River Region
WAHO	West African Health Organisation
WCR	West Coast Region
WHO	World Health Organisation
WHOFCTC	WHO Framework Convention on Tobacco Control
WHO PEN	WHO Package of Essential Non-communicable Disease Interventions
WHR	Waist-to-hip ratio

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Abstract

Introduction

Non-communicable diseases (NCDs) account for 70% of global deaths, 80% occurring in low- and middle-income countries. This study aimed to assess the magnitude of NCDs in sub-Saharan Africa (SSA); estimate the prevalence and associated risk factors of hypertension, obesity and smoking in The Gambian adult population (25-64 years); and assess the clustering of NCD risk factors in the country.

Methods

I conducted a systematic review of WHO STEP surveys conducted in SSA and undertook secondary analysis of the nationally representative 2010 WHO STEP cross sectional survey data of The Gambia. Analyses were restricted to non-pregnant participants with three valid blood pressure measurements (n=3573) and valid weight and height measurement (n=3533) for the analyses on hypertension and obesity respectively. The analysis on smoking was restricted to men (n=1766) and that of clustering included participants with valid information on all five NCD risk factors (n=3000). I conducted gender-stratified univariate and multivariate regression analyses to identify the strongest factors associated with each of my outcome variables.

Results

The prevalence of hypertension and CVD risk factors are high in SSA. Almost one-third of adults in The Gambia were hypertensive, two-fifths were overweight/obese and 30% had three or more risk factors. Rural and semi-urban residents and overweight/obese persons had increased odds of hypertension. Urban residence was associated with obesity and was also associated with the clustering of three or more risk factors.

Conclusions

Rural residence was strongly associated with hypertension but urban residence was associated with obesity and clustering of risk factors in The Gambia. Intervention to reduce the burden of hypertension in The Gambia could be further targeted towards persons living in rural areas. Preventive efforts should focus on diet and possible socio-cultural factors that might facilitate the increasing burden of hypertension, obesity and the clustering of risk factors. These unique findings generate new hypotheses that should be explored further.

Impact statement

This research has generated many important findings important for public health research and policy. For instance, I found the burden of hypertension to be significantly higher in rural than urban areas, even after adjusting for potential confounders. However, the prevalence of obesity and the clustering of three or more risk factors in one individual were significantly higher in urban areas. Therefore, the higher prevalence of hypertension in rural areas is not related to obesity and hence these findings generate new hypotheses that require further research. The study has also identified the most significant predictors of hypertension and other CVDs in SSA and The Gambia, which can be used to guide policy-making and intervention strategies. Despite the higher prevalence of hypertension, treatment levels were lower in rural areas. Intervention strategies aimed at reducing the burden of hypertension in The Gambia could be further targeted towards rural areas. There is also a high burden of overweight/obesity in The Gambia and hence preventive strategies should be directed at raising awareness, discouraging harmful beliefs on weight, and promotion of healthy diets and physical activity. From my systematic review, I found that only one study assessed factors associated with awareness/ undiagnosed hypertension in SSA. My study explored factors associated with having high blood pressure being diagnosed and therefore has contributed to filling this gap in the literature.

I have written a paper based on the second objective (Chapter 5) of my thesis, which has been published in the prestigious *International Journal of Epidemiology*. Staff in the Non-Communicable Disease Prevention and Control Unit of the Ministry of Health and Social Welfare of The Gambia are now using my findings as a guide in their routine radio and television programmes as well as their community outreach sensitisation campaigns. The manuscript is also being used as a guide for the development of a new NCD Strategy and Multi-sectoral Action Plan for NCDs in The Gambia. My findings provide up-to-date information on NCDs and their risk factors in The Gambia and have therefore significantly improved the NCD epidemiological surveillance capacity of the country. In addition, I am planning to submit each results chapter as a journal paper after submitting my thesis; I have already presented findings at the Society for Epidemiologic Research (June 2018, USA) and Society for Social Medicine (September 2017 and September 2018, Manchester and Glasgow respectively) international scientific conferences. I participated in the 2018 UCL Faculty of Population Health Research Symposium Poster Competition and took third place out of more than 40 entrants.

In contrast to previous work, my analyses are nationally representative, covering both urban and rural areas. It is also based on health examination data and hence is able to identify cases of undiagnosed disease. As highlighted above, all my key findings have important policy and research implications crucial to national and international development and the reduction of inequalities. The prevention and control of NCDs should therefore be included in the development agenda of The Gambia and of other low- and middle-income countries.

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1. Chapter 1: Introduction

1.1 Geography and political context

The Gambia is the smallest country on mainland Africa and is surrounded by Senegal on three sides (East, South and North), while the West lies on the North Atlantic Ocean (Gambia Bureau of Statistics, 2007). The country is divided into seven local government administrations: two municipalities and five administrative regions (**Figure 1.1**). The two municipalities are Banjul, the capital city, and Kanifing Municipality which are purely urban. The five administrative regions are West Coast Region (WCR), North Bank Region (NBR), Lower River Region (LRR), Central River Region (CRR), and Upper River Region (URR). CRR and LRR are more than 90% rural and are the poorest regions in the country. More than 90% of the population in CRR are below the poverty line compared with Banjul (the capital) where it is only 8% (Gambia Bureau of Statistics, 2009). A mayor heads each of the municipalities and regional governors head the regions. The mayors and governors represent the president in their respective municipalities and regions. More than 50% of the population of The Gambia live in Kanifing Municipality and West Coast Region (Gambia Bureau of Statistics, 2013). The regions are further divided into districts/constituencies headed by chiefs. There are 53 districts in the country. Each district consists of several towns and villages.

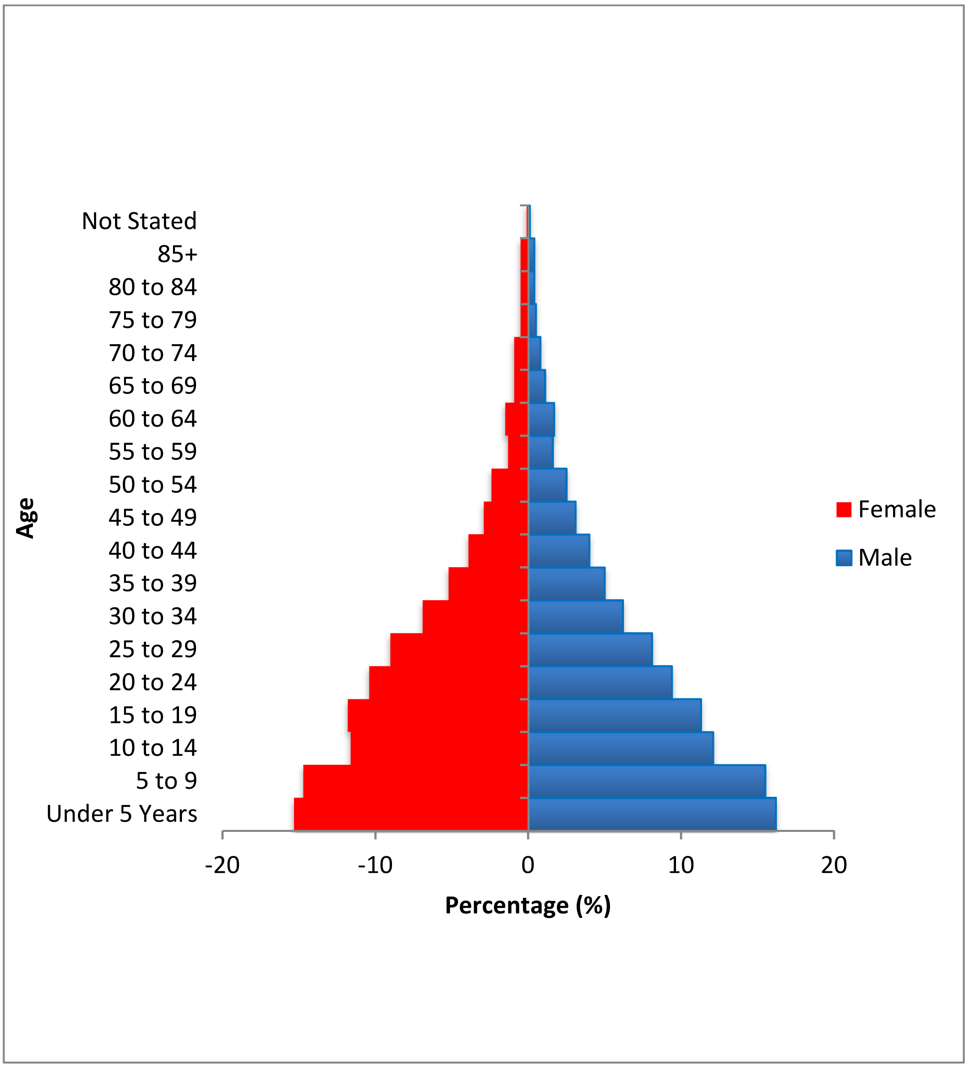
Figure 1.1: Map of The Gambia

Courtesy of Gambia Political World Map: https://www.mapsales.com/graphiogre/country-wall-maps/gambia-political-wall-map.aspx

1.2 Population and Demographic Characteristics

The Gambia has a population of 1.8 million with an annual growth rate of 3%. It has a very high population density (176 persons per km^2) and the average household size is eight (Gambia Bureau of Statistics, 2013). Life expectancy at birth was 62 years for the general population in 2016 (WHO, 2018d). Life expectancy (LE) has been steadily increasing since 1990 (observed data: 1990: 63 years and 58 years for females and males respectively; 2017: 68 years and 64 years for females and males respectively) (GBD 2017 DALYs and HALE Collaborators, 2018). Although no specific LE projections have been published for The Gambia, estimates from the Institute for Health Metrics and Evaluation (IHME) suggest that LE will significantly increase in SSA as a whole (from 52 years in 1980 to 71 years in 2040) (Foreman et al., 2018). However there is much variability in the projected LEs within SSA reflecting impacts of war and political instability. For example, LE is projected to be less than 65 years in four SSA countries (Central African Republic, Lesotho, Somalia, and Zimbabwe) (Foreman et al., 2018). Healthy life expectancy at birth was 56 years among men and 58 years among women in 2017 in The Gambia (GBD 2017 DALYs and HALE Collaborators, 2018, IHME, 2019). The country has a very youthful population as shown in **Figure 1.2**. Data from the 2013 national population census revealed that forty-two percent of the population were under 15 years and 84% were under 40 years. Fewer than 10% of the population were above 50 years and only 4% of the population were above 60 years (Gambia Bureau of Statistics, 2013).

Figure 1.2: Population pyramid of The Gambia (2013 Census)



Source: Gambia Bureau of Statistics 2013 Population Census

1.2.1 Infant and maternal mortality

The infant mortality rate is currently 41/1000 live births; mortality of children under five years is 64/1000 (United Nations Inter-agency Group for Child Mortality Estimation, 2018). Even though these figures are relatively high, the rates are less than the average for sub-Saharan Africa (SSA) as a whole (52/1000 and 76/1000 respectively for infant and under five mortality rates (United Nations Inter-agency Group for Child Mortality Estimation, 2018). There has been a steady decline in infant and under five mortality in The Gambia. Both infant mortality and under-five mortality declined by more than 50% in

The Gambia from 1990 to 2017 (United Nations Inter-agency Group for Child Mortality Estimation, 2018). The maternal mortality rate is currently 706/100,000 live births; 57% of births between 2006 and 2014 were attended by skilled health personnel (WHO, 2018d). With a significant decline in infant and under five mortality and an approximate six-year increase in LE from 1990 to 2017 (IHME, 2019) – reflecting to a large extent the ageing of The Gambian population, the burden of non-communicable diseases (NCDs) is expected to increase in The Gambia. For example, the IHME estimates that the number of NCD deaths in The Gambia will be approximately 9800, in 2040; more than double the number of NCD deaths in 2016 (4190) (Foreman et al., 2018).

1.2.2 Religion and ethnicity

The Gambia is a predominantly Muslim country with 95% of the population being Muslims. Four percent are Christians and a very small proportion follow traditional and other religions (Gambia Bureau of Statistics, 2013). There are eight main officially recognised ethnic groups, namely*:* Mandinka, Wollof, Fula, Jola, Serer, Sarahule, Manjago, and Aku. Each of these ethnic groups has their distinct socio-cultural and traditional norms.

The Mandinkas are the largest ethnic group in The Gambia and constitute 34% of the population (Gambia Bureau of Statistics, 2013). They are spread throughout the country and many other places in West Africa. They are mostly engaged in business and in farming (Colley, 2016).

The Fulas are the second largest ethnic group and constitute 24% of the population. They are traditionally nomadic pastoralists and mostly live in small hamlets mainly in the central and eastern parts of the country. Nowadays they are mostly involved in farming, business and raising cattle, sheep and goats (Colley, 2016).

The Wollofs are believed to originate from Mauritania and migrated to the Senegambia region because of drought. They are the third largest ethnic group, constituting 15% of the population, but their language is the most widely spoken. Their culture and traditions have a remarkable influence on other ethnic groups especially in Banjul, Kanifing Municipality and the North Bank Region. They are very prominent in business, large scale farming and the civil service (Colley, 2016, Roots, 2016).

The Jolas are the fourth largest ethnic group, constituting 11% of the population (Gambia Bureau of Statistics, 2013). Although many have embraced Islam or Christianity, they have retained most of their traditional beliefs and practices, unlike other tribes. They are mostly engaged in rice cultivation and the production of palm oil and palm wine (Colley, 2016).

The Akus, Serers, Sarahules*,* and Manjagoes are minority ethnic groups in The Gambia. The Akus (Creole) are descendants of European traders and their African wives as well as liberated slaves from Sierra Leone. Most of them are Christians with European surnames (Colley, 2016). They were among the few people to receive formal education and therefore played a very influential role during the colonial era and continue to the present day to figure prominently in the civil service.

The Manjagoes are believed to have arrived in The Gambia as seasonal migrants from Guinea Bissau and some eventually settled down. They are mostly Christians or believers of traditional religion. Their main occupations are palm wine tapping, producing palm oil, cashew farming and production of cashew wine and the rearing of pigs (Colley, 2016).

The Serers are believed to be the oldest ethnic group in The Senegambia region. Fishing is their main occupation and they are mostly found along the mouth of the River Gambia. They are also very prominent in wrestling, which is the main traditional sport in the Senegambia region (Colley, 2016).

The Sarahules have a very long history as rulers and merchants of the Ghana Empire but those living in The Gambia arrived during the 19th century as refugees. Generally their literacy rate is very low but they are very famous for their trading activities in gold and in diamonds (Colley, 2016, Roots, 2016).

Each of the ethnic groups has their unique cultural beliefs and practices. Most of them especially the Jolas, Wollofs and Manjagoes view overweight as a sign of beauty among women and prosperity among men. Married women with a heavy weight are regarded as being well taken care of by their husbands. Although I have not seen it in The Gambia, a special beauty pageant locally known as "*Miss Jongoma*" is usually conducted in neighbouring Senegal where Wollofs form the majority. One of the criteria used in this beauty pageant is to have a "healthy weight" (i.e. overweight) to be eligible to participate. The Gambia and Senegal have the same ethnic groups and have very similar cultural practices. In many communities in The Gambia and Senegal, larger body size is viewed as being attractive. In many communities, overweight and obesity is therefore not seen as a risk factor for cardiovascular disease (CVD), for example, but rather as a sign of good health.

1.3 Health System: Organization and Administration

The Ministry of Health and Social Welfare is the main government agency responsible for health care delivery in The Gambia. Health care delivery comes both in the form of preventive and curative services. The health sector is managed at two levels, the central level and the regional levels (The Ministry of Health and Social Welfare, 2012). The Ministry has seven directorates at the central level, namely: Health Services, Planning and Information, Social Welfare, Health Promotion, Human resources, Pharmaceutical Services, National Public Health Laboratory Services, and a newly established Directorate of Public Health Research.

For effective management of public health services, the country is divided into seven health regions each with a management team. The functions of the directorates are decentralized at these regions and the Regional Health Management Teams are answerable to the directorates at the central level (The Ministry of Health and Social Welfare, 2012). There is a small distinction between the local government regions highlighted in (1.1) above and the health administrative regions. Banjul and the Kanifing Municipality are combined, forming the Western Health Region I; the whole of West Coast Region, the region with the highest population, is Western Health Region II. Over 60% of the population of The Gambia live in these two health regions. The North Bank Region is divided into two health regions, North Bank Region East and North Bank Region West. The other three regions (LRR, CRR and URR) each has its own health administrative region.

The central government is the main provider of health services in the country. Health care services are funded by the government through its annual budgetary allocation to the health sector. Local and international donor partners and Non-Governmental Organisations (NGOs) also provide support to the health sector (The Ministry of Health and Social Welfare, 2012).

1.3.1 Primary Health Care

The Gambia adopted the Primary Health Care strategy in the delivery of health care services in 1978 after the Alma Ata Conference. Health services consist of three levels namely: primary, secondary and tertiary (The Ministry of Health and Social Welfare, 2012). The primary level is the first point of contact with the health system at a community level. It provides mainly preventive care and treatment of minor ailments. A network of village health posts are linked to a key village staffed with a community health nurse. Community health nurses in most cases are mobile and responsible for the health services in their circuit, which usually consists of a key village where they reside and a number of other villages. They also supervise community health workers, i.e. traditional birth attendants and village health workers in their circuit.

The secondary level comprises basic health facilities such as clinics, dispensaries, minor and major health centres. They are staffed with professional nurses and midwives, and other health professionals. In addition to these health professionals, the major health centres have at least one medical doctor. The services provided are preventive, curative and inpatient services. In this category, the major health centres are the highest level as they are envisaged to provide more advanced care and services. The clinics, dispensaries and minor health centres nearby refer cases that cannot be managed at their level to the major health centres.

The tertiary level comprises the hospitals, which provide all services including specialist care. They also take referrals from major and minor health centres. Each public hospital has a management board with a semi-autonomous status in managing the affairs of the hospital. Geographical access to health care has rapidly increased over the years in line with the national health policy, which recommends that all communities should be within 5km of the nearest health facility. This increased geographical access has reduced the distance to the nearest basic health facility. However, the required functions of these facilities are limited due to lack of trained, skilled and motivated personnel (The Ministry of Health and Social Welfare, 2012).

Like many other developing countries, the public health sector is the main provider of health services for the majority of the population. This sector comprises a teaching hospital which is also the main referral hospital; five general hospitals; three district hospitals; three major health centres; 45 minor health centres; and 492 village health posts. There are also a number of community health clinics which are usually built and managed by community members with support from government in terms of clinical staff and medications.

The public health sector is complemented by private health facilities, which comprise both for-profit and not-for-profit (usually NGO clinics), faith or community based clinics. These are few and smaller in bed capacity. In addition, there are a number of private for-profit pharmacies and medicines outlets that deliver health services. The majority of the private health facilities including private pharmacies, laboratory and drug outlets are located in Health Regions I and II, making choice in accessing health from the private sector for persons living in the other regions and in rural Gambia very limited. The healthcare delivery of the private sector is regulated and monitored by the Directorate of Health Services (The Ministry of Health and Social Welfare, 2012).

1.3.2 Health care financing

There is no national/social health insurance system. However, there are a number of private insurance companies that offer health insurance, mostly to employees of corporate institutions. Services for pregnant women and for children under five years are free of charge, including immunisation.

1.3.3 Immunisation services

The Gambia has one of the best Expanded Programme on Immunisation (EPI) in SSA. The country continues to maintain high immunization rates, with more than 90% of children being immunised for most of the vaccine preventable diseases (WHO, 2015). The Gambia was declared polio free in 2004 (Ministry of Health and Social Welfare, 2011b). The Pneumococcal Conjugate vaccine was introduced in the routine EPI services in 2009 and The Gambia was the second country in Africa to introduce this vaccine, the first being South Africa (Madhi et al., 2012). This has probably been a significant contributor to the reduction of infant and child mortality rates over recent years.

1.3.4 Traditional medicine

Although not regulated, traditional medicine is a very important component of the healthcare delivery system in The Gambia. There are a number of indigenous and foreign traditional medical practitioners scattered throughout the country (The Ministry of Health and Social Welfare, 2012). Although there is a national association of traditional healers and a Traditional Medicine Unit at The Ministry of Health and Social Welfare, only a small proportion of traditional healers belong to the national association and there is no system to register and licence traditional medicine practitioners (The Ministry of Health and Social Welfare, 2012)

1.4 Economy

The Gambia is a low income country with per capita Gross Domestic Product (GDP) of $473.00 and a very low Human Development Index, ranked 174 out of 189 countries in the 2018 United Nations Development Program (UNDP) Human Development Report (UNDP, 2018). Half (49%) of the total population lives below the poverty line; the proportion is much higher in rural areas compared with urban areas (The World Bank, 2018). Poverty levels range from 63% to 94% in the more rural regions compared with 8% in the capital (Gambia Bureau of Statistics, 2009). Extreme poverty decreased from 11% to 8% in urban areas between 2010 to 2015 but increased from 32% to 36% in rural areas during the same period (The World Bank, 2018). Agriculture and tourism form the backbone of the economy. Over 60% of the population are farmers: agriculture contributes 20% of the country's GDP (IMF, 2011).

1.5 Education

The formal education system in The Gambia consists of three years of pre-school education, nine years of uninterrupted compulsory basic education (starting at age six or seven) , three years of secondary education and four years of tertiary and higher education. There are also a number of technical and vocational training institutions (Ministry of Basic and Secondary Education, 2014a). The literacy rate of adults 15 years and above in The Gambia is 56% (64% among men and 48% among women) (UNESCO Institute for Statistics, 2015). There is only one public university, which was established in

1999. The 2014-2015 National Education Policy called for free, compulsory education from grades 1-9 for all children, with additional support for girls up to grade 12 in all government and grant-aided schools (Ministry of Basic and Secondary Education, 2014b). There is also free basic and secondary education for girls in all public schools. This has attracted more students into basic education and has increased the enrolment rate from 76% in 1999 to 97% in 2014 (Ministry of Basic and Secondary Education, 2014a).

1.6 Burden of Non-communicable diseases in The Gambia

The burden of NCDs in The Gambia can be broadly classified into diseases, disability, and risk factors. First, in relation to communicable diseases, recent estimates by IHME have shown that mortality and disability-adjusted life years (DALYS) associated with communicable/infectious diseases such as malaria and diarrhoeal diseases has significantly decreased from 2007 to 2017 (IHME, 2019). Secondly, in relation to NCDs, according to the latest WHO NCDs country profile of The Gambia, NCDs account for 34% of all deaths in the country (WHO, 2018c). Risk of premature mortality from NCDS among adults 30-70 years is 20%. Therefore, The Gambia is undergoing the “epidemiological transition” i.e. the shift in the leading causes of morbidity and mortality from infectious to non-communicable diseases (NCDs). Ischaemic heart disease is now the leading cause of mortality in The Gambia and stroke is fourth in the list (IHME, 2019). The future burden of NCDs will hinge to some extent on the progress countries make in reducing the key risk factors for NCDs such as hypertension, smoking, obesity, poor diet, and physical inactivity. In terms of the present burden of these risk factors, according to the recent NCD country profile based on hospital data and projections from past surveys, 22% of the adult population aged 18 years and above in The Gambia were hypertensive in 2015 (WHO, 2018c). The prevalence of physical inactivity, obesity and current smoking among adults aged 18 years and above in 2016 were 19%, 9% and 15% respectively based on projections from past surveys (WHO, 2018c). As the burden of NCDs in The Gambia represents a key rationale for my Thesis, I give fuller details on the burden of NCDs in The Gambia in the following chapter.

2. Chapter 2: Rationale and aims of thesis

There is extensive literature on the "epidemiological transition", which describes the changes in the patterns of morbidity and mortality over the past centuries (Adogu et al., 2015, Boutayeb and Boutayeb, 2005, Santosa and Byass, 2016). A very remarkable feature of this transition is the shift in the leading causes of morbidity and mortality from infectious to non-communicable diseases (NCDs). There are also variations in this transition in different places and at different times. This transition is very much pronounced in low and middle income countries (LMICs), especially in sub-Saharan Africa (SSA) where there is a double burden of communicable and non-communicable diseases (Adogu et al., 2015, Santosa and Byass, 2016). The double burden of disease can increase poverty, poses a barrier to poverty alleviation and can also hinder the attainment of the United Nations Sustainable Development Goals (SDGs) particularly goal 3.4, which calls for a reduction in premature mortality due to NCDs by one-third by 2030 (Clark, 2013, Lal et al., 2013, WHO, 2017a).

Globally, there is an increasing change in the disease profile from infectious diseases and nutritional deficiencies to NCDs, including cardiovascular diseases (CVDs), but the burden is higher in SSA (Celermajer et al., 2012, Dalal et al., 2011, WHO, 2014b, Rosengren et al., 2009, Mensah, 2013, Kayima et al., 2013, Ataklte et al., 2015). NCDs are on the increase in many low-income countries including The Gambia (Celermajer et al., 2012, Dalal et al., 2011, WHO, 2014b, van der Sande et al., 1997, van der Sande et al., 2000, van der Sande et al., 2001c, Awad et al., 2014). They are estimated to account for 34% of total deaths in The Gambia according to the WHO 2018 NCD country profile.

The WHO 2014 and 2018 NCD country profiles, and other reports have provided useful insights on the prevalence of NCDs in The Gambia (WHO, 2014b, Omeleke, 2013, van der Sande et al., 1997, WHO, 2018c). A few studies conducted during the last two decades have provided some indication on the burden of NCDs in The Gambia but morbidities, mortality and risk factors have not been adequately established and most of the previous studies were not based on nationally representative samples. For example, a nationwide study on hypertension conducted in 1996 reported a prevalence of 10% among adults aged above 15 years (using ≥160/95mmHg as the benchmark for classifying persons as hypertensive) (van der Sande et al., 1997). However, the prevalence was 24% when a lower benchmark of ≥140/90mmHg was used. This and similar studies also found that obesity, ageing, gender, physical inactivity and genetics were risk factors associated with CVDs in The Gambia (van der Sande et al., 1997, van der Sande et al., 2000, van der Sande et al., 2001b). As mentioned in chapter 1, the 2018 NCD country profile revealed that 22% of the adult population 18 years and above were hypertensive in 2015 (WHO, 2018c). Preliminary findings of the unpublished draft of the WHO STEPwise survey report in 2010 revealed that 23% of The Gambian adult population aged 25-64 years had hypertension and that 91% of those classed as having hypertension were not currently on treatment (Ministry of Health and Social Welfare, 2011a). The study also revealed that only 7% consumed five or more portions of fruits and vegetables a day. The WHO recommends at least 600 metabolic equivalent (MET) minutes of total physical activity (irrespective of domains) per week for health benefits. This would be achieved, for example, by 150 minutes/week of moderate activity (e.g. brisk walking) or 75 minutes/week of vigorous activity (e.g. running), or a pro rata combination (WHO, 2012a). The same study (in The Gambia) revealed that 23% of the adult population achieved this.

There is very limited up-to-date information on the burden of diagnosed and undiagnosed hypertension and the associated risk factors for being hypertensive in the country. Therefore, exploring the prevalence of hypertension, other CVD risk factors such as obesity and smoking, and exploring the clustering of risk-factors (e.g. being both hypertensive and obese) and the factors associated with risk factor clustering is crucial. Having this information would serve as an important benchmark to inform policy makers in the process of developing effective strategies toward the achievement of reducing NCD related morbidity and mortality. It will also contribute to addressing the gaps in the literature on the burden of NCDs in SSA especially on the issue of undiagnosed hypertension and the factors associated with it.

Previous studies on hypertension in The Gambia had numerous limitations and few were population-based health examination surveys. One survey was conducted among urban and rural residents in the capital Banjul and North Bank Region East respectively between 1996 and 1997 (van der Sande et al., 2000). A study using data from urban areas in The Gambia in 2000 and data collected in 2001, 2003 and 2009 in Sierra Leone reported a combined hypertension prevalence of 45% in The Gambia and Sierra Leone (Awad et al., 2014). The prevalence of hypertension was 32% among adults 20 years and above in The Gambia in 2000; and 47% in Sierra Leone (hypertension was defined as SBP ≥140 mmHg, or DBP ≥90 mmHg and/treatment). To my knowledge, there was only one country-wide population based survey on hypertension conducted in The Gambia apart from the WHO STEPwise survey conducted in 2010 (van der Sande et al., 1997). This was part of a nationwide survey on blindness and low vision in 1996. Hypertension was based on blood pressure measurements and was defined as blood pressure ≥160/95mmHg. More than half of the participants were surveyed during the holy month of Ramadan. This can have an

influence on both the anthropometric and blood pressure measurements. None of these studies assessed the proportion of hypertension that was undiagnosed, nor the factors associated with people with high blood pressure being diagnosed. The rapid socio-demographic and lifestyle changes over the years and the change in the definition of hypertension (i.e. the lowering of the SBP/DBP thresholds) renders application/generalisation of findings from the previously mentioned studies difficult.
The philosophy of the current National Health Policy of The Gambia 2012-2020 is "*Health is Wealth*", but the attention given to NCDs is very limited compared with other diseases such as malaria, tuberculosis and HIV/AIDs (The Ministry of Health and Social Welfare, 2012). To give NCDs the attention it deserves, policy makers need clearer evidence of the magnitude of the burden.

A number of studies have been conducted in SSA using the WHO STEPwise approach to NCD surveillance (see Chapter 3). However, few of the studies assessed the factors associated with hypertension and the clustering of CVD risk factors and therefore the findings of the review outlined in Chapter 3 may not be generalizable to all countries including The Gambia. The multi-cultural and socioeconomic differences in SSA also make generalizability of these studies to all settings in SSA questionable. Information on the major risk factors for CVD such as overall prevalence and distribution among population subgroups is scarce in The Gambia, due to the lack of data. Moreover, whether the major risk factors for CVD cluster within persons is an issue that has not been explored before in The Gambia. There is also paucity of data on the clustering of CVD risk factors in SSA as a whole.

2.1 Research Hypotheses

The hypotheses that my PhD research will investigate are as follows:

1. The prevalence of hypertension and cardiovascular disease risk factors in The Gambia are high and vary by social and demographic factors, but levels of awareness, treatment and control of hypertension are low.

2. Other risk factors associated with CVD (obesity, smoking, low fruit and vegetable intake and clustering of these risk factors) vary by similar social and demographic factors.

2.2 Aim

The aim is to examine CVD risk factors in the general adult population in The Gambia, with a particular focus on hypertension and obesity, using The Gambia 2010 WHO STEPwise survey data.

I first conducted a systematic literature review to describe the prevalence and factors associated with CVD risk factors and hypertension in SSA. The results of this systematic literature review enabled me to determine the content of my PhD. It allowed me to focus on the prevalence of diagnosed and undiagnosed hypertension as well as overweight and obesity, smoking and factors associated with them in The Gambia where there is a major gap in the literature. It also allowed me to compare findings of my PhD research with findings from similar studies in other countries in SSA.

2.3 Objectives

1. To conduct a systematic literature review to describe and summarize the prevalence and factors associated with hypertension and CVD risk factors among adults in SSA (Chapter 3).
2. To estimate the prevalence and distribution of hypertension and the proportion that is undiagnosed among the adult population (25-64years) in The Gambia and investigate the most prominent modifiable and non-modifiable factors associated with measured, total and undiagnosed hypertension in The Gambia (Chapter 5).
3. To estimate the prevalence of overweight and obesity and its associated factors in The Gambian adult population (Chapter 6).
4. To estimate the prevalence and factors associated with current smoking among men (Chapter 7). (Women were excluded because of the low prevalence of smoking: only 1% of women were current smokers).
5. To examine the presence of multiple risk factors (clustering) by age, gender and region (Chapter 8).The five risk factors covered were smoking, physical inactivity, low fruit and vegetable intake, hypertension and overweight or obesity.

2.4 Structure of the thesis

The following chapters of this thesis are structured according to my objectives. Chapter 3 is an in-depth systematic literature review conducted on WHO STEP surveys in SSA, and addresses objective one of my thesis. The WHO STEPwise approach is briefly described in Chapter 3 (section 3.1) and a detailed description of the STEPwise approach and the data used in my analysis is described in Chapter 4.

Chapter 4 is the methods section that explains the source of the data, the research setting and design and my approach to data management and analysis. Chapters five, six, seven and eight address objectives two (hypertension), three (obesity), four (smoking among men) and five (clustering of CVD risk factors) respectively. As explained above, I used the 2010 WHO STEP survey data of The Gambia to address objectives 2-5. Chapter 9 is a summary and discussion of the key findings from all the aforementioned objectives. It also discusses the research and policy implications of my findings (a brief summary of these can also be found in the Impact statement at the beginning of the thesis).

Although there are numerous cardiovascular conditions, my thesis especially focuses on hypertension and its associated risk factors. There are a number of reasons for this.
First, hypertension is a global health challenge: it is the leading risk factor for ischaemic heart disease and stroke, which are the first and fourth leading causes of death in The Gambia. Second, information on hypertension in The Gambia is not up-to-date: policy-makers require more updated information. Third, hypertension is also associated with other risk factors for CVD such as obesity, smoking, physical inactivity, and poor diet. Knowledge on how these risk factors cluster together is currently not available in The Gambia.

Fourth, in terms of data availability, the WHO STEPwise approach to NCDs surveillance only collects information on hypertension, diabetes and their risk factors. It does not collect any information on other CVDs including stroke and chronic heart disease. There is a different surveillance approach to stroke known as “the WHO STEPwise approach to stroke surveillance (WHO-stroke)”(WHO, 2005a). However, this has never been conducted in The Gambia nor most of the countries in SSA. Fifth, the data from objective measurements of blood pressure collected by the WHO survey allows an investigation of diagnosed and undiagnosed hypertension.

Undiagnosed or total diabetes could not be examined due to lack of data on blood glucose as the survey in The Gambia was limited to WHO STEPS one and two (biochemical analysis of blood glucose and cholesterol, as outlined in WHO STEP three was not done in The Gambia because of its expensive costs and technical challenges). The number of participants with self-reported diabetes was very small (n=329) and so further analysis except the estimation of prevalence was not possible. I could not examine diabetes mainly because of the lack of objective blood glucose data (and hence unable to identify those with undiagnosed disease).

Alcohol consumption is a known risk factor of CVD. However, I excluded alcohol from the list of risk factors covered in my analysis because of the low prevalence: 98% of the survey participants reported being lifetime abstainers of alcohol.

3. Chapter 3: Systematic Literature Review

3.1 Introduction

As highlighted in chapter 2, NCDs, including CVDs, are becoming an increasing global health burden (WHO, 2014a, Mendis, 2014, Bauer et al., 2014, Celermajer et al., 2012). According to the WHO, CVDs are the leading cause of death globally; more than three-quarters of deaths related to CVDs occur in LMICs (WHO, 2016a). NCDs can pose a barrier to poverty alleviation and to sustainable development (WHO, 2014a, Clark, 2013, Lal et al., 2013). They can therefore hinder the attainment of the United Nations SDGs.

A major risk factor for CVDs (e.g. heart attack, angina and stroke) and other related diseases is hypertension. According to the WHO, the worldwide prevalence of hypertension among adults 25 years and above was 40% in 2008 and it was highest in the African region (46%) (WHO, 2016c). Hypertension-related complications account for more than 9 million deaths globally every year and the prevalence is highest in Africa (WHO, 2016b). Hypertension contributes to the increasing burden of CVDs in SSA (Kengne et al., 2012). What is of even greater public health concern is that a large proportion of persons with hypertension in Africa are undiagnosed (Ataklte et al., 2015, Adeloye and Basquill, 2014). Amongst hypertensives, levels of treatment and control are also very low in Africa (Ataklte et al., 2015). Antihypertensive treatment effectively reduces cardiovascular and total mortality (Law et al., 2009), hence adequate detection, treatment and control of hypertension are key in improving cardiovascular health.

Despite the high burden of NCDs in SSA, there is limited research and most of the studies are limited in that they are based on health service data or health interview surveys. In contrast, population based health examination surveys have the potential to identify the prevalence of NCDs and their risk factors in the community and, importantly, are able to identify persons with undiagnosed disease. In 2000, the WHO initiated the STEPwise approach to NCD surveillance and countries started implementing this approach in 2002 (WHO, 2003a, WHO, 2009, Riley et al., 2016, Armstrong and Bonita, 2003). The African region however has the least data on NCDs among all WHO regions (WHO, 2009). It also has the weakest capacity for NCD epidemiological surveillance. The WHO Global Action Plan for the prevention and control of NCDs 2013-2020 outlines global targets (WHO, 2013a). Among these targets are a 25% reduction in the risk of premature mortality from CVD, cancer, diabetes, and chronic respiratory disease; a 25% reduction in the prevalence of raised blood pressure by 2025 (25 x 25 strategy); a 30% reduction in salt/sodium intake; and drug therapy and counselling to a minimum of 50% of eligible patients (WHO, 2013a). A recent review by Nyaaba et al (2017) indicated that the African region is off track in achieving these set targets. The lowest achievement recorded to date is on levels of treatment (Nyaaba et al., 2017).

The STEPwise approach (STEPS) is a recommended framework for the surveillance of NCDs in LMICs with the goal to identify and tackle risk factors and ensure data comparability over time and between countries (WHO, 2003a, Armstrong and Bonita, 2003). It is a standard health examination approach that could be implemented even in settings with limited resources. The STEPwise approach advocates for small amounts of good quality data, rather than large amounts of poor quality data to ensure sustainability (WHO, 2003a). Based on local needs and resources, the approach can therefore allow the development of complex and comprehensive surveillance systems for NCDs (WHO, 2003a). It enables countries to monitor and evaluate policies and also build institutional and human capacity for the surveillance of NCDs (Armstrong and Bonita, 2003, WHO, 2009). STEPS applies population-based cross-sectional household surveys; multi-stage cluster sampling is used by most countries (WHO, 2009). The STEPwise approach to NCDs involves data collection in three STEPS: face to face interview; physical measurements; and biochemical measurements in STEPS one, two, and three respectively (Chapter 4, section 4.1).

3.2 Aims and objectives of the systematic review

A number of systematic reviews and meta-analyses have been conducted on the prevalence of hypertension, diabetes and some cardiovascular risk factors in SSA (Addo et al., 2007, Ataklte et al., 2015, Hilawe et al., 2013, Twagirumukiza et al., 2011, Townsend et al., 2006, Dalal et al., 2011, Adeloye and Basquill, 2014). Even though three of these studies were very comprehensive (Addo et al., 2007, Ataklte et al., 2015, Adeloye and Basquill, 2014), to my knowledge, none have been based exclusively on population based studies that applied the WHO STEPwise approach. To ensure comparability of data between and within countries in SSA, it is crucial to review studies that applied very similar methods of sampling, data collection and analysis. The WHO STEPS is a standard approach that can ensure the comparability of data between different countries, regions and time scales. This is the data source I will be using in my thesis, and the comparability of different studies via the STEPS approach will aid the evaluation of my findings.

3.2.1 Aim

The aim of this systematic literature review is to describe the prevalence of hypertension, diabetes and CVD risk factors in SSA. It will also try to determine the factors associated with hypertension, diabetes and CVD risk factors in SSA.

3.2.2 Specific objectives

1. To describe and summarise the estimates of the prevalence of and factors associated with hypertension among adults in SSA.
2. To describe and summarise the estimates of the proportion of hypertensive patients that are undiagnosed in SSA.
3. To investigate the most prominent risk factors associated with hypertension in SSA.
4. To assess the prevalence of diabetes and the factors associated with it in SSA.
5. To determine the most common risk factors for CVDs and the factors associated with these risk factors in SSA.
6. To determine the content of my PhD by identifying what is already known and what the gaps in knowledge are regarding the prevalence of diagnosed and undiagnosed hypertension as well as overweight and obesity, smoking and factors associated with them in The Gambia.
7. To help identify the explanatory variables to examine in my quantitative analysis of data from the WHO STEPS survey from The Gambia.

3.3 Literature search method

I conducted a comprehensive, systematic literature search on PubMed (Medline), Web of Science and Google Scholar from May 2016 to June 2016 after slightly modifying the initial topic and objectives of the systematic review. I conducted a second search and updated the systematic review in August 2018. I also used the WHO website to search for fact sheets, reports and publications related to STEP surveys on NCDs. The systematic review is limited to health examination surveys/studies that used the WHO STEPwise approach conducted in SSA to make it more focused and ensure the comparability of the information collected.

The sub-topics of this review, that include hypertension, diabetes, overweight and obesity, physical activity, tobacco use, alcohol consumption, fruit and vegetable intake and cholesterol, were searched separately and then combined in PubMed (Appendix III Table S1). Key words related to each of these sub topics were used in the search and combined with "STEPS" OR "STEPwise" OR "WHO STEPS" OR "STEP". I further combined these search terms with "Africa" OR "sub-Saharan Africa" OR "Africa South of the Sahara" (more details in Table S1). I also used a similar search strategy in the Web of Science and Google Scholar databases. In addition, I manually scanned the reference lists of reviewed articles for other relevant articles.

3.3.1 Inclusion and exclusion criteria for the systematic review

Only population-based cross-sectional human studies conducted in SSA among adolescents and/or adults (13 years and above) from 2002 to August 2018 using the WHO STEPwise survey methodology were included. This criterion was used because there was no WHO STEP survey before 2002. My initial search revealed that some health examination surveys were conducted earlier but I focused on those using the WHO STEP approach only to ensure comparability. I excluded all studies that did not meet this criterion. In addition, studies of a low sample size (fewer than 300 participants) and/or that did not collect information on at least STEPS one and two were excluded. The search was limited to articles published in English. However, factsheets reported in either English or French were reviewed as most countries adopt a unique reporting format recommended in the WHO STEP manual (WHO, 2005b).

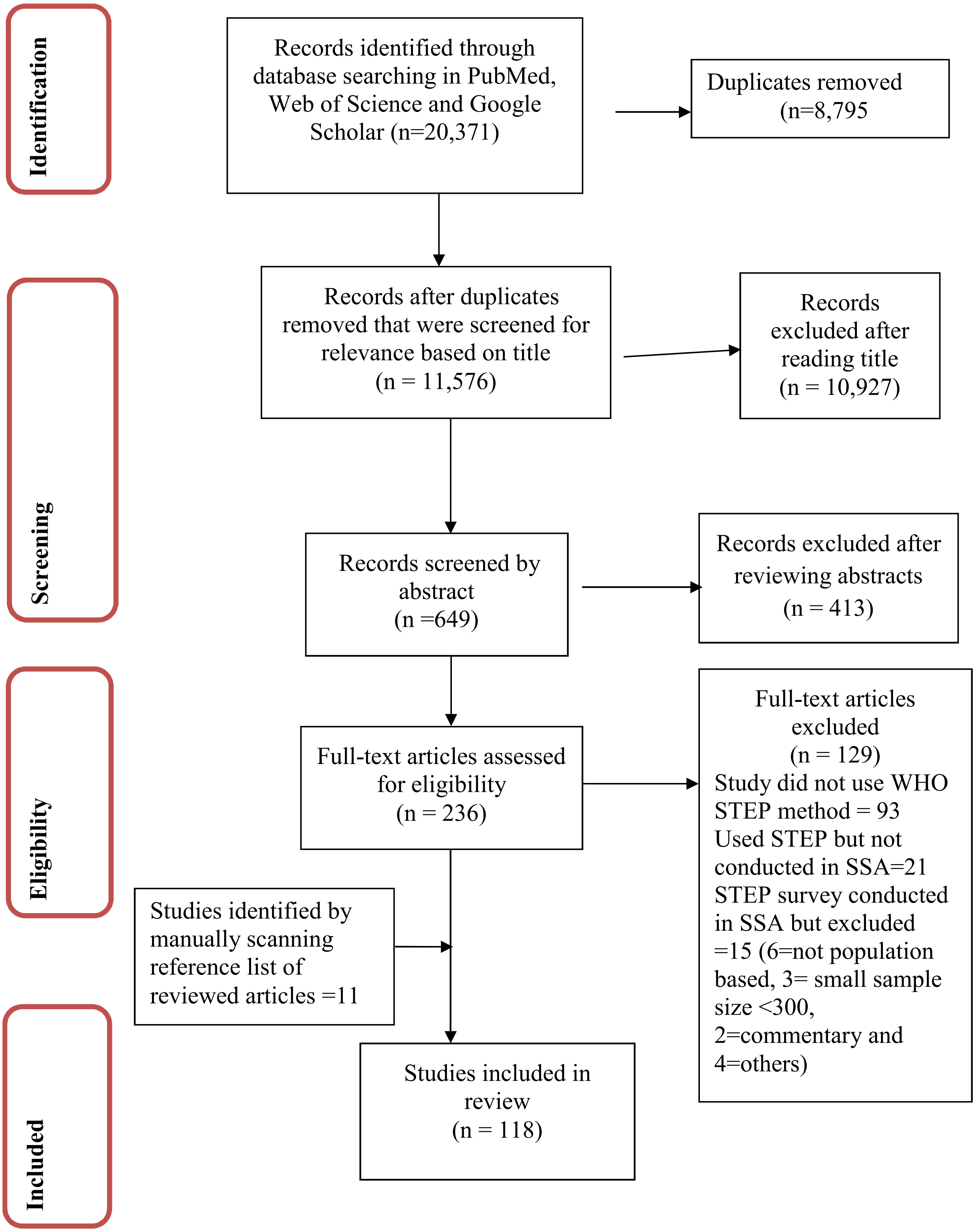
3.3.2 Extraction of information from reviewed articles

I summarised all the articles that met my inclusion criteria and the WHO fact sheets and reports using Microsoft Excel. I used the Excel sheet to extract information from the articles reviewed. The information extracted included the following: country, survey year, publication date, coverage (i.e. national or sub national), sampling method, sample size and analytical sample, response rate, gender distribution, age range, mean age, proportion from rural and urban areas, topic and objectives, blood pressure measurements, and diagnosis of hypertension. I extracted information on almost all the variables captured in the WHO STEP survey questionnaire. This included information on each of the risk factors as well as prevalence of diagnosed and undiagnosed disease for diabetes and for hypertension.

3.4 Results of literature search

I used the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline to summarise the articles found (Liberati et al., 2009). The search yielded 20,371 records (**Figure 3.1**). This included 10,761 from PubMed, 4472 from Web of Science and 5138 from Google Scholar. I further screened the 11,576 articles retained after the removal of duplicates. These records were screened for relevance based on title and as a result, 10,927 irrelevant records were excluded. The remaining records (n=649) were further screened by reading the abstracts, which resulted in the exclusion of another 413 ineligible records.

Figure 3.1: PRISMA Flowchart of Literature Search



Overall, 236 full text articles were assessed for eligibility, which resulted in the further exclusion of 129 articles. These included 93 studies that did not use the WHO STEP methodology; 21 studies where the STEP approach was used but not conducted in SSA; and 15 WHO STEP studies conducted in SSA but that did not meet the eligibility criteria described above.

Overall, 107 articles met my inclusion criteria. I included these together with 11 other articles identified from the reference list of reviewed articles (n=118). In addition to these, I also reviewed 48 survey reports and fact sheets on STEPS accessed from the WHO website (WHO, 2016d). Supplementary documents of included articles that were available online were also reviewed.

3.5 Summary of studies included and characteristics

3.5.1 Extent and focus of included studies

All the studies included were population-based and used the WHO STEPwise approach in which at least both STEPS one and two were done. Two thirds (68%) of the 118 articles were based on sub-national surveys. The largest sub-national survey was conducted in four urban districts in Cameroon with a sample of 10,011 (Kamadjeu et al., 2006b, Kamadjeu et al., 2006a). The focus of 52 of the studies was hypertension and 21 focused on impaired fasting blood glucose or diabetes. The other main topics covered include NCDs/CVDs in general, overweight and obesity, tobacco use and alcohol intake. The characteristics of the reviewed articles are in Table 3.1.

3.5.2 Sampling and response rates

Most of the studies reviewed employed complex multi-stage sampling but very few applied the WHO STEP principle of selecting only one eligible subject per household using the Kish Method (WHO, 2005b). In some of the studies, all the eligible subjects within the selected households who were available were invited. In a study in Southern Sudan, all eligible adults in the selected villages were invited to participate (Bushara et al., 2015). Some studies in Ethiopia were based on communities, households and individuals that were already participating in an ongoing Demographic Surveillance System (Tesfaye et al., 2007, Ng et al., 2006, Muluneh et al., 2012). A study in South Africa was based on the Dikgale Health and Demographic Surveillance Site, Limpopo Province (Ntuli et al., 2015). Villages already on the surveillance site were used as clusters. Two studies in Kenya were based on the Nairobi Health and Demography Surveillance System (Oti et al., 2013, van de Vijver et al., 2013b). Two of the studies in Uganda were based on the MRC/Uganda Virus Research Institute General population cohort (Murphy et al., 2013, Asiki et al., 2015). In one of the studies in Malawi, participants were drawn from the Malawi Epidemiology and Intervention Research Unit (MEIRU) ongoing NCD study (Mudie et al., 2018). In a nationwide study in Cameroon, participants who took part in the nationally representative Cameroon Burden of Diabetes (CAMBoD) 2006 survey and were not diagnosed with diabetes were enrolled (Mbanya et al., 2015). In one of the studies in Nigeria, three eligible participants were selected from each household that was part of the sample (Oladapo et al., 2010). In another study in South Eastern Nigeria, two eligible adults, one of each gender were selected from each household (Chukwuonye et al., 2015). In a similar study in Nigeria, interviews and screening were conducted at schools, primary health care centres, and town halls after community sensitization. All eligible participants who responded to the call were invited (Oguoma et al., 2015). Three of the studies (Wu et al., 2015, Minicuci et al., 2014, Gatimu et al., 2016) were based on the wave 1 cohort of the WHO's Study on Global AGEing and Adult Health (SAGE) (Kowal et al., 2012). This was a longitudinal study among ageing adults in six LMICs in Africa, Asia, Europe and America (Ghana, South Africa, China, Russia, India and Mexico) (Kowal et al., 2012). In the Republic of Seychelles, eligible participants were selected from a computerised database of the population and were invited to designated centres for the survey (Bovet et al., 2006, Faeh et al., 2007b).

The response rates were generally good and ranged from 67.4% in South Africa (Maimela et al., 2016) to 99.6% in Ethiopia (Anteneh et al., 2015) and Tanzania (Dewhurst et al., 2013). However, some of the studies did not report their response rate, while some indicated it could not be computed because of lack of sufficient information. The analytical sample size of the studies ranged from 393 in a study conducted on urban Fulanis only in Nigeria (Sabir et al., 2011) to 22,906 in Malawi (Mudie et al., 2018). Even though some of the studies used the target age group used in most WHO STEP surveys (25-64 years) (WHO, 2005b), the minimum age was 13 years (Asiki et al., 2015, Murphy et al., 2013) and the maximum age is not known because of the way some of the studies are reported. However, the maximum age in studies where this information was provided was 99 years (Kengne et al., 2007). Four of the studies were conducted among adults 50 years and above (Wu et al., 2015, Minicuci et al., 2014, Tianyi et al., 2018, Gatimu et al., 2016).

There were more females than males in most of the studies reviewed (Table 3.1). The majority of participants in studies conducted in both rural and urban areas lived in rural areas. Some of the studies were conducted only in urban communities and some in purely rural communities. Six of the studies conducted in urban areas were conducted among residents of urban slums (Oti et al., 2013, Ayah et al., 2013, Ezeala-Adikaibe et al., 2016, Joshi et al., 2014, Olack et al., 2015, van de Vijver et al., 2013b).

Table 3.1: Characteristics of the articles reviewed

First author and year of publication	Country	STEPS	Coverage	Main area of focus	Age Group	Mean age ±SD	Achieved sample	Response rate (%)	Sample analysed	Female (%)	Rural (%)
Pires et al 2013	Angola	3?	S	Hypertension	18-64	33.7±12.5	n/a	n/a	1464	59.1	12.1
Pedro et al 2018	Angola	3	S	Hypertension, diabetes and cholesterol	15-64	32.5±13.6	2487	70.7	2354	63.0	19.0
Pedro et al 2017	Angola	?	S	Tobacco use	15-64		3515		2472		
Houehanou et al 2015	Benin	3	N	NCDs and risk factors	25-64	42.8 ±0.3	6904	99.0	6762	49.5	66.4
Keetile et al 2015	Botswana	3	N	Hypertension and CVD and risk factors	25-64	n/a	4003	n/a	4003	67.9	n/a
Soubeiga etal 2017	Burkina Faso	3	N	Hypertension	25-64		4800	96.4	4629	57.9	72.2
Millogo et al 2018	Burkina Faso	3	N	Diabetes	25-64		4800	92.0	4417	52.7	72.8
Kamadjeu et al 2006 a	Cameroon	3	S	Hypertension	≥15	31.6M 31.1F	10,011	92.5	10,011	60.0	0.0
Kamadjeu et al 2006 b	Cameroon	3	S	Obesity	≥15	31.6M; 31.1F	10,011	92.5	9454	60.4	0.0
Kengne et al 2007	Cameroon	2	S	Hypertension	15-99	n/a	2559	92.5	2559	59.7	0.0
Kufe CN et al 2015	Cameroon	3	S	Diabetes	≥25	39.7±12.9	2062	82.5	1623	58.9	0.0
Mbouemboue et 2016	Cameroon	3	S	Hypertension	18-93	36±17			700	51.4	
Arrey et al 2016	Cameroon	2	S	Hypertension	≥21				733	45.6	100.0
Kufe et al 2016	Cameroon	2	S	NCDs risk factor	≥20	36.1±14.4	1921	90.8	1921	66.8	
Mbanya et al 2015	Cameroon	3	N	Anthropometric measures	≥25		10,000	86.6	8663	60.0	
Tianyi et al 2018	Cameroon	?	S	Hypertension	≥50				501	68.8	
Longo- Mbenza et al 2008	DRC	3	S	Hypertension and CVD and risk factors	≥15	n/a	1952	97.6	1952	60.7	n/a
Mufunda et al 2006	Eritrea	3	N	Hypertension and obesity	15-64	n/a	2352	95.6	2352	50.3	n/a
Mufunda et al 2007	Eritrea	3	N	Tobacco use	15-64	n/a	2304	93.7	2251	50.3	n/a
Usman et al 2006	Eritrea	2	N	NCDs and risk factors	15-64	n/a	2352	95.6	2352	50.5	n/a
Tesfaye et al 2009	Ethiopia	2	S	Hypertension and CVD and risk factors	25-64	40	3713	93.0	3713	56.8	n/a

First author and year of publication	Country	STEPS	Coverage	Main area of focus	Age Group	Mean age ±SD	Achieved sample	Response rate (%)	Sample analysed	Female (%)	Rural (%)
Abebe et al 2014	Ethiopia	3	S	Diabetes and its risk factors	≥35	49±12 (u) 46.6±3(r)	2141	97.3	2141	54.2	51.0
Abebe et al 2015	Ethiopia	3	S	Hypertension &risk factors	≥35	47.0 ±12.4	2141	97.3	2141	54.2	51.0
Tesfaye et al 2007	Ethiopia	2	S	BMI and HBP	25-64	n/a	4050	n/a	4050	51.3	70.3
Tesfaye et al 2008	Ethiopia	3?	S	Smoking and High blood pressure	25-64	41.7±11.5	4001	98.2	4001	41.2	0.0
Anteneh et al 2015	Ethiopia	2	S	Hypertension	≥30	49.2±1.37	681	99.6	678	54.4	0.0
Awoke et al 2012	Ethiopia	?	S	Hypertension	≥35	51.5±14.4	679	97.6	679	52.4	0.0
Muluneh et al 2012	Ethiopia	3	S	Chronic NCDs	15-64	n/a	4469	81.3	4469	53.3	n/a
Tessema et al 2012	Ethiopia	3	S	Blood pressure and anthropometric measurements	15-64	40.6 M; 40.1 F	n/a	n/a	2466	50.3	n/a
Helelo et al 2014	Ethiopia	2	S	Hypertension	≥31	47.4±12.2	518	96.6	518	55.8	0.0
Nawi NG et al 2006	Ethiopia	2	S	NCDs and risk factors (hypertension)	25-64	n/a	4050	n/a	4050	56.4	n/a
Gebrihet et al 2017	Ethiopia	2	S	Hypertension	≥18	36.4±12.7	544	96.0	521	61.0	
Demisse et al 2017	Ethiopia	3	S	Hypertension	≥18	41±18.5	3059	94.8	3059	54.1	56.9
Aynalem et al 2018	Ethiopia	3	S	Diabetes	15-78	31.0±6.5	414	97.1	402	62.4	
Asfaw etal 2018	Ethiopia	3	S	Hypertension	25-64	35.4±7.7	524	99.8	524	47.1	
Gebreyes et al 2018	Ethiopia	3	N	Hypertension and metabolic syndrome	15-69		100,260	95.6	9788	59.4	88.5
Animaw et al 2017	Ethiopia	3	S	Diabetes	18-97	33(median)	1472	95.5	1405	56.7	50.8
Mekonneh et al 2018	Ethiopia	3	S	Obesity	≥18	37.0±16.0	1484	94.7	1405	56.7	50.8
Minicuci et al 2013	Ghana	2	N	NCDs and their risk factors	≥50		5571	95.9	4724	50.3	59.4
Gatimu et al 2016 (SAGE)	Ghana	3	N?	Diabetes	≥50		4305		4089	48.0	40.5
Wu et al 2015	Ghana &	3?	?	NCDs and risk factors	≥ 50	n/a	n/a	80.0	4305	47.6	52.7
	South Africa	3?	?	NCDs and risk factors	≥ 50		n/a	77.0	3836	55.9	35.1

First author and year of publication	Country	STEPS	Coverage	Main area of focus	Age Group	Mean age ±SD	Achieved sample	Response rate (%)	Sample analysed	Female (%)	Rural (%)
Ayah et al 2013	Kenya	3	S	Diabetes	18-90	33.4±11.6	2045	99.0	2045	48.4	0.0
Joshi et al 2014	Kenya	3	S	Hypertension	18-90	33.4±11.6	2061	98.0	2045	49.1	0.0
Olack et al 2015	Kenya	3	S	Hypertension	35-64	46.7	1528	89.0	1528	58.0	0.0
van de Vijver et al 2012	Kenya	3	S	Hypertension	≥18	n/a	5190	94.0	5190	46.0	0.0
Oti et al 2013	Kenya	3	S	Diabetes and obesity	≥18	n/a	5190	94.0	5190	46.0	0.0
Msyamboza et al 2011	Malawi	3	N	NCDs/CVD and risk factors	25-64	n/a	5206	95.5	5206	67.5	87.4
Msamboza eta al 2014	Malawi	3	N	Diabetes	25-64	n/a	5206	95.5	3056	70.2	87.9
Msyamboza et al 2013	Malawi	3	N	Overweight and obesity	25-64	n/a	5206	95.5	4845	65.7	87.6
Msyamboza etal 2012	Malawi	3	N	Hypertension and CVD and risk factors	25-64	n/a	5206	95.5	3910	69.2	89.6
Price et al 2018	Malawi	3	S	NCDs	≥18	36.6±15.7	41,173	72.0	28891	61.7	48.0
Mudie et al 2018	Malawi	3	S	Obesity	≥18	35.9±15.1	28891	97.0	22906	60.3	48.0
Ba et al 2018	Mali	3	S?	Hypertension	≥16	47.8±13.2			2103	60.2	26.6
Gomes et al 2010	Mozambique	3	N	BMI and waist circumference	25-64	n/a	3323	98.4	2913	n/a	≈ 50
Damasceno et al 2009	Mozambique	3	N	Hypertension prevalence awareness and control	25-64	3/4< 45	3323	n/a	3081	58.4	⅔ rural
Padrao et al 2011	Mozambique	3?	N	Alcohol consumption	25-64	n/a	3323	98.4	3265	58.4	49.8
Padrao et al 2013	Mozambique	3?	N	Tobacco use	25-64	⅔ <45	3323	98.4	3304	58.2	50.1
Padrao et al 2012 a	Mozambique	3?	N	Physical activity	25-64	⅔ <45, only 10% >50 years	3323	98.4	3211	n/a	≈⅔
Padrao et al 2012 b	Mozambique	3?	N	Fruit and vegetable intake	25-64		3323	98.4	3298	58.2	50.0
Pires etal 2011	Mozambique	3?	N	Alcohol consumption	25-64	≈⅔ ≤44	n/a	n/a	3264	57.1	>67
Padrao et al 2014	Mozambique	3	N	Cardiovascular risk factors	25-64	n/a	3323	98.4	3177	57.6	n/a
Silva-Maltos etal 2010	Mozambique	3	N	Diabetes	25-64	40	3323	98.4	2343	60.0	48.0

First author and year of publication	Country	STEPS	Coverage	Main area of focus	Age Group	Mean age ±SD	Achieved sample	Response rate (%)	Sample analysed	Female (%)	Rural (%)
Damasceno et al 2013	Mozambique	3	N	Hypertension and CVD and risk factors	40-64	n/a	3323	98.4	1116	56.4	50.8
Gama et al 2013	Mozambique	3	N	Treatment of hypertension	25-64	≈1/2< 45	3323	98.4	1140	53.9	61.0
Okpechi etal 2013	Nigeria	3	S	Hypertension and CVD and risk factors	≥ 18	41 ±0.3	2983	99.5	2983	52.1	53.2
Oladapo et al 2010	Nigeria	3	S	NCDs/CVD and risk factors	18-64	42.81±21.6	2000		2000	56.3	100.0
Sabir et al 2013	Nigeria	3	S	Diabetes	n/a	38.5±14.2	393	98.3	393	46.6	100.0
Ezeala-Adikaibe et al 2016	Nigeria	3	S	Hypertension	≥20	43.9	811	n/a	774	64.7	0.0
Chukwuonye et al 2015	Nigeria	2	S	BMI& obesity	≥18	41.7±18.5	2928	97.6	2987	48.1	53.6
Oguoma et al 2015	Nigeria	3	S	CVD risk factors and income	≥18	38.3±20.5(M) 42.9±20.7(F)	n/a	n/a	422	64.7	n/a
Okafor et al 2014a	Nigeria	2	S	Obesity	≥15	40.6±14.3	5392	n/a	5392	45.5	0.0
Okafor et al 2014b	Nigeria	2	S	Obesity and HBP	18-70	49.1±13	792	n/a	775	64.0	0.0
Sabir et al 2011	Nigeria	3	S	Dysglycaemia	16-65	39.3±14.2	389	97.3	389	48.8	n/a
Ulasi et al 2010	Nigeria	3	S	hypertension and cardiometabolic syndrome	25-64	43.8±13.7	2189	n/a	1458	51.4	25.6
Oluyombo et al 2014	Nigeria	3	S	CVD risk factors	18-82	61.7±18.2	835	89.8	750	70.6	
Okafor et al 2016	Nigeria	?	S	Performance of WC for defining weight	?	?	6098			46.9	0.0
Arugu et al 2017	Nigeria	3	S	Diabetes	18-82	40.5±14.4		96.3	462	50.0	100
Bushara 2016	North Sudan	3	S	Hypertension	18-90	39.5±16.6			954	54.3	0.0
Nahimana et al 2017	Rwanda	3	N	Hypertension	15-64	35.3±12.5	7116		7116	62.8	
Doupa et 2014	Senegal	3	S	Dyslipidaemia, obesity and CVD risk	≥ 18	47.6 ±15.7	1037	n/a	1037	62.0	45.0
Pessinaba et 2013	Senegal	3	S	Hypertension & CVD risk factors	15-96	43.4±17.8	n/a	n/a	1424	31.0	0.0

First author and year of publication	Country	STEPS	Coverage	Main area of focus	Age Group	Mean age ±SD	Achieved sample	Response rate (%)	Sample analysed	Female (%)	Rural (%)
Secka et al 2015	Senegal	3	S	Diabetes	≥18	48.0±16.9	1056	99.1	1026	65.7	44.3
Bovet et al 2006	Seychelles	3	N	Prevalence of CVD risk factors	25-64	n/a	1255	80.2	1255	n/a	n/a
Faeh et al 2007 a	Seychelles	3	N	Prevalence of diabetes &excess weight	25-64	45.2±0.3	1255	80.2	1255	54.7	n/a
Faeh et al 2007 b	Seychelles	3	N	Diabetes	25-64	n/a	1255	80.2	1255	n/a	n/a
Bovet et al 2009	Seychelles	3	N	Fifteen year trend in CVD risk factors	25-64	42±11	1255	80.2	1255	n/a	n/a
Danon-Hersch et al 2007	Seychelles	3	N	Association between BMI and Blood pressure	25-64		1255	80.2	1255	n/a	n/a
Chioloero et al 2008	Seychelles	3	N	Blood pressure measurements	25-64		1255	80.2	1217	n/a	n/a
Rodondi et al 2007	Seychelles	3	N	Microalbuminuria and atherosclerosis	35-64	52	1255	80.2	523	n/a	n/a
Ntuli et al 2015	South Africa	2	S	Hypertension	15-98	44.2±20.9	1407	91.0	1281	63.0	100.0
Maimela et al 2016	South Africa	3	S	NCDs and their risk factors	≥15	41.29±21.46m 45.74±20.39f	1407	67.4	1403	62.6	100.0
Bushara etal 2015	South Sudan	3	S	Undiagnosed hypertension	18-90	39.6±15.9	n/a	n/a	1099	58.1	100.0
Dewhurst et al 2013	Tanzania	2	S	Hypertension	≥70	median age =76m,76f	2223	99.6	2223	56.3	100.0
Mosha et al 2017	Tanzania	3	S	Hypertension	≥15	29(median)	9742		9678	65.0	
Katalambula et al 2017	Tanzania	3	S	Hypertension	25-64	40.7±12.1	549		549	57.6	
Kavishe et al 2015	Tanzania &		S	NCDs and HIV	≥ 18		n/a	72.0	1096	53.8	52.6
	Uganda		S	NCDs and HIV	≥ 18	n/a	916	68.0	916	59.1	47.2
Cham et al 2018	The Gambia	2	N	Hypertension	25-64	38.3±10.9	4111	77.9	3573	54.1	
Baragou etal 2012	Togo	3	S	Hypertension and CVD and risk factors	18-98	39±10	?	n/a	2000	55.9	0.0

First author and year of publication	Country	STEPS	Coverage	Main area of focus	Age Group	Mean age ±SD	Achieved sample	Response rate (%)	Sample analysed	Female (%)	Rural (%)
Mondo etal 2013	Uganda	3	S	NCDs and risk factors	25 -64 and above	n/a	518	84.8	518	54.5	100.0
Murphy et al 2013	Uganda	3	S	NCDs risk factors	13-97	34.4	7809	93.9	6867	55.0	100.0
Asiki et 2015	Uganda	3	S	Prevalence of dyslipidaemia	≥13	49.4% under 30 years		93.9	7741	56.3	100.0
Guwatudde et al 2015	Uganda	3	S	Hypertension	18-69	35.1±13	3987	81.4	3906	59.8	27.1
Musinguzi et al 2013	Uganda	3?	S	Hypertension, prevalence and awareness	≥ 15	36.2&34.1	4818	n/a	4563	64.5	66.7
Musinguzi et al 2013	Uganda	?	S	Uncontrolled hypertension	≥ 15	34.5±15.5	n/a	n/a	4432	63.7	66.9
Mayega et al 2013	Uganda	3	S	Diabetes	35-60	44±6.9	1497	90.4	1497	52.5	85.2
Mayega et al 2012	Uganda	2	S	Overweight and hypertension	35-60	44±7	1656	98.6	1656	51.4	84.1
Guwatudde et al 2016	Uganda	3	N	Physical activity	18-69	35.1±13.1	3987	81.4	3987	59.8	72.8
Bahendeka et al 2016	Uganda	3	N	Diabetes	18-69		3987	81.4	3689	60.2	81.1
Twinasiko et al 2018	Uganda	3	S	Hypertension	≥35	-	310		310	50.0	
Nsakashalo-Senkwe et al 2011	Zambia	3	N	Impaired glucose level and diabetes	≥ 25		1928	n/a	1928	67.0	0.0
Goma et al 2011	Zambia	3	S	Hypertension	≥ 25		n/a	n/a	1298	67.0	0.0
Siziya et al 2012	Zambia	2	S	Hypertension	≥25		1627	n/a	1627	57.7	0.0
Zyaambo et al 2013	Zambia	2	S	Prevalence of smoking	≥25	56% between 25-34	1627	n/a	1627	57.7	
Rudatsikira et al 2012	Zambia	3	S	Obesity: prevalence & correlates	≥25	53% 25-34years	n/a	n/a	1928	67.0	0.0
Siziya et al 2011	Zambia	2	S	Prevalence of smoking	≥25	53% between 25-34	n/a	n/a	1928	67.0	0.0
Mulenga et al 2013*	Zambia(Kaoma)	3	S	Hypertension	≥ 25		895	n/a	895	59.7	100.0
	Zambia(Kassama)	3	S	Hypertension	≥ 25		1198		1198	57.2	100.0

First author and year of publication	Country	STEPS	Coverage	Main area of focus	Age Group	Mean age ±SD	Achieved sample	Response rate (%)	Sample analysed	Female (%)	Rural (%)
Olusegun Babaniyi et al 2014a*	Zambia(Kaoma)	3	S	Impaired glucose level and diabetes	≥25		n/a	Could not compute it	895	59.7	100.0
	Zambia(Kassama)	3	S	Impaired glucose level and diabetes	≥25		n/a	Could not compute it	1198	57.2	100.0
Olusegun Babaniyi et al 2014b*	Zambia(Kaoma)	3	S	Prevalence of smoking	≥25	n/a	895	Could not compute it	886	59.7	100.0
	Zambia(Kassama)	3	S	Prevalence of smoking	≥25		1198	Could not compute it	1195	57.2	100.0

*Analysis stratified by district

M=Male, F=Female; U=Urban, R=Rural; N=National S=Sub-national;

3? At least steps 1 and 2 were conducted but I am not sure from the description in the paper if Step 3 was conducted.

DRC: Democratic Republic of Congo

In addition, I reviewed the fact sheets and reports of STEP surveys published on the WHO website (Table 3.2). This included 48 surveys conducted between 2003 and 2015. 14 out of these 48 surveys were sub-national surveys. Some of the countries conducted repeat surveys. Benin conducted a subnational survey in Cotonou in 2007 and national surveys in 2008 and 2015. Ethiopia conducted two sub-national surveys in 2003 in Bulajira and in 2006 in Addis Ababa and a national survey in 2015. The Republic of Seychelles conducted two national surveys in 2004 and 2013-2014; likewise Swaziland in 2007 and 2014. There is an overlap between some of the articles reported in Table 3.1 and some of the reports and factsheets summarized in Table 3.2 below.

3.6 Summary of major findings on cardiovascular disease risk factors in sub-Saharan Africa

I summarized the results of the articles reviewed as well as the fact sheets and reports according to behavioural and biological risk factors for NCDs. The behavioural risk factors covered are tobacco use, alcohol consumption, physical inactivity, and low fruit and vegetable consumption (unhealthy diet). The biological risk factors are overweight and obesity, high blood glucose, high total cholesterol and hypertension (WHO, 2005b). In addition, I also reported the proportion of survey participants with combined risk factors defined for the purpose of this review as those with at least three of the risk factors. Tables on objectives 4 and 5 of the systematic review, which consist of a report on the prevalence as well as the factors associated with each of these risk factors, can be found in appendix III. Information on the CVD risk factors are briefly summarized below; except hypertension which is covered in more detail in sections 3.7-3.9.

Table 3.2: Summary of fact sheets and reports from WHO webpage

Survey Year	Country	STEPS	Coverage	Age Group	Sample	Response rate (%)
2007	Benin (Cotonou)	3	S	25-64	2568	
2008	Benin	3	N	25-64	6904	
2015	Benin	3	N	18-69	5126	98.6
2007	Botswana	2	N	25-64	4003	
2014	Botswana	3	N	15-69	4074	63.7
2013	Burkina Faso	3	N	25-64	4737	98.7
2003	Cameroon	3	N	15-64+	9720	89.8
2005	Ivory Coast	2	N	15-64+	4756	
2004	Congo (Brazzaville)	3	N	25-64	2030	
2007	Cape Verde	3	N	25-64	1762	
2010	Central African Republic (Bangui)	3	S	25-64	4029	
2008	Chad (Njamena)	3	S	25-64	2016	
2011	Comoros	3	N	25-64	5556	96.5
2005	Democratic Republic of Congo	3	S	15-64+	1948	
2004	Eritrea	2	N	15-64	2319	95.6
2003	Ethiopia (Butajira)	2	S	25-64	3990	98.0
2006	Ethiopia (Addis Ababa)	2	S	25-64	4000	98.2
2015	Ethiopia	3	N	15-69	9801	98.5
2009	Gabon	2	N	15-64	2708	
2010	Gambia	2	N	25-64	4111	77.9
2006	Ghana(Accra)	3	S	25-64	2662	99.9
2009	Guinea (Conakry and Basse)	3	S	15-64	2491	98.8
2015	Kenya	3	N	18-69	6000	
2012	Lesotho	3	N	25-64	2310	80.0
2011	Liberia	3	N	25-64	2508	87.1
2005	Madagascar	2	S	25-64	5743	
2009	Malawi	3	N	25-64	5206	95.5
2007	Mali	3	S	15-64	2810	
2006	Mauritania (Nouakchott)	3	S	15-64	2600	
2004	Mauritius	3	N	20-74	4200	91.0
2005	Mozambique	3	N	25-64	3310	98.4
2007	Niger	3	N	15-64	2760	91.3
2003	Nigeria(Lagos)	2	N	≥15	1018	
11/2012-03/2013	Rwanda	3	N	15-64	7225	99.8
2008	Sao Tome and Principe	3	N	25-64	2457	
2015	Senegal	3	N	18-69	6306	94.2
2004	Seychelles	3	N	25-64	1255	80.3
2013-2014	Seychelles	3	N	25-64	1240	73.0
2009	Sierra Leone	2	N	25-64	4997	90.0
2007	Swaziland	3	N	25-64	1302	87.0
2014	Swaziland	3	N	15-69	3281	76.0
2005	Sudan	3	S	25-64	1573	98.3
2012	Tanzania	3	N	25-64	5680	94.7
12/2010-01/2011	Togo	3	N	15-64	4370	91.0
2014	Uganda	3	N	18-69	3987	99.0
2008	Zambia (Lusaka)	3	S	≥25	1912	
2011	Zanzibar (Tanzania)	3	S	25-64	2639	
2005	Zimbabwe	3	N	25-65+	3081	102.0*

*respondents exceeded the target as stated in report

[a] S: Subnational ; N: National

3.6.1 Tobacco smoking

The studies that reported on smoking in a format appropriate for this review and the WHO STEP survey reports and fact sheets are summarized in Supplementary Tables S2 and S3. There were some differences in the reporting of smoking prevalence. As a result, prevalence was categorized into 'current smoking', defined as smoking in the past 30 days, and 'current daily smoking', defined as the proportion of participants who smoke/use tobacco daily.

Generally, the prevalence of smoking was very low among females. It ranged from 0% in Northern Nigeria (Sabir et al., 2013) to 18% in Mozambique (Padrao et al., 2013) among studies reported in academic journal. It ranged from 0.1% in Burkina Faso to 11% in Sierra Leone among the WHO reports and factsheets. The prevalence of current tobacco use among men ranged from 13% in Ghana (Minicuci et al., 2014) to 41% in Mozambique (Padrao et al., 2013) among studies reported in journal papers; and it ranged from 9% in Niger to 49% in Lesotho among the WHO reports and factsheets. The prevalence of current tobacco use among males was highest in Lesotho (49%).

Only seven papers published in academic journals focused on tobacco use (Olusegun Babaniyi et al., 2014, Zyaambo et al., 2013, Siziya et al., 2011, Tesfaye et al., 2008, Padrao et al., 2013, Mufunda et al., 2007, Pedro et al., 2017). Three of these studies looked at factors associated with tobacco use in multivariate regression; all were conducted in different districts in Zambia (Siziya et al., 2011, Zyaambo et al., 2013, Olusegun Babaniyi et al., 2014). In addition to these three studies, two studies on NCD risk factors (in Benin and South Africa) also looked at the factors associated with tobacco use (Houehanou et al., 2015, Maimela et al., 2016). Tobacco use was higher among males, rural residents, people from lower socio-economic background, and those with lower levels of education. Generally, use of tobacco, especially smoking, is viewed amongst the populations as not being acceptable among females in SSA. However, women in some communities in SSA use smokeless tobacco and the prevalence of this is generally higher in women compared with men (Townsend et al., 2006, Peltzer et al., 2001).

3.6.2 Alcohol consumption

The prevalence of current alcohol consumption (defined as current drinkers who drank alcohol in the 30 days prior to the survey) among studies reported in journal papers was lowest in a rural Nigerian Fulani community, where only one person in the study population reported current drinking (Sabir et al., 2013). It was highest in a study conducted in Duala, Cameroon, where 85% of the study population (89% males, 82% females) were current alcohol consumers (Kengne et al., 2007). The prevalence of current alcohol consumption was also high in Mozambique (58% and 29% among men women respectively) (Padrao et al., 2011). From the WHO STEPS fact sheet and reports, it ranged from 0.3% in Niger to 87% in the Republic of Seychelles (Table S4).

The prevalence of alcohol use varied widely by country. It was generally higher in rural areas and lowest in communities where Muslims form the majority. The higher prevalence of alcohol use in rural communities could be associated with the local production of alcohol in some rural communities in SSA. This was the case in Northwest Ethiopia, where 98% of males and 96% of the females are current drinkers (Abebe et al., 2014). The low prevalence of drinking among Muslim communities could be associated with the prohibition of alcohol use in Islam and/or because of under reporting.

3.6.3 Low fruit and vegetable intake

Fruit and vegetable intake was generally low both in studies reported in academic journal papers and those covered in WHO fact sheets and reports. More than two-thirds of the surveyed population in all these studies consumed fewer than five combined servings of fruits and vegetables a day. The mean number of days on which fruits and vegetables were consumed in a week was also extremely low, ranging from 0.8 in Ethiopia to 4.5 in Seychelles for fruit and from 0.3 in Botswana to 2.1 in Madagascar for vegetables. The consumption of fruits was generally higher than for vegetables (Table S5). A high proportion of studies provided information on fruit and vegetable intake but only one focussed entirely on fruit and vegetable intake (Padrao et al., 2012b).

There could be a number of explanations for the low levels of fruit and vegetable consumption in SSA. Urbanisation is a possible explanation. A study among adolescents in seven African countries attributed the inadequate consumption of fruits and vegetables in those countries to an increase in urbanisation (Peltzer and Pengpid, 2010). Economic reasons for the farming community is another possible explanation. Farmers are more likely to cultivate crops that are more economically viable. Low fruit and vegetable consumption has also been attributed to the increasing cultivation of more commercial crops, including cereals, roots and tubers, from which farmers earn more income compared with fruits and vegetables (Musinguzi et al., 2006). The lack of adequate storage facilities and the high perishability of fruits and vegetables, especially in hot tropical countries, may also discourage farmers from cultivating fruits and vegetables for commercial purposes. Related to both urbanisation and economic reasons, the low intake of fruits and vegetables in SSA could also be associated with the increasing penetration of processed foods and flavour enhancers (e.g. monosodium glutamate in The Gambia), contributing to the reduction in the consumption of traditional foods.

However it is important to note that the observed low levels of fruit and vegetable intake in SSA found in this systematic review does not necessarily mean that persons in SSA have poor diets or that they do not consume traditional diets. Therefore the above findings on the low consumption of fruits and vegetables in SSA should be interpreted with caution. A survey on the global variability on fruits and vegetable consumption that compared fruit and vegetable intake in 52 countries revealed a high percentage of adults in all these countries do not consume the minimum recommended servings of fruits and vegetables (Hall et al., 2009). However, all the countries in the study that reported a higher percentage of adults in their population consuming at least five servings were in SSA. Most of the SSA countries in the study reported better levels of fruit and vegetable consumption compared with more developed countries including Spain, Russia, Turkey, Malaysia, Czech Republic and United Arab Emirates (Hall et al., 2009). Therefore the low intake of fruits and vegetables in SSA as found in my systematic review does not necessarily entail poor diets and/or not consuming traditional diets at all. People could consume fruits and vegetables as part of their daily diets but it may be below the WHO recommendation of at least five servings per day.

Although not part of my systematic review, salt consumption and cooking practices are other important issues in terms of diet quality. Salt consumption was not part of the STEP survey tool when most (>99%) of the studies included in my review were conducted. Furthermore, the WHO STEP does not collect information on cooking practices. First, evidence shows high sodium intake is a major risk factor for hypertension, especially among people of black African descent (De Wardener and MacGregor, 2002, Ukoh et al., 2004, Forrester, 2004, Stamler et al., 2018). Mean population salt intake among adults 20 years and above was 8g/day in 2010 in The Gambia. This far exceeds the WHO recommendation of <5g/day salt or < 2g/day sodium intake (WHO, 2012b) and may reflect the use of salt in everyday cooking in The Gambia. Such high levels of salt consumption may contribute to the high burden of hypertension in the country. Secondly, the use of solid fuels including charcoal, wood, dung and kerosene for cooking have been causally linked to indoor air pollution in LMICs (WHO, 2018b); in turn, systematic reviews of studies conducted in LMICs have shown links between indoor air pollution and CVDs such as hypertension (Uzoigwe et al., 2013, Fatmi and Coggon, 2016).

3.6.4 Physical activity

The prevalence of low levels of physical activity (defined as doing less than 600 MET-minutes of activity per week, i.e. less than 150 minutes/week moderate intensity or 75 minutes/week -vigorous intensity , or a pro rata combination) ranged from 3% in a rural Yoruba Community in South West Nigeria (Oladapo et al., 2010) to 88% in Botswana (Keetile et al., 2015). From the WHO STEP survey fact sheet and reports, the prevalence of a low level of physical activity ranged from 1% in Sudan to 86% in Accra, Ghana. Generally, low physical activity was more common among females, except in Mozambique where it was found to be slightly more frequent among males (Padrao et al., 2012a). Most of the activity reported was work and transport related; leisure time physical activity was generally low. Low levels of physical activity were generally more common among women and urban residents. This could be because rural residents in SSA are mostly subsistence farmers involved in laborious farm work. The commonest mode of transport-related activity in rural areas and in some urban slum communities is walking and bicycling.

3.6.5 Overweight and obesity

Mean BMI, mean waist circumference and the prevalence of overweight and obesity (BMI between 25.0-29.9kg/m^2 and BMI $\geq$30kg/m^2 respectively) were higher among females and urban residents (Tables S7 and S8). The prevalence of overweight among females ranged from 2% in rural Nigeria to 68% in the Republic of Seychelles among studies reported in journal papers (Oladapo et al., 2010, Bovet et al., 2006). In the WHO factsheets and country reports, it ranged from 2% in Ethiopia to 72% in The Republic of Seychelles. Similarly, the prevalence among males ranged from 2% in Nigeria to 52% in The Republic of Seychelles among studies reported in journal papers; prevalence ranged from 3% in Ethiopia to 57% in the Republic of Seychelles among WHO reports and factsheets. Few of the studies assessed the factors associated with overweight and obesity in multivariate regression. Generally, being female and urban residence were the most significant predictors of overweight and obesity. Other variables such as age, family history of diabetes and hypertension, physical inactivity, socioeconomic status and education were also associated with overweight and obesity in some of the studies. However, the direction of the associations were not consistent.

The prevalence of overweight and obesity in SSA is generally high and the strongest predictors were female gender and urban residence. This could be related to the fact that many communities in SSA consider overweight to be associated with good life and high status especially among women (BBC, 2007, Simmons, 2006, Scott et al., 2012). There are special “*fattening rooms*” in some communities where women will pay to be given special treatment and meals for a couple of months to gain weight (BBC, 2007, Simmons, 2006).

3.6.6 Impaired fasting blood glucose and diabetes

The prevalence of diabetes (defined as plasma venous glucose concentration ≥7.0 mmol/L (≥126 mg/dl), or capillary whole blood value ≥6.1 mmol/L (≥110 mg/dl) and/or currently on treatment for diabetes) ranged from 0.8% in a rural Fulani community in Northern Nigeria to 14% in Kinshasa, Democratic Republic of Congo among studies reported in journal papers (Sabir et al., 2013, Longo-Mbenza et al., 2008). The prevalence was highest among females in Kasese district, Uganda (31%) (Mondo et al., 2013). The prevalence of impaired fasting blood glucose was lowest among males in Niger (0.6%) and was highest among males in the Republic of Seychelles (43%). The proportion of diabetes that was undiagnosed (defined as the proportion of participants with diabetes as defined above who did not report diagnosis by a health care professional) was very high and ranged from 43% to 87%. Levels of treatment (proportion of diabetics currently on medication) and control for diabetes were also very low. Age and overweight/obesity were the most significant predictors of impaired fasting glucose and/or of diabetes. Other factors such as gender, physical inactivity, urban residence, family history of diabetes and hypertension, were significantly associated with diabetes in some of the studies.

3.6.7 Cholesterol level

Very few of the articles reviewed reported on mean total cholesterol and/or on the prevalence of high cholesterol, and therefore most of my summary is based on the WHO fact sheets. The prevalence of high total cholesterol (defined as total cholesterol ≥5.0

mmol/L or ≥190 mg/dl) was lowest in Rwanda (3%) and highest in the Republic of Seychelles (60%). A high number of other countries also were reported to have a very high prevalence of high cholesterol (Table S10).

3.6.8 Combined risk factors

Generally, the proportion of participants with none of the five major risk factors for NCDs (hypertension, overweight/obesity, smoking, physical inactivity and low fruit and vegetable intake) was extremely low, reflecting the high prevalence of hypertension, overweight and low fruit and vegetable intake. It ranged from 0.3% in Ethiopia to 14% in Madagascar. A high proportion of the participants aged 25-64 years in almost every WHO STEP survey conducted in SSA had at least three NCD risk factors. The prevalence was highest in Accra, Ghana (56%) and lowest in Uganda (10%). The prevalence of three or more risk factors was even high in the younger age group. These figures are very alarming and can significantly contribute to the increasing burden of CVDs in SSA.

3.7 Hypertension in sub- Saharan Africa

3.7.1 Introduction

The definition of hypertension used in the studies as well as the reported levels of prevalence are summarised in Tables 3.3, 3.4 and 3.5. In addition, I extracted and tabulated the factors significantly associated with hypertension found in the reported multivariate regression analyses (Tables 3.6 and 3.7). The information extracted from the WHO fact sheets and reports included information on the prevalence of Stage II hypertension (raised SBP ≥160 and/or DBP ≥100 mmHg or currently on medication for raised blood pressure) and also included information on the proportion of hypertensive participants who were on treatment. However, few of the journal papers reported on levels of treatment and control.

Most of the studies that reported on undiagnosed hypertension described awareness, that is, the proportion of survey-defined hypertensive participants who were aware of their condition; mainly through being told by a health care professional. Therefore, the figures reported here on the levels of hypertension unawareness or undiagnosed hypertension are the inverse of the figures reported in these studies (e.g. one in five hypertensive participants reporting a previous diagnosis corresponds to 80% of hypertensive participants being undiagnosed). Only six of the studies reviewed focused on awareness of / undiagnosed hypertension (Bushara et al., 2015, Damasceno et al., 2009, Pires et al., 2013, Musinguzi and Nuwaha, 2013, van de Vijver et al., 2013b, Kamadjeu et al., 2006b). One study reported on uncontrolled hypertension (Musinguzi et al., 2014) and one study reported on the low prevalence of treatment amongst hypertensives (Gama et al., 2013).

3.7.2 Measurement and diagnosis of hypertension in sub-Saharan Africa

Blood pressure measurements

The majority of the studies used the average of the second and third of three available blood pressure measurements as recommended in the WHO STEPS manual (WHO, 2005b), (Tables 3.3., 3.4 and 3.5). However, some were based on the mean of all three measurements. A few studies used a different basis for the results analysed (Tables 3.3, 3.4 and 3.5).

Definition/diagnosis of hypertension

Like the protocol to measure blood pressure, all of the studies reported in WHO factsheets and reports, and most of the studies reported in academic journal papers, defined hypertension using the WHO STEPS recommendation of systolic blood pressure (SBP) ≥140mmHg and/or diastolic blood pressure (DBP) ≥90mmHg and/or reported history or on treatment for hypertension. However, some of the studies used a different criterion (Tables 3.3). A study in Sudan excluded participants previously diagnosed with hypertension and/or on medication for hypertension, to focus on undiagnosed hypertension (Bushara et al., 2015). Two studies in Nigeria and a study in Uganda excluded all participants with reported history of hypertension and/or diabetes (Okafor et al., 2014a, Okafor et al., 2014b, Asiki et al., 2015). A study in Cameroon excluded participants with a history of diabetes (Mbanya et al., 2015). In Togo, where those who had raised BP ≥140/90mmHg were followed up to have their BP measured again at a later date, hypertension was defined as BP≥140/90mmHg at the second session and/or on medication (Baragou et al., 2012). A study in Nigeria defined hypertension using lower thresholds: BP≥130/85mmHg (Oguoma et al., 2015).

3.7.3 Prevalence of hypertension in sub-Saharan Africa

The prevalence of hypertension was generally high in all the countries in SSA. The proportion of hypertensive cases that were undiagnosed was also extremely high and was above 70% in most of the studies reviewed. As mentioned in section 3.7.2, some of the studies reported in journal papers did not use the WHO STEP definition of hypertension. From the studies that used this definition with similar age cohorts, the prevalence of hypertension ranged from 9% in Douala Cameroon to 53% in Nigeria (Kengne et al., 2007, Ezeala-Adikaibe et al., 2016). A study in Nigeria based on survey-measured hypertension only (i.e. not taking previous diagnosis into account) reported a prevalence of 48%, while a study in Senegal - where hypertension was based on the highest of three BP measurements and/or on treatment - reported a prevalence of 46%. A recent study among adults 50 years and above in Cameroon reported a prevalence of 53% (Tianyi et al., 2018). The prevalence ranged from 9% in Butajira Ethiopia to 40% in the Republic of Seychelles from WHO fact sheets and reports. The Republic of Seychelles reported the highest prevalence of hypertension among studies that used nationally representative data, in both journal articles and WHO factsheets and reports. However, it is important to note that there is a slight difference in the rates reported in the fact sheets and reports, and in some of the academic journal articles that used the same survey data. This could be because the analytical samples were different.

Table 3.3: Prevalence of hypertension from articles reviewed

(Hypertension defined as SBP ≥140mmHg and/or DBP ≥90mmHg and/or reported treatment)

Study	Country	Survey year	Age Group	BP Measurement	Hypertension Prevalence (%)			% of hypertension that is undiagnosed		
				-	M	F	All	M	F	All
Pedro et al 2018	Angola	09/2013-03/2014	15-64	a			18.0	-	-	-
Pires etal 2013	Angola	2011	18-64	a	26.4	19.8	23.0	84.7	72.5	78.4
Houehanou et al 2015	Benin	2008	25-64	a	28.3	28.4	28.4	-	-	-
Soubeiga etal 2017	Burkina Faso	2013	25-64	b	-	-	18.0	-	-	-
Millogo et al 2018	Burkina Faso	2013	25-64	n/a	-	-	19.9	-	-	-
Mbouemboue et 2016	Cameroon	2014	18-93	b/a(2)	19.7	21.1	20.4	-	-	-
Arrey et al 2016	Cameroon	2013	≥21	n/a(2)	-		31.1	-	-	71.1
Kufe et al 2016	Cameroon	2013	≥20	d	-	25.0	24.3	-	-	
Mbanya et al 2015	Cameroon	2006	≥25	a*	7.2	7.7		-	-	
Tianyi et al 2018	Cameroon	2013	≥50	n/a	60.9	55.7	57.3	-	-	36.6
Kamadjeu et al 2006 a	Cameroon	2003	≥15	b	25.6	23.1	24.6	-	-	77.0
Kengne et al 2007	Cameroon	2004	15-99	c	-	-	8.9	-	-	-
Kufe et al 2015	Cameroon	2007	≥25	a	-	-	26.6	-	-	-
Longo- Mbenza et al 2008	DRC	n/a	≥15	b	-	-	15.2	-	-	70.0
Usman et al 2006	Eritrea	2004	15-64	n/a	-	-	16.0	-	-	80.0
Gebrihet et al 2017	Ethiopia	2015	≥18	c	-	-	16.5	-	-	57.0
Demisse et al 2017	Ethiopia	n/a	≥18	a	29.0	25.4	27.4	-	-	72.6
Aynalem et al 2018	Ethiopia	2016	15-78	c			18.2	-	-	-
Asfaw etal 2018	Ethiopia	2014	25-64	c	26.4	34.0	30.0	-	-	75.4
Gebreyes et al 2018	Ethiopia	2015	15-69	b	15.5	16.3	15.8	-	-	-
Animaw et al 2017	Ethiopia	2016	18-97	b			11.4	-	-	-
Muluneh et al 2012	Ethiopia	09/2008-01/2009	15-64	d	10.3	8.4	-	-	-	-
Tesfaye et al 2007	Ethiopia	2003&2004	25-64	a	12.3	8.2	-	-	-	-
Tesfaye et al 2009	Ethiopia	2006	25-64	a	31.5	28.9	-	-	-	64.8

Study	Country	Survey year	Age Group	BP Measurement	Hypertension Prevalence (%)			% of hypertension that is undiagnosed		
				-	M	F	All	M	F	All
Abebe et al 2015	Ethiopia	2012	≥35	a	23.3	29.3	27.9	-	-	83.4
Awoke et al 2012	Ethiopia	2012	≥35	c	26.0	30.3	28.3	-	-	37.0
Helelo et al 2014	Ethiopia	2013	>31	c	19.4	26.2	22.4	-	-	
Anteneh Z A et al 2015	Ethiopia	2014	≥30	c	-	-	25.1	-	-	38.6
Minicuci et al 2013	Ghana	2007/08	≥50	a	50.7	51.5	51.1	-	-	-
Wu et al 2015	Ghana	2007-2010	≥50	a	-	-	60.0	-	-	-
Wu et al 2015	South Africa	2007-2010	≥50	a	-	-	78.0	-	-	-
van de Vijver et al 2012	Kenya	2008-2009	≥18	a	12.0	12.7	12.3	89.2	69.3	80.5
Joshi et al 2014	Kenya	2010	18-90	a	11.6	13.7	12.6	-	-	80.0
Olack et al 2015	Kenya	2013	35-64	a	21.5	17.1	27.4	90.2	70.8	61.0
Price et al 2018	Malawi	05/2013-02/2016	≥18	a	-	-	16.0	-	-	58.0
Mudie et al 2018	Malawi	2013	≥18	n/a	-	-	14.7	-	-	
Msyamboza KP et al 2011	Malawi	2009	25-64	a	37.2	29.2	32.9	-	-	93.3
Msyamboza etal 2012	Malawi	2009	25-64	a	36.9	29.9	33.2	-	-	94.9
Ba et al 2018	Mali	2013	≥16	-	-	-	23.5	-	-	-
Damasceno et al 2009	Mozambique	2005	25-64	d	35.7	31.2	33.1	89.4	81.6	85.2
Gamaet al 2013	Mozambique 2005	2005	25-64	d	-	-	-	-	-	85.0
Oluyombo et al 2014	Nigeria	n/a	18-82	n/a	-	-	47.2	-	-	-
Okpechi IG etal 2013	Nigeria	08/2010-3/2012	≥18	a	34.9	28.1	31.4	-	-	59.3
Oladapo et al 2010	Nigeria	12/2002-11/2005	18-64	b	21.1	20.5	20.8	88.6	83.5	85.8
Ezeala-Adikaibe et al 2016	Nigeria	2013	≥20	b	55.4	50.8	52.5	80.4	56.9	59.9
Ulasi et al 2010	Nigeria	n/a	25-64	d	-	-	32.8	-	-	-
Chukwuonye et al 2015	Nigeria	n/a	≥18	n/a	-	-	36.5(u)42.5(r)	-	-	-

Study	Country	Survey year	Age Group	BP Measurement	Hypertension Prevalence (%)			% of hypertension that is undiagnosed		
				-	M	F	All	M	F	All
Sabir et al 2011	Nigeria	n/a	≥18	n/a	16.6	8.4	12.6	-	-	-
Bushara 2016	North Sudan	2016	18-90	b	-	-	35.7	-	-	-
Nahiimana et al 2017	Rwanda	11/2012-04/2013	15-64	a	16.5	14.4	15.4	-	-	70.7
Secka et al 2015	Senegal	2012	≥18	c	-	-	39.1	-	-	
Pessinaba et 2013	Senegal	2010	15-96	d	41.7	47.9	46.0	-	-	50.0
Bovet et al 2006	Seychelles	2004	25-64	a	43.6	35.5	39.6	-	-	
Bovet et al 2009	Seychelles	2004	25-64	a	44.0	36.0	40.0	-	-	36.0
Danon-Hersch et al 2007	Seychelles	2004	25-64	a	44.0	36.0	40.0	45.0	25.0	36.0
Ntuli et al 2015	South Africa	06/2011-03/2012	15-98	b	42.0	41.0	41.4	-	-	-
Maimela et al 2016	South Africa	n/a	≥15	a	-	-	38.9	-	-	-
Mosha et al 2017	Tanzania	2013	≥15	a	-	-	8.0	-	-	-
Katalambula et al 2017	Tanzania	2016	18-64	d	-	-	45.0	-	-	-
Dewhurst et al 2013	Tanzania	11/2000-7/2010	≥70	a	62.2	75.8	69.9	82.0	68.0	62.3
Cham et al 2018	The Gambia	2010	25-64	a	27.7	30.5	29.0	86.0	71.4	79.0
Guwatudde et al 2016	Uganda	2014	18-69	a	-	-	25.9	-	-	-
Bahendeka et al 2016	Uganda	2014	18-69	a	24.6	24.1	24.3	-	-	-
Twinasiko et al 2018	Uganda	n/a	≥35	n/a	-	-	24.5	-	-	69.7
Mondo etal 2013	Uganda	12/2011-2/2012	25-64	a	22.1	20.5	-	-	-	-
Murphy et al 2013	Uganda	2011	13-97	a	16.9	16.1	16.5	-	-	-
Asiki et 2015	Uganda	2011	≥13	a	13.6	11.3	12.3	-	-	-
Musinguzi et al 2013	Uganda	2012	≥15	b	22.3	21.7	21.8	87.6	37.4	71.8
Musinguzi et al 2015	Uganda	2012	≥15	b	-	-	20.2	-	-	-
Mayega et al 2013	Uganda	2012	35-60	c	-	-	20.5	-	-	-
Mayega et al 2012	Uganda	2012	35-60	c	20.7	20.4	20.5	-	-	-
Guwatudde et al 2015	Uganda	2014	18-69	a	28.3	25.2	26.4	-	-	92.3

Study	Country	Survey year	Age Group	BP Measurement	Hypertension Prevalence (%)			% of hypertension that is undiagnosed		
				-	M	F	All	M	F	All
Siziya et al 2012	Zambia n/a	n/a	≥25	b	33.5	31.1	32.3	64.2	29.9	44.6
Mulenga et al 2013	Zambia(Kaoma)n/a	n/a	≥25	b	27.5	24.6	25.8	-	-	-
	Zambia(Kassama)	n/a	≥25	b	31.3	29.5	30.3	-	-	-

u= urban, r=rural, n/a= not available, M= Men, F= Women

Shaded rows= study that used 25-64 age cohort; +* excluded participants with diabetes

Measurement used in analysis

a=mean of second and third based on 3 measurements

b =mean of three measurements

c =mean of two measurements

d =others

- Information not available/not reported

Table 3.4: Prevalence of Hypertension from articles reviewed (using other definitions)

Study	Country	Survey year	Age Group	Measurement	Hypertension prevalence (%)			% of hypertension that is undiagnosed
					M	F	All	All
Okafor et al 2014a	Nigeria	n/a	≥15	a	40.8	40.4	40.6^	100.0**
Okafor et al 2014b	Nigeria	06/2006-03/2007	18-70	a	-	-	47.7^	100.0**
Nawi et al 2006	Ethiopia	2002	25-64	d	11.8	7.1	-	-
Goma et al 2011	Zambia	n/a	≥25	b	38.0	33.3	34.8	-
Mufunda et al 2006	Eritrea	2004	15-64	d	16.9	15.3	-	80.0
Oguoma et al 2015	Nigeria	2014	≥18	a	-	-	35.7	-
Bushara etal 2015	Sudan	2013	18-90	b	36.7	39.3	38.2*	100.0**
Baragou etal 2012	Togo	10/2009-01/2010	18-98	b	27.7	25.7	26.6	67.3
Keetile Mpho et al 2015	Botswana	2007	25-64	n/a	9.9	18.9	28.8	-

^Participants with history of hypertension and/or diabetes excluded

*study on undiagnosed hypertension

Shaded rows= study used 25-64 age range

**All cases of hypertension were undiagnosed

Measurement used in analysis

a=mean of second and third based on 3 measurements

b =mean of three measurements

c =mean of two measurements

d =others

- Information not available/not reported

Table 3.5: Prevalence of Hypertension (WHO Fact sheets and reports)

Country	Survey date	Mean Systolic BP*			Mean Diastolic BP*			HBP≥140/90 or reported**			HBP≥160/100			% with HBP not on treatment		
		M	F	All	M	F	All	M	F	All	M	F	All	M	F	All
Benin(Cotonou)	2007	130.8	126.2	128.0	80.2	79.5	79.8	29.1	28.2	28.6	13.5	14.8	14.3	-	-	-
Benin	2008	130.3	127.5	128.9	79.2	79.2	79.2	28.7	28.7	28.7	9.7	13.6	11.6	-	-	-
Benin	2015	127.5	123.5	125.4	81.7	81.0	81.3	27.8	24.3	25.9	-	-	-	96.9	95.4	96.2
Botswana	2007	129.8	129.0	129.8	80.1	83.4	81.9	28.8	37.0	33.1	10.9	21.0	16.2	-	-	-
Botswana	2014	130.8	123.7	127.3	80.0	79.7	79.8	30.4	28.4	29.4	12.5	15.0	13.7	84.8	67.1	76.4
Burkina Faso	2013	124.3	119.5	121.7	77.7	76.9	77.2	19.4	16.0	17.6	-	-	-	97.7	92.0	94.9
Cameroon	2003	125.7	119.7	122.1	75.2	74.0	74.5	19.9	15.5	17.3	8.8	7.8	8.2	-	-	-
Ivory Coast	2005	132.4	124.5	128.0	78.2	75.9	76.9	32.5	20.7	25.9	13.1	8.8	10.7	-	-	-
Congo(Brazzaville)	2004	129.5	125.8	127.7	83.8	82.8	83.3	34.1	32.5	33.3	16.6	18.0	17.3	-	-	-
Cape Verde	2007	137.0	129.6	133.3	79.8	79.7	79.8	43.8	33.5	38.7	12.3	17.1	14.8	-	-	-
Central African Republic	2010	128.7	127.5	128.1	83	81.3	82.1	36.8	32.3	34.5	-	-	-	94.3	86.6	90.7
Chad (Njamena)	2008	125.9	119.3	123.1	75.6	75.9	75.7	27.7	27.6	27.6	8.3	12.7	10.2	-	-	-
Comoros	2011	128.6	125.7	127.2	77.5	79.1	78.3	24.2	26.5	25.4	-	-	-	90.9	81.1	85.8
Democratic Republic of Congo	2005	122.5	117.2	119.3	75.6	73.7	74.4	19.9	15.3	17.1	8.0	6.1	6.8	-	-	-
Eritrea	2004	121.2	116.4	118.8	77.7	76.4	77.0	17.6	15.6	16.6	4.0	6.3	5.2	-	-	98.3
Ethiopia(Butajira)	2003	117.4	108.9	112.6	75.4	70.7	72.7	11.9	6.6	8.9	4.0	2.7	3.3	-	-	-
Ethiopia(Addis Ababa)	2006	128.8	125.3	126.7	80.9	79.4	80.0	32.0	30.2	30.9	13.3	15.2	14.4	-	-	-
Ethiopia	2015	120.2	118.7	119.5	76.5	78.8	77.5	15.7	16.5	16.0				15.3	16.0	15.6
Gabon	2009	126.0	119.6	122.8	76.6	73.9	75.3	22.2	18.4	20.3	8.7	9.0	8.8			
Gambia	2010	130.5	129.3	129.9	79.9	80.0	80.0	26.4	26.1	26.3	-	-	-	95.2	86.5	90.6
Ghana(Accra)	2006	136.6	131.4	133.2	82.6	83.3	83.1	41.4	37.8	36.7	-	-	-	95.0	85.6	89.1
Guinea	2009	130.9	128.8	129.9	76.5	79.1	77.8	28.3	28.0	28.1	-	-	-	-	-	-
Kenya	2015	126.9	122.1	124.4	80.3	81.0	80.7	25.1	22.6	23.8	7.5	9.4	8.4	95.2	88.3	91.8
Lesotho	2012	126.1	126.2	126.1	80.5	84.5	82.6	26.3	35.6	31.0	-	-	-	91.8	78.1	83.8
Liberia	2011	129.7	127.8	128.7	79.5	79.9	79.7	30.3	31.0	30.7	-	-	-	90.5	86.0	88.2

Country	Survey date	Mean Systolic BP*			Mean Diastolic BP*			HBP≥140/90 or reported**			HBP≥160/100			% with HBP not on treatment		
		M	F	All	M	F	All	M	F	All	M	F	All	M	F	All
Madagascar	2005	129.4	127.2	128.3	82.9	82.9	82.9	36.3	35.4	35.8	15.0	15.8	15.4	-	-	-
Malawi	2009	135.8	130.3	132.8	79.1	79.1	79.1	37.2	29.2	32.9	-	-	-	96.4	93.3	94.9
Mali	2007	115.6	116.8	116.3	71.1	72.4	71.9	11.9	18.7	15.9	6.3	10.4	8.7	-	-	-
Mauritania (Nouakchott)	2006	127.2	123.9	125.2	76.5	77.1	76.9	20.6	23.8	22.4	7.8	9.9	9.0	-	-	-
Mauritius	2004	-	-	-	-	-	-	30.6	26.9	28.5	-	-	-	-	-	-
Mozambique	2005	136.0	131.5	133.4	80.0	80.0	79.9	37.5	33.0	34.9	15.0	15.6	15.4	-	-	-
Niger	2007	136.4	130.7	133.7	82.3	80.3	81.3	41.7	30.4	36.3	15.1	11.4	13.4	-	-	-
Nigeria(Lagos)	2003	-	-	-	-	-	-	-	-	34.8	-	-	-	-	-	-
Rwanda	11/2012-03/2013	-	-	-	-	-	16.1	14.1	15.0	-	-	-	-	-	-	-
Sao Tome and Principe	2008	136.7	132.7	134.6	81.8	82.6	82.2	41.1	36.3	38.6	16.6	20.1	18.4	-	-	-
Senegal	2015	125.6	123.0	124.3	79.4	82.3	80.9	29.8	24.5	34.7	-	-	-	95.0	94.0	94.4
Seychelles	2004	131.1	124.4	127.8	85.5	81.3	83.4	43.6	35.6	39.6	26.5	27.8	27.1	-	-	-
Sierra Leone	2009	132.7	129.0	130.8	80.0	80.6	80.3	36.6	33.1	34.8	-	-	-	94.1	92.4	93.2
Swaziland	2007	126.8	124.9	125.8	80.4	81.1	80.8	37.6	34.7	36.0	16.1	17.7	17.0			
Swaziland	2014	126.0	122.3	124.0	78.4	80.7	79.7	22.9	25.9	24.5	-	-	-	87.0	72.8	78.9
Sudan	2005	130.2	131.2	130.8	84.0	84.0	84.0	24.8	22.7	23.6	9.4	10.0	9.7	-	-	-
Tanzania	2012	131.1	126.3	128.6	79.7	80.8	80.3	25.4	26.5	26.0	-	-	-	96.7	88.9	92.6
Togo	12/2010-01/2011	122.6	117.9	120.1	75.1	74.9	75.0	20.6	17.7	19.0	-	-	-	95.9	85.4	90.7
Uganda	2014	126.6	122.5	124.5	80.2	80.9	80.6	25.8	22.9	24.3	-	-	-	96.9	90.1	93.5
Zambia(Lusaka)	2008	135.1	131.2	132.5	82.0	81.9	81.9	36.6	31.7	33.3	14.2	16.9	16.0			
Zanzibar (Tanzania)	2011	135.0	128.0	131.3	78.2	77.9	78.0	37.0	29.4	33.0	-	-	-	88.5	85.5	87.1
Seychelles	2013-2014	137.3	127.2	-	82.0	78.3	-	42.7	35.6	-	13.1	6.7	-	-	-	-
Zimbabwe	2005	131.1	133.2	-	81.7	83.9	-	23.2	29.0	-	8.5	13.3	-	-	-	-

*BP=Blood pressure, **systolic ≥ 140 and/or diastolic ≥ 90 mmHg or currently on medication for hypertension. (as diagnosed by a doctor or health professional, which included all participants receiving treatment) ; Shaded rows= study used 25-64 age range

- Information not available/not reported

3.7.4 Factors associated with hypertension in sub-Saharan Africa

Hypertension was present in all age groups in all the studies reviewed but prevalence increased significantly with age in all countries. There was no consistency in the direction of the associations between gender and hypertension. No significant difference was observed in most of the studies reviewed. However, in some of the studies, the prevalence was significantly higher among males while the reverse was observed in other studies (Table 3.7). The association between hypertension and socioeconomic status (SES)/education/occupation was not conclusive, as low SES was associated with increased risk of hypertension in some studies but the reverse was observed in other studies; most of the studies did not find a statistically significant association. Urban residents were generally at an increased risk of hypertension compared with rural residents. There was a positive correlation between hypertension and modifiable risk factors such as overweight/obesity, tobacco use and alcohol consumption. However with the exception of overweight/obesity, the association between hypertension and most of these risk factors were largely not statistically significant. Table 3.6 summarises the risk factors associated with hypertension and Table 3.7 summarises the magnitude of the associations.

Table 3.6: Factors associated with hypertension in multivariate analysis

Author	Country and survey year	Variables included in regression model	Variables associated with hypertension	Variables not statistically significantly associated
Pedro et al 2018	Angola 09/2013-03/2014	Age, residence, education, BMI, abdominal obesity, smoking, alcohol use	Age, education, BMI, abdominal, smoking, alcohol use	residence, smoking,
Pires et al 2013	Angola 2011	Age, education, BMI, abdominal obesity, alcohol use and tobacco use	Old age , lower level of education, high BMI and abdominal obesity(men only), tobacco use (men only)	Tobacco use and abdominal obesity in women
Houehanou et al 2015	Benin 2008	Age , gender and occupation	Age and gender	Occupation (excluded in final model)
Keetile Mpho et al 2015	Botswana 2007	Gender, age, daily smoking, hazardous drinking, lack of physical activity, poor veg consumption, type of employment, obesity	Model I: whole sample(Gender, age, type of employment, obesity) Model II: Males(age, type of employment, education and obesity) Model III: Females(age and obesity)	Model I: smoking, drinking, lack of physical activity(PA), poor veg consumption, and education Model II: smoking, drinking, lack of PA and poor veg consumption. Model III: smoking, drinking, lack of PA, poor veg consumption, type of employment and education
Soubeiga et al 2017	Burkina Faso 2013	Age , gender, education, marital status, family history of high blood pressure, smoking, physical activity, type of fat used, BMI, HDL cholesterol	Rural: Age, marital status, gender, family history of hypertension, type of fat used, BMI, HDL cholesterol, Rural: Age and BMI	Rural: Education, smoking and physical activity Urban: All the variables except age and BMI
Kengne et al 2007	Cameroon 2004	Age, alcohol use, tobacco use, obesity, sedentary	Age and obesity	Alcohol use, tobacco use, sedentary
Arrey et al 2016	Cameroon 2013	Age, marital status, educational status, body mass index, smoking, alcohol, diabetes	Age, marital status, educational status, body mass index,	smoking, alcohol, diabetes
Tianyi et al 2018	Cameroon 2013	Age, sex, marital status, education, occupational level	overweight/obesity	Age, sex, marital status, education occupational level,
Mbouemboue et al 2017	Cameroon 2014	Age, sex, obesity, alcohol consumption, tobacco consumption, physical inactivity, excess salt consumption, hyperglycaemia, marital status	Age, alcohol consumption, hyperglycaemia, marital status	Sex, tobacco use, physical inactivity, obesity (? the results are contradictory), excess salt intake,
Longo- Mbenza et al 2008	DRC	Gender, age ≥40, age≥60 diabetes, Obesity BMI≥30) BMI≥27, Kg/m^2, abdominal obesity	Age ≥40, age≥60 , Obesity BMI≥30) BMI≥27, Kg/m^2, abdominal obesity	Gender and diabetes

Author	Country and survey year	Variables included in regression model	Variables associated with hypertension	Variables not statistically significantly associated
Mufunda et al 2006	Eritrea 2004	Two models were run BMI (using BMI categories) and BP (three different forms of BP: SBP, DBP and MAP) and Model II SBP and BMI in two age groups, <45 and >45	For model I, BP was positively correlated with BMI but only the regression coefficient for normal BMI and SBP and MAP were significant. None of the variables model in II was significant	
Helelo et al 2014	Ethiopia	Age, gender, veg eating habit/week, salt intake, no of days walking 10mins/week, family history of hypertension, BMI	Age, gender, veg eating habit/week, salt intake, family history of hypertension, BMI	Not mentioned and does not also appear in the tables
Demisse et al 2017	Ethiopia	Age, sex, birth place, marital status, alcohol use, religious fasting practice, BMI,	Age, sex, birth place, marital status	total cholesterol, fasting blood glucose, alcohol use, religious fasting practice
Tesfaye et al 2007	Ethiopia 2003&2004	Age, BMI, Gender, Education, occupation, residence	Age, BMI, Gender, residence	Education, occupation
Abebe et al 2015	Ethiopia 2012	Age, gender, waist circumference, FBG, BMI, residence, smoking, currently alcohol use, moderate physical activity	Age, FBG, BMI, currently alcohol use	Gender, waist circumference, residence, smoking. moderate physical activity
Awoke et al 2012	Ethiopia 2012	Age, education level, marital status, occupation, BMI, self-reported DM, family history of HTN, vegetable use /week, walking status for 10 minutes	Age, self-reported diabetes BMI, family history of hypertension	Education level, marital status, occupation, vegetable use /week, walking status for 10 minutes
Anteneh et al 2015	Ethiopia 2014	Age, marital status, occupation, ever smoked, no of hours spent walking/cycling, Hours spent watching TV, occupation involves vigorous PA, occupation involves moderate PA, walk /bike to work, number of days walked /week, number of hours spent to walk /cycle/day, history of high blood glucose, add additional salt to food and BMI	Age, ever smoked, no of hours spent walking/cycling. Hours spent watching TV, history of high blood glucose, add additional salt to food and BMI	Occupation, occupation involves vigorous PA, occupation involves moderate PA, walk /bike to work, number of days walked /week, number of hours spent to walk /cycle/day
Asfaw etal 2018	Ethiopia 2014	Age, sex, marital status, aerobic physical activity	Age, sex, marital status, aerobic physical activity	
Gebrihet at al 2017	Ethiopia 2015	Age, education, fruit consumption, vegetable use, physical activity, family history of hypertension, knowledge on physical activity s a risk factor of hypertension, knowledge on stress as a risk factor of hypertension, BMI	Education, fruit consumption, physical activity, knowledge on physical activity as a risk factor of hypertension, BMI	Age, vegetable use, family history of hypertension, , knowledge on stress as a risk factor of hypertension, BMI
Gebreyes et al 2018	Ethiopia 2015	Age, sex, locality, BMI, quintiles of income, physical activity, frequency of adding salt,	Age, locality, BMI, raised waist circumference, waist hip ratio level, raised total cholesterol	Sex, quintiles of income, physical activity, frequency of adding salt,

Author	Country and survey year	Variables included in regression model	Variables associated with hypertension	Variables not statistically significantly associated
		raised waist circumference, waist hip ratio level, raised blood glucose, raised total cholesterol		frequency of adding salt, raised blood glucose
Tesfaye et al 2009	Ethiopia n/a	Gender, age , BMI , waist to hip ratio, education level, religion, ethnic group, smoking, physical activity, add salt to plate, binge drinking	Age, gender, BMI and education, religion (females only), physical activity (males only)	Ethnic group, WHR, daily smoking, adding salt to plate, binge drinking
Minicuci et al 2013	Ghana 2007/08	Age, gender, residence, education level, income, BMI, physical activity, smoking and alcohol use	Two models were run, one for measured HTN and the other for reported HTN. Only BMI and residence were associated with HTN in both models	
Joshi et al 2014	Kenya 2010	Logistic regression (The association between HTN and three measure of obesity, BMI , WC and WHR was assessed and they all remained significantly associated with HTN after adjusting for age, sex, smoking and alcohol except WHR) Linear regression (age, WC, BMI and gender and their association with SBP and DBP)	Age, sex, alcohol, obesity, waist circumference defined obesity, diabetes, elevated waist	Logistic regression (waist hip ratio) For linear regression the authors didn't mention which variables were significantly associated with increased SBP and DBP but increased age, waist circumference and BMI both increased SBP and DBP. Being female was associated with a higher increase in both SBP and DBP
Olack et al 2015	Kenya 2013	Age, gender, marital status, education, occupation, wealth quintiles, current smoking, alcohol consumption, physical activity, BMI	Age, marital status, BMI, physical activity, wealth quintiles	Age, education, occupation, , current smoking, alcohol consumption,
van de Vijver et al 2012	Kenya2008-2009	Age, ethnicity, current smoking, drinking, BMI waist circumference, diabetes	Age, ethnicity, current drinking(men), ethnicity, BMI waist circumference, diabetes(females)	Not mentioned. Report only indicates variables associated with HTN at p 0.2 were entered in a multi variate model.
Price et al 2018	Malawi 05/2013-02/2016 Men	Site(residence), age, wealth quintiles, education, employment, physical activity, smoking, alcohol consumption, sugary drinks intake/ teaspoons of sugar per day, BMI, waist-hip ratio	Site(residence), age, wealth quintiles, education, physical activity, sugary drinks intake/ teaspoons of sugar per day, BMI, waist-hip ratio	employment, smoking, alcohol consumption
	Women	Site(residence), age, wealth quintiles, education, employment, physical activity, smoking, alcohol consumption, sugary drinks intake/ teaspoons of sugar per day, BMI, waist-hip ratio	Site(residence), age, wealth quintiles, education, physical activity, sugary drinks intake/teaspoons of sugar per day, BMI, waist-hip ratio	Education, employment, smoking, alcohol consumption,
Ba et al 2018	Mali 2013 Rural setting	Age, sex, marital status, educational level, smoking ,alcohol consumption, BMI, waist circumference, waist-to-hip ratio and diabetes	Age, waist hip ratio, resting heart rate >90/min,	Sex, marital status, education, smoking, alcohol consumption, BMI, waist circumference, diabetes

Author	Country and survey year	Variables included in regression model	Variables associated with hypertension	Variables not statistically significantly associated
	Urban setting	Age, sex, marital status, educational level, smoking ,alcohol consumption, BMI, waist circumference, waist-to-hip ratio and diabetes	Age, sex, BMI, waist circumference	Sex, marital status, education, smoking, alcohol consumption, BMI, waist circumference, diabetes, resting heart rate >90/min,
Damasceno et al 2009	Mozambique 2005	The association between HTN and rural/urban residence was assessed adjusting for age, education and BMI		
Ezeala-Adikaibe et al 2016	Nigeria	Age, gender, education, BMI, diabetes, family history of HTN, tobacco use , stroke	Age, BMI	Gender, education, diabetes, family history of HTN, tobacco use , stroke
Okpechi etal 2013	Nigeria 08/20103/2012	Age, gender, place of residence, use of smokeless tobacco, smoking, alcohol use, physical activity, annual income	Age, gender and overweight/obesity	Smoking, alcohol use, physical activity
Nahimana et al 2017	Rwanda 11/2012-04/2013	Age, gender, locality, education, marital status, occupation, smoking, alcohol consumption, physical activity, Fruit and vegetable intake, BMI, blood glucose, total cholesterol, HDL cholesterol	Age, gender, locality(semi-urban), occupation, alcohol consumption, , BMI, HDL cholesterol	education, marital status, smoking, physical activity, fruit and vegetable intake, blood glucose, total cholesterol,
Danon-Hersch N et al 2007	Seychelles 2004	The association between BMI and systolic and DBP was assessed controlling for age, sex, survey year, alcohol intake, treatment for hypertension and occupation.	Difficult to determine from tables and report but age and BMI are associated with SBP and DBP	From the report, its only smoking as only smoking was not associated with hypertension and only the variables associated with SBP or DBP were entered in the multivariate analysis.
Maimela et al 2016	South Africa	Age, overweight/obesity, smoking , alcohol consumption	Age, overweight/obesity, alcohol consumption	Smoking
Dewhurst et al 2013	Tanzania 11/2000-7/2010	Age, gender, BMI, highland/lowland dwelling, Tribe	Age, gender(being female), BMI, highland dwelling, Chagga tribe	Moderate/severe disability
Mosha et al 2017	Tanzania 2013	Age , gender, education level, marital status, residence, alcohol use, smoking, waist circumference, BMI, raised blood sugar and HIV status	Age , gender, waist circumference, BMI, raised blood sugar, HIV status,	Education level, marital status, residence, alcohol use, and smoking
Katalambula et al 2017	Tanzania 2016	Age, BMI, healthy dietary pattern	Age, BMI, healthy dietary pattern	Gender, education level, employment, marital status,
Cham et al 2018	The Gambia 2010 Men	Age, ethnicity, education, residence, physical activity, smoking, servings of fruits and vegetable, BMI, abdominal obesity	Age, residence, smoking, abdominal obesity	Ethnicity, education, physical activity, servings of fruits and vegetable, BMI,

Author	Country and survey year	Variables included in regression model	Variables associated with hypertension	Variables not statistically significantly associated
	Women	Age, ethnicity, education, residence, physical activity, servings of fruits and vegetable, BMI, abdominal obesity	Age ethnicity, residence, physical inactivity, BMI, abdominal obesity	Ethnicity, education, servings of fruits and vegetable,
Twinasiko et al 2018	Uganda	Age, gender, employment status, ever smoked, current smoking, sedentary workstyle, told have elevated BP by health worker, past diagnosis of diabetes, seen a traditional healer for diabetes in the pas t 12 months, fasting blood glucose, obesity	Age, sedentary work style, NB: All the variables except gender and current smoking were associated with hypertension in the univariate analysis but only age , obesity and sedentary work style were included in the adjusted model ;the authors did not mention the reasons	Obesity
Musinguzi et al 2013	Uganda 2012	Age, gender, residence, level of education, marital status, tobacco smoking, alcohol use, BMI	Age, residence, BMI	Gender, level of education, marital status, tobacco smoking, alcohol use
Musinguzi et al 2015	Uganda 2012	Age, gender, residence, level of education, alcohol use, BMI	Age, residence, level of education, alcohol use, BMI	Gender and education
Mayega et al 2012	Uganda 2012	Age group, gender, residence, SES quintile, family history of diabetes, BMI, physical activity, stress level, knowledge about life style diseases, tobacco use, harmful use of alcohol, dietary diversity,	Age group, BMI, residence, knowledge about life style diseases	Education, Gender, SES quintile, family history of diabetes, physical activity, stress level, tobacco use, harmful use of alcohol, dietary diversity
Guwatudde et al 2015	Uganda 2014	Age, gender, residence(rural-urban), region, education, ethnicity, BMI, Fasting blood glucose, physical activity, tobacco use, alcohol use, add salt to food, fruit and vegetable intake.	Age and BMI	Age, gender, residence ,region, education, ethnicity, BMI, Fasting blood glucose, physical activity, tobacco use, alcohol use, add salt to food, fruit and vegetable intake.
Mulenga et al 2013	Zambia n/a	Age, BMI, smoking and heart rate	Multivariate analysis was stratified by district. Age and BMI in Kaoma and age, smoking and heart rate in Kassama	gender, education, time spent sitting, cigarette smoking, WHR, cholesterol level and Fasting blood glucose
Goma et al 2011	Zambia n/a	Age, gender, BMI, alcohol consumption, sedentary lifestyle, and FBG	Age, gender, BMI, alcohol consumption, sedentary lifestyle, and FBG	
Siziya et al 2012	Zambia n/a	Age , BMI and education	Age and BMI	Education Gender, sedentary life style, alcohol consumption, cigarette smoking, WHR, and heart rate

BMI=Body mass index

FBG=fasting blood glucose, WHR= waist to hip ratio

Table 3.7: Magnitude of factors associated with hypertension in multivariate analysis

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
Pires et al 2013	Angola 2011 Females	18-40:1 41-64:7.2(4.7-10.9)		≥9years:1 5-8 years:1.2 (0.4-3.3) 1-4 years:1.6(0.6-4.3) None:2.6 (1.0-7.2)		<25: 1 25-30: 1.3 (0.8-2.0)	Abdominal obesity (Yes):2.5 (1.5-4.0)	Tobacco use, alcohol use
	Males	18-40:1 41-64:1.7 (1.1-2.6)		≥9 years :1- 5-8 years:1.3 (0.8-2.1) 1-4 years:1.4 (0.7-2.6) None :1.8 (0.9-3.4)		<25: 1 25-30: 1.9 (1.1-3.3) ≥30: 4.2 (1.4-13.0)	Tobacco use(Yes):1.6 (1.0-2.7	alcohol use
Pedro et al 2018	Angola 09/2013-03/2014 Males	15-24:1 25-34: 4.6(2.6-8.2) 35-44:8.7(4.7-16.0) 45-54:16.2(8.7-30.0) 55-64:26.4(13.9-50.0)		Years completed >10 years: 1 None: 2.0(0.6-8.2) 1-4(years): 0.8(0.5-1.5) 5-9 years: 0.9(0.6-1.4)		Underweight: 1 Normal: 1.3(0.7-2.5) Overweight: 2.2(1.1-4.7) Obese: 5.1(1.9-13.4)	Abdominal obesity No: 1 Yes : 2.8(1.8-4.3) Alcohol consumption No consumption: 1 Occasional (< 3days/week): 2.5(1.6-4.0) Frequent(≥3 days/week): 2.5(1.7-3.9)	
	Females	15-24:1 25-34: 6.6(2.8-15.4)		Years completed >10 years: 1		Underweight: 1 Normal: 1.1(0.6-2.1)	Abdominal obesity No: 1 Yes : 1.6(1.2-2.3)	

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m²)**	**Other significant variables included in final model**	**Other variables retained in final model**
		35-44:20.3(8.9-46.5) 45-54:36.6(16.0-83.8) 55-64:63.4(27.1-147.9)		None: 4.3(1.8-10.2) 1-4(years): 2.4(1.0-5.4) 5-9 years: 2.2(0.9-5.1)		Overweight: 1.2(0.6-2.3) Obese: 2.0(1.0-4.1)	Alcohol consumption No consumption: 1 Occasional (< 3days/week): 0.9(0.6-1.4) Frequent(≥3 days/week): 1.7(1.1-2.7)	
Houehanou et al 2015	Benin 2008 (adjusted for age group and gender)				R:1 U:1.4(1.2–1.6)		None	None
Keetile Mpho et al 2015	Botswana 2007 (Model I: All)	25-34:1 35-44: 2.1(1.6–2.8) 45-54: 3.7(2.5–5.1) 55-64: 7.1(5.0–9.9)	M: 1 F:1.9(1.5–2.4)	Primary/ less:1 Secondary:1.0(0.8-1.3) Tertiary/higher:1.3(0.9–1.8)		Obesity(No): 1 Yes: 2.1(1.7–2.7)	Employment: Unpaid workers:1 Government employees:1.5(1.1-2.0) Non-government employees:1.3(1.0-1.6) Self-employed:1.(0.8-1.5)	Daily smoking, Lack of PA, Poor vegetable consumption
	(Model II: Males)	25-34:1 35-44: 1.5(0.9-2.4) 45-54:2.8(1.7-4.8) 55-64:6.3(3.6-11.1)		Primary or less:1 Secondary:1.1(0.7–1.8) Tertiary/higher:1.8(1.0-2.7)		Obesity(No): 1 Yes: 3.8(2.4–6.1)	Employment: Unpaid workers: 1 Government employees:1.9(1.2-3.0) Non-government employees:1.6(1.0-2.6) Self-employed:.3(0.8-2.2)	Daily smoking ,Hazardous drinking, Lack of physical activity, Poor vegetable consumption

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
	(Model III: Females)	25–34:1 35–44:2.6(1.8-3.7) 45–54:4.5(3.0-6.6) 55-64:7.9(5.1-12.1)		Primary or less:1 Secondary:1.0(0.7-1.4) Tertiary/higher :1.0(0.6-1.5)		Obesity(No): 1 Yes: 1.7(1.3–2.3)		Employment, Daily smoking, Hazardous drinking, Lack of PA, Poor veg. intake
Soubeiga et al 2017	Burkina Faso 2013 Rural	25-34: 1 35-44: 1.8(1.3-2.5) 45-54:2.8(1.9-4.1) 55-64: 4.5(3.0-6.7)	Male: 1 Female;0.7(0.6-0.9)	None: 1 Primary: 0.8(0.6-1.2) Sec/Tertiary: 1.1(0.5-2.1)		Underweight: 1 Normal: 1.0(0.7-1.5) Overweight: 1.9(1.1-3.1) Obese: 4.6(2.2-9.7)	Marital status Single: 1 Married : 0.4(0.2-0.8) Divorced/widowed:0.7(0.3-1.5) Family history of HBP Yes: 1 No: 0.6(0.4-0.8) Main type of fat used None: 1 Vegetable oil: 1.4((0.9-2.0) Butter/lard/margarine: 2.0(1.2-3.2) Family history of HBP Yes : 1 No : 0.6(0.5-0.8) HDL cholesterol High: 1 Low : 1.8(1.3-2.2)	Smoking, physical activity
	Urban	25-34: 1	Male: 1	None: 1		Underweight: 1		Marital status,

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m²)**	**Other significant variables included in final model**	**Other variables retained in final model**
		35-44: 1.4(0.8-2.3) 45-54:3.0(1.7-5.4) 55-64: 7.7(4.1-14.6)	Female: 0.8(0.5-1.2)	Primary:1.2(0.7-2.0) Sec/Tertiary: 1.1(0.6-1.7)		Normal: 2.0(0.8-5.2) Overweight: 3.8(1.4-10.1) Obese: 8.0(2.9-21.8)		Family history of HBP, physical inactivity, HDL cholesterol
Kengne et al 2007	Cameroon 2004	Age (continuous):1.1 (1.1-1.1)				Underweight /normal:1 Obese/overweight:1.9(1.4-2.5)		Alcohol use ,Tobacco smoking Sedentarily
Mbouemboue et al 2017	Cameroon 2014	< 30 : 1 30-39: 0.9(0.4-2.2) 40-49: 3.8(1.7-8.9) ≥ 50:7.1(3.4-15.2)	Male : 1 Female: 0.8(0.4-1.7)			Obesity Yes: 1 No: 1.0(0.05-0.2) It is not correct but this is how it was reported in the manuscript	Marital status: Unmarried: 1 Divorced: 4.1(0.9-18.3) Married: 0.8(0.4-1.6) Widowed: 1.2(0.1-12.5) Alcohol consumption No: 1 Yes 0.2(0.05-0.5) Hyperglycaemia No ; 1 Yes : 4.2(1.2-15.2)	Tobacco consumption, physical inactivity, Excessive salt consumption,
Arrey et al 2016	Cameroon 2013	20-39: 1 40-59: 3.0(2.0-4.6) 60-79: 8.3(4.4-15.7) ≥ 80: 11.6(2.1-64.6)		High :1 None : 6.7(3.6-12.4) Primary:2.0(1.3-3.2) Secondary: 1.2(0.7-2.0)		Normal: 1 Overweight: 1.0(0.7-1.5) Obese: 2.8(1.9-4.2)	Marital status: Unmarried: 1 Married: 1.5(1.1-2.2)	Smoking, alcohol use, diabetes

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
Tianyi et al 2018	Cameroon 2013					Overweight/ obesity: 3.5(2.4-5.0)		Occupation
Tesfaye et al 2009 Males (SBP)	Ethiopia survey year n/a Multi-variable Linear regression(β(95% CI for β)	Age: 0.6(0.5-0.7), p<0.000		Education:-0.5(-0.7 -0.2), p<0.000		BMI: 1.5(1.2-1.8), p<0.000	Total physical activity: -1.6 (-2.9 -0.4),p=0.013	Religion, Ethnic group, WHR, Current daily smoking, Adding salt on plate ,Binge drinking
	Females (SBP)	Age: 0.6((0.6-0.7), p<0.000		Education:-0.5(-0.7 -0.3)		BMI: 0.9(0.7-1.1), p<0.000	Waist-to-hip ratio:12.2(1.0-23.2),p=0.032 Religion: 3.9(0.1-7.7), p=0.043	Total physical activity, Ethnic group, Current daily smoking, Adding salt on plate ,Binge drinking
	Males (DBP)	Age: 0.2(0.1-0.3), p<0.001		Education: -0.1(-0.2-0.1)		BMI: 1.0(0.8-1.1), p<0.000	Current daily smoking: 2.3(-0.9-5.4), p=0.001	Religion, Ethnic group, WHR, Total PA, Adding salt on plate ,Binge drinking
	Females (DBP)	Age:0.1(0.0-0.1), p=0.005		Education: -0.1(-0.2-0.1)		BMI: 0.7(0.6-0.9), p<0.000	Waist-to-hip ratio: 6.6(0.1-13.1), p=0.046	Religion, Ethnic group Current daily smoking, Total PA, Adding salt on plate , Binge drinking

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
Abebe et al 2015	Ethiopia 2012	Age(continuous):1.1 (1.1-1.1)	M:1 F:1.2 (1.0-1.5)		Rural:1 Urban: 1.3 (0.9-1.7)	BMI (continuous): 1.1 (1.0-1.1)	WC(continuous):1.0 (1.0-1.0) FBG (continuous):1.0 (1.0-1.0) Alcohol use (No):1. (yes):1.7 (1.2-2.4)	Smoking At least Moderate PA
Tesfaye et al 2007	Ethiopia 2003&2004	25–34: 1 35–44: 1.3(1.0-1.8) 45–54:2.2(1.5-3.1) 55–64:4.7(3.3-6.6)	Male: 1 Female:0.5(0.4-0.8)	No formal education:1 1-6 years of schooling :0.9(0.6-1.2) > 6 years of schooling:1.1(0.7- 1.7)	Rural:1 Urban: 1.42(1.02, 1.96)	BMI<18.5 :1 BMI:18.5–24.99: 1.1(0.9-1.5) BMI 25.0+: 2.5(1.4-4.3)		Main Occupation
Anteneh A et al 2015	Ethiopia 2014	30–40 : 1 41–50 :2.5(1.3–5.0) .50 years:7.1(3.5–14.2)				<18.5:1 18.5–24.9: 2.1 (0.7–6.0) 25.0–29.5: 6.7(2.2–20.5) >30.0: 11.6 (2.9–46.2)	Ever smoked cigarettes(No): 1 Ever smoked cigarettes(Yes): 3.2(1.4–7.7) Number of hours spent watching TV per day(≥4):1 (<4):2.1(1.3–5.8) Had history of high blood sugar level (No): 1 (Yes):2.8 (1.6–4.8) Add additional salt to food (No): 1 (Yes):3.0(1.4–6.6)	

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
Awoke et al 2012	Ethiopia 2012	35-44: 1 45-54:1.4(0.7-2.7) ≥ 55: 3.3(1.9-5.9)		No formal education: 1 Primary :0.6(0.3-1.2) Secondary:0.9(0.4-1.8) Tertiary: 0.8(0.3-2.1)		Normal :1 Underweight: 0.5(0.2- 1.2) Overweight: 1.6 (0.9-2.6) Obese: 5.5(2.1-14.6)	Self-reported DM(No):1 (Yes) :4.2(1.8-9.7) FHH (No):1 (Yes):2.7(1.4-5.4) Walking status for 10 minutes (Yes):1 (No):2.9(1.2-7.1)	Marital status Occupation Vegetable use/week
Helelo et al 2014	Ethiopia	31-40:1 41-50:8.9(2.9-27.0) > 50:29.5(10.7-81.3)	Female:1 Male: 2.03(1.05–3.93)			Normal:1 Under Weight: 0.2(0.3-2.1) Overweight/ obese: 15.7(7.9–31.2)	vegetable eating habit/week(4-7 days):1 ≤3 days:2.3(1.2-4.5) Salt use(No): 1 Salt use(Yes):6.5(2.3-18.5) number of days walking 10 min/week(4-7 day):1 1-3 day:1.5(0.7–2.9) None in a week: 7.8(2.4-25.8) FHH (No):1 (Yes):2.5(1.3–4.6)	
Gebrihet at al 2017	Ethiopia 2015	18-29: 1 30-49: 0.5(0.2-1.5) ≥50 :0.8(0.3-1.8)		Above secondary: 1 Unable to read and write: 4.7(1.1-20.2) Primary: 31.0.9-11.2) Secondary: 1.3(4.9)		Normal: 1 Underweight: 0.3(0.1-1.7) Overweight/ obesity: 9.2(4.5-18.7)	Fruit consumption: Yes: 1 No :4.3(1.7-10.7) Physical activity Active ; Inactive : 20.1(8.9-46.2) Knowledge on physical inactivity as	Age, vegetable use, family history of hypertension, knowledge on stress as a risk factor of hypertension

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
							a risk for hypertension: 3.6(1.7-7.7)	
Demisse et al 2017	Ethiopia	18-24: 1 25-34: 1.8(1.3-2.6) 35-44:2.7(1.8-3.7) 45-54;3.9(2.7-5.8) 55-64:4.7(3.2-6.9) ≥ 65: 5.6(3.7-8.4)	Female:1 Male: 1.4(1.2-1.7)			Underweight: 1 Normal weight: 1.5(1.1-2.0) Overweight: 2.3(1.6-3.2) Obese: 2.6(1.7-4.0)	Marital status Single: 1 Married: 1.0(0.8-1.3) Separated: 1.9(1.3-2.8) Divorced: 1.1(0.7-1.8) Widowed: 1.9(1.3-2.8)	Alcohol use, religious fasting practice, total cholesterol, fasting blood sugar
Asfaw etal 2018	Ethiopia 2014	25-34:1 35-44:0.4(0.2-0.8) 45-54: 0.1(0.04-0.3) 55-64:0.40.02-1.2)	Female: Male: 1.9(1.1-3.2)				Marital status Single: 1 Married: 4.1(1.0-16.2) Divorced: 1.7(0.3-7.3) Widowed: 1.2(0.2-7.8) Aerobic physical activity Yes :1 No :3.0(1.4-6.5)	

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
Gebreyes et al 2018	Ethiopia 2015	15-24:1 25-34: 1.5(1.2-1.8) 35-44:2.0(1.6-2.5) 45-54:2.7(2.1-3.4) 55-64:4.0(3.1-5.2) 65+: 4.9(3.6-6.7)	Male: 1 Female:1.1(0.9-1.2)		Rural: 1 Urban: 1.3(1.1-1.5)	Underweight: 1 Normal: 1.6(1.3-1.9) Overweight: 2.4(1.8-3.1) Obese: 3.1(2.1-4.5)	Waist circumference Normal :1 Raised: 1.6(1.3-1.9) Waist hip ratio Normal: 1 Raised: 1.3(1.1-1.4) Raised total cholesterol Normal :1 Raised: 1.4(1.1-1.7)	Income, physical activity, frequency of adding salt, raised blood glucose
Minicuci et al 2013	Ghana2007/08 Model I (Measured hypertension)	50-64:1 65-74:1.3(1.1-1.6) 75+:1.1(0.9-1.5)	M:1 F:1.1(0.9-1.4)	No formal education:1 Primary (completed or not):1.1(0.9 - 1.3) Secondary high school:0.9 (0.6-1.4) High school completed:1.2 (0.9-1.5) College and higher:0.7 (0.4-1.1)	U:1 R: 0.8(0.6-1.0)	Normal: 1 Underweight: 0.6(0.5-0.8) Overweight: 1.7(1.4- 2.1) Obese: 2.0(1.5-2.7)	Region Greater Accra: 1 Ashanti:1.1 (0.8 1.7) Brong Ahafo:1.0 (0.7 1.5) Central: 1.0 (0.7-1.5) Eastern:1.0 (0.7-1.5) North :0.9(0.5-1.5) Upper East:0.4(0.2-0.6) Upper West:0.2(0.1-0.5) Volta:1.0(0.65 1.48) Western: 08(0.5-1.2)	
	Model II (Self-reported hypertension)	50-64: 1 65-74:2.0(1.6-2.6) 75+1.6(1.2-2.2)	M:1 F:1.5(1.1-1.9)	No formal education:1 Primary (completed or not):1.28 (0.92 1.79)	U:1 R:0.5(0.3- 0.7)	Normal: 1 Underweight: 0.7(0.4- 1.0) Overweight: 1.9 (1.5-2.4)	Region Greater Accra: 1 Ashanti: 0.6(0.4-1.0) Brong Ahafo : 0.6(0.3-1.0) Central: 0.4(0.3-0.6)	

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
				Secondary high school:1.7 (0.9-3.1) High school completed:2.1(1.5-2.9) College and higher:2.0 (1.2-3.3)		Obese: 2.4(1.7-3.4)	Eastern:0.7(0.4-1.1) North :0.2(0.1-0.4) Upper East:0.1(0.0-1.1) Upper West:0.4(0.1-1.3) Volta: 0.8(0.5-1.3) Western :0.5(0.3-0.7)	
Joshi et al 2014	Kenya 2010	All variables adjusted for age, gender, smoking and alcohol use but AOR for these not reported				18.5-25:1 <18.5: 1.2(0.5-2.7) >25-29.9: 1.8(1.2-2.5) ≥ 30: 2.9(1.9-4.4)	WC(Normal):1 (elevated): 2.4 (1.6-3.6) Diabetes (Yes):1 (No) :4.4 (2.4-8.3)	Waist Hip Ratio (Normal): 1 (High) :1.3 (0.8-2.0)
Olack et al 2015	Kenya 2013	35–44: 1 45–54: 2.3(1.8–3.1) 55–64 :4.5(3.2–6.5)	M: 1 F:0.9(0.6-1.2)	None : 1 Primary:0.8(0.6-1.0) Secondary and above :0.9(0.6–1.2)		Normal :1 Underweight: 1.4(0.8-2.3) Overweight: 2.0(1.5–2.7) Obese: 2.4(1.7–3.4)	Marital status Married : 1 Never Married: 1.2(0.7–2.1) Divorced/Separated :1.2(0.7–2.1) Widowed : 1.7(1.1–2.6) Wealth quintiles Middle :1 Lowest :1.1(0.7–1.6) Second :1.2(0.8–1.7) Fourth : 1.2(0.8–1.7) Highest : 1.6(1.0–2.5) Physical activity (High) :1	Occupation Unemployed:1 Formal Employment:1(0.6–1.6) Casual worker:1.2(0.8–1.8) Self-employed:0.9(0.6–1.3) Current Smoking(Yes):1.1(0.7–1.8) Alcohol consumption(yes): 1.2(0.8–1.6)

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m²)**	**Other significant variables included in final model**	**Other variables retained in final model**
							(Moderate):1.6(1.1-2.2)	
van de Vijver 2012	Kenya 2008-2009 Model I (women)	18–29: 1 30–39: 1.9(1.1–3.1) 40–49: 4.1(2.6–6.7) 50–59: 8.4(5.0–14.2) ≥60: 17.3 (9.8–30.6)				<18.5: 1 18.5-24.9: 0.6(0.3–1.2) 25-29.9: 1.0(0.4–2.4) >30 : 2.3 (1.0–5.5)	Ethnicity Kamba:1 Kikuyu: 0.6(0.4-0.9) Luhya: 0.8(0.4-1.3) Luo: 0.9(0.5-1.5) Others: 0.6((0.3-1.0) Diabetes (RBS≥11.1 mmol/l):(No): 1 (Yes): 3.7(1.8-7.4)	Current drinking WC
	Model II (Men)	18–29:1 30–39: 1.3(0.8–2.0) 40–49: 1.8(1.2–2.8) 50–59: 4.9(3.3–7.4) 60 or older: 7.7(4.9-12.1)				<18.5: 1 18.5– 24.9: 0.6(0.4–0.9) 25– 29.9: 0.7(0.4–1.1) >30: 1.5(0.7–3.1)	Ethnicity Kamba:1 Kikuyu: 0.8(0.6–1.2) Luhya: 0.8(0.5–1.2) Luo :0.5(0.3–0.9) Others:0.8(0.5–1.3) Current drinking (Yes):2.2(1.5–3.1) WC (Normal): 1 94cm (men)/ 80 cm (women): 1.9(1.3–2.9)	Diabetes
Price et al 2018	Malawi 05/2013-02/2016 Men	18-29: 1 30-39: 2.0(1.7-2.4) 40-49: 3.1(2.6-3.6) 50-59: 5.4(4.6-6.3) 60-69: 8.6(7.4-10.0)		Standard 5-8: 1 None: 0.8(0.6-1.0) Standard 1-5: 0.9(0.7-1.0) Secondary: 1.2(1.0-1.4) Post-secondary : 1.4(1.2-1.7)	Karonga(rural): 1 Lilongwe (urban): 1.4(1.2-1.6)	18.0-24.9: 1 < 18.0: 0.8(0.6-1.0) 25.0-29.9: 1.9(1.7-2.1) ≥ 30: 2.8(2.4-3.3)	Wealth quintiles Poorest: 1 Second: 1.1(0.9-1.3) Third: 1.2(1.0-1.4) Fourth: 1.2(1.0-1.4) Wealthiest: 1.3(1.1-1.6) Physical activity Met WHO recommendation: 1	Employment, smoking, alcohol consumption,

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
		≥70: 12.0(10.3-14.0)					Recommendation not meet: 1.2(1.0-1.3) Sugary drinks intake/teaspoons of sugar per day < 6:1 ≥ 6: 0.8(0.8-0.9) Waist-to-hip ratio Normal : 1 High : 1.6(1.4-1.8)	
	Malawi Women	18-29:1 30-39:3.3(2.8-3.9) 40-49:8.3(7.1-9.9) 50-59:18.5(15.7-21.5) 60-69:26.8(22.3-31.0) ≥70:35.1(29.4-41.4)		Standard 5-8: 1 None: 1.1(1.0-1.2) Standard 1-5: 1.1(1.0-1.2) Secondary: 1.1(1.0-1.3) Post-secondary: 1.2(1.0-1.4)	Karonga(rural): 1 Lilongwe (urban): 1.4(1.2-1.5)	18.0-24.9: 1 < 18.0: 0.9(0.8-1.1) 25.0- 29.9: 1.5(1.4-1.6) ≥ 30: 2.0(1.9-2.2)	Wealth quintiles Poorest: 1 Second: 1.0(0.9-1.2) Third: 1.1(1.0-1.3) Fourth: 1.3(1.1-1.4) Wealthiest: 1.3(1.2-1.5) Physical activity Met WHO recommendation: 1 Recommendation not meet: 1.2(1.1-1.3) Sugary drinks intake/teaspoons of sugar per day < 6:1 ≥ 6: 0.8(0.7-0.9) Waist-to-hip ratio Normal : 1	Education, employment, smoking, alcohol consumption,

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m²)**	**Other significant variables included in final model**	**Other variables retained in final model**
							High : 1.3(1.2-1.4)	
Ba et al 2018	Mali 2013 Rural setting	< 30 : 1 30-44: 2.6(1.1-6.4) 45-59: 5.0(2.0-12.4) ≥60: 9.7(3.4-17.7)	Male: 1 Female: 0.4(0.2-1.0)	Unschooled: 1 Level 1: 0.7(0.3-1.7) Level 2: 0.9(0.4-2.0) Level 3: 1.0(0.4-2.3) Level 4(0.2(0.02-1.6)		Underweight: 1 Normal: 1.5(0.4-5.4) Overweight: 1.7(0.4-6.8) Obesity: 1.5(0.3-7.3)	Waist-hip ratio Normal :1 Overweight: 1.4(0.6-3.1) Obese: 2.9(1.2-7.2) Resting heart rate <90/min: 1 >90/min: 4.7(1.3-16.9)	Marital status, smoking, alcohol consumption, waist circumference, diabetes
	Urban setting	< 30 : 1 30-44: 2.1(1.2-3.4) 45-59: 4.3(2.6-7.2) ≥60: 7.3(4.0-13.1)	Male: 1 Female: 0.5(0.3-0.7)	Unschooled: 1 Level 1: 0.9(0.6-1.4) Level 2: 1.0(0.6-1.6) Level 3: 0.7(0.4-1.1) Level 4: 0.5(0.3-1.1)		Normal: 1 Overweight: 1.5(1.0-2.3) Obesity: 2.7(1.6-4.4)	Waist circumference Normal: 1 Overweight: 1.6(1.0-2.6) Obesity: 2.0(1.1-3.4)	Marital status, smoking, alcohol consumption, waist-hip ratio, diabetes, resting heart rate
Damasceno et al 2009 Women (urban vs rural)	Mozambique 2005 Prevalence(measured +diagnosed [a]				2.0 (1.2-3.0)			Assessed the association between place of residence and hypertension, awareness, treatment and control [a](adjusted for age and education) [b](adjusted for age, education and BMI)
	Prevalence(measured +diagnosed [b]				1.7 (1.1-2.7)			
	Awareness(all hypertensive participants) [a]				4.3 (1.9-9.5)			
	Awareness(only participant's having measured their blood pressure before) [a]				2.1 (1.1-4.3)			
	Treatment [a]				1.4 (0.5-4.4)			
	Control(urban vs rural) [a]				0.2 (0.0-1.0)			
	Control(urban vs rural) [b]				0.2 (0.0-1.3)			
Men (urban rural)	Prevalence(measured +diagnosed)[a]				1.3 (0.9-2.0)			
	Prevalence(measured +diagnosed)[b]				1.2 (0.8-1.7)			
	Awareness(all hypertensive participants)[a]				1.5 (0.5-4.7)			

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m²)**	**Other significant variables included in final model**	**Other variables retained in final model**
	Awareness(only participants having measured their blood pressure before)[a]				0.6 (0.2-1.7)			
	Treatment(urban vs rural)[a]				0.3 (0.1-1.4)			
	Control(urban vs rural)[a]				78.1(2.2-2716.6)			
	Control(urban vs rural)[b]				69.3(1.1-4459.2)			
Okpechi et al 2013	Nigeria 08/20103 /2012 β(S.E), P value	Age (continuous):0.012 (0.001), p<0.0001	Gender:0.072 (0.023), p=0.002(did not mention how gender was coded)			Overweight and obesity 0.073 (0.021) ,p=0.001		
Ezeala-Adikaibe et al 2016 (B (%, 95% CI)	Nigeria(multiple linear regression for) SBP	Age (continuous):0.36 (0.23- 0.50), p<0.0001	Gender(0,1):3.25(−0.77 to 7.27),p=10.11	− 1.5(−4.3- 1.2),p=0.28		1.0(0.7 -1.3) p<0.0001		History of diabetes:− History of stroke, FHH
	DBP	Age (continuous):0.12(0.04 - 0.19),p=0.02	Gender(0,1):1.02(−1.23- 3.37),p=0.37	− 0.86 (−2.42 -4.12),p=0.35		0.64(0.46 -0.83) p<0.0001		Tobacco use , History of diabetes History of stroke, FHH
Nahimana et al 2017~~8~~	Rwanda 11/2012-04/2013	15-24: 1 25-34: 1.7(1.3-2.8) 35-44: 2.5(1.8-3.5) 45-54:4.4(3.1-6.1) 55-64: 8.0(5.6-11.4)	Male: Female: 0.8(0.6-0.9)	No formal education:1 Primary school: 0.9(0.8-1.1) Secondary school: 1.2(0.9-1.6) University/higher: 1.0(0.6-1.8)		Rural: 1 Semi-urban: 1.3(1.0-1.7) Urban:1.0(0.6-1.8)	<18.5: 1 18.5-24.9: 1.7(1.3-2.3) 25-29.9: 2.6(1.9-3.6) ≥ 303.9(2.5-6.1)	Alcohol consumption No : 0 Yes: 1.291.1-1.4) HDL cholesterol Low: 0 Normal: 1.2(1.0-1.4) Occupation Employed/paid:1

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m²)**	**Other significant variables included in final model**	**Other variables retained in final model**
								Self-employed: 0.8 (0.6-1.2) Student: 0.5(0.3-0.8) Unemployed : 0.8(0.6-1.3)
Danon-Hersch N et al 2007 1989 (B(95% CI)	Seychelles 2004 Compared 1989 and 2004 surveys	**SBP 1989**		**SBP 2004**		**DBP 1989**	**DBP 2004**	
		Males (all):1.5(1.0-1.9) Males(not treated)1:1.6(1.1-2.1) Women(all) :0.9(0.6-1.3) Women(not treated):1.1(0.8-1.4) Total) (All):1.1(0.8-1.4) Total (Not treated): 1.2(1.0-1.5)		M(all):0.7(0.4-1.0) M(not treated)0.9(0.6-1.2) W(all) :0.3(0.1-0.5) women(not treated)0.4(0.2-0.6) Total(All)0.5(0.3-0.6) Total(Not treated): 0.6(0.4-0.7)		Males (all): 1.2(0.9-1.5) Males(not treated) 1.3(1.0-1.7) Women(all): 0.7(0.6-0.9) Women (not treated):0.8(0.6-1.0) Total) (All): 0.9(0.7-1.0) Total (Not treated): 1.0(0.8-1.1)	Males (all): 0.5(0.3-0.7) Males(not treated) 0.6(0.4-0.9) Women(all) 0.3(0.2-0.4) Women(not treated): 0.4(0.2-0.5) Total) (All): 0.4(0.3-0.5) Total (Not treated): 0.5(0.3-0.6)	Adjusted for age, gender, alcohol intake, occupation and antihypertensive treatment. Not treated: models did not include persons under antihypertensive treatment
Maimela et al 2016	South Africa	15–39:1 ≥40 :4.7(3.2–6.9)				Overweight/Obesity(No): 1 Yes: 1.7(1.2–2.3)	Alcohol consumption(No): 1 (Yes): 1.6 (1.1–2.5)	Smoking, Region Ethnicity, Fasting plasma glucose Met WHO recommendation for PA, Tobacco use Alcohol use Add salt to food during meals Fruit and Veg servings/ day

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m²)**	**Other significant variables included in final model**	**Other variables retained in final model**
Dewhurst et al 2013	Tanzania 11/2000-7/2010	70-74 :1 75-79 :1.1(0.9-1.4) 80-84 :1.2(0.9-1.6) ≥ 85 :1.5(1.1-2.1)	M:1 F:1.8(1.5-2.2)		Lowland village dwelling :1 Upland village dwelling:1.5(1.2-1.9)		Non chagga tribal origin : 1 Chagga tribal origin: 1.7(1.2-2.3)	
Katalambula et al 2017	Tanzania 2016	25-34: 1 35-44: 1.6(1.2-2.2) 45-54:2.3(1.7-3.0) 55-64:2.5(1.9-3.3)				30≥ : 1 <18: 0.4(0.2-0.9) 18-24.9: 0.8(0.6-0.1) 25-29.9: 0.9(0.8-1.1)	Healthy dietary pattern No : 1 Yes : 0.8(0.7-0.1)	
Cham et al 2018	The Gambia 2010 Men	25-34: 1 35-44:1.5(1.0-2.3) 45-54:3.7(2.3-5.8) 55-64:6.1(3.5-10.7)		>12 years:1 7-12 years: 1.7(1.0-2.9) ≥ 6 years :1.3(0.8-2.2)	Urban : Semi-urban: 1.8(1.0-3.0) Rural: 1.4(1.0-2.0)	Normal: 1 Underweight: 1.1(0.6-1.9) Overweight: 1.2(0.8-1.7) Obese: 0.8(0.4-1.7)	Smoking Non-smoker: 1 Current smoker : 1.2(0.9-1.7) Ex-smoker 2.0(1.1-3.7) Waist circumference Normal: 1 High: 2.0(1.3-3.1)	Ethnicity, physical inactivity, servings of fruits and vegetables
	Women	25-34: 1 35-44: 2.2(1.5-3.2) 45-54: 3.7(2.0-4.8) 55-64: 8.1(4.6-14.3)		>12 years:1 7-12 years: 1.2(0.5-2.8) ≥ 6 years: 1.6(0.7-3.7)	Urban : Semi-urban: 1.8(1.1-2.9) Rural: 1.6(1.1-2.3)	Normal: 1 Underweight: 0.6(0.3-1.0) Overweight: 1.3(0.9-1.9) Obese: 2.2(1.5-3.3)	Ethnicity Mandinka: 1 Wollof; 0.8(0.6-1.1) Fula: 0.7(0.5-1.1) Jola: 0.6(0.4-0.9) 0.8(0.4-1.3) Physical activity ≥600 METS pw: 1	servings of fruits and vegetables

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
							< 600METS pw: 1.7(1.1-2.9) Waist circumference Normal: 1 High: 1.5(1.10-2.1)	
Guwatudde et al 2015	Uganda 2014	18–19 : 1 20–29: 1.8(1.2-2.6) 30–39: 2.1(1.4–3.1) 40–49: 2.6(1.7–3.8) ≥50: 3.6(2.4–5.3)	Females: Males:1.14 (1.00–1.3)]	None: 1 Primary: 1.0(0.8–1.2) Secondary: 1.0(0.8-1.2) University/ higher: 1.1(0.8-1.4)	Rural:1 Urban: 1.0(0.9–1.2)	< 25.0: 1 25.0–29.9: 1.5(1.3–1.7) ≥30.0: 1.6(1.3–2.0)		
Musinguzi et al 2013	Uganda 2012	15-24: 1 25-34: 1.5 (1.2-1.9) 35-44: 3.0 (2.3-4.4) 45-54: 5.3 (4.1-6.9) 55-64: 10.5(7.5-14.3) ≥65: 17.5(11.9-26.3)	M: 1 F: 0.9(0.8-1.1)	None: 1 Primary: 0.7 (0.5–1.0) Secondary: 0.9 (0.9–1.3) Tertiary: 0.5 (0.7–1.3)	R: 1 U: 1.5(1.2–1.8)	Normal :1 Underweight: 0.8 (0.6–1.1) Overweight: 1.5 (1.2–1.9) Obese: 2.3 (1.8–3.2)		Current smoke, Currently drinks alcohol ,Marital status
Musinguzi et al 2015	Uganda 2012 Model I(ISH)	<35: 1 35-49: 2.0 (1.4-2.8) 50+: 11.9 (8.8-16.3)	F:1 M: 1.0 (0.8–1.3)	Post primary: 1 Primary and below: 1.4 (1.0–1.9)	R: U: 1.3(1.0-1.7)	<25: 1 ≥25: 1.4(1.0–2.0)		Consumed alcohol
	Model II(IDH)	<35: 1 35-49: 2.0 (1.5–2.9)	F: 1 M: 1.1 (0.8–1.5)	Post primary: 1	Rural: 1 Urban: 1.6(1.2–2.2)	<25 ≥25: 1.2(0.8–1.7)	Consumed alcohol (No): 1 (yes): 1.6 (1.2–2.2)	

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
		50+: 1.3 (0.8–2.1)		Primary and below: 0.9(0.7–1.3)				
	Model III(SDH)	<35: 1 35-49: 4.0 (3.0–5.3) 50+: 10.3(7.7–13.9)	F: 1 M: 1.2(0.9–1.5)	Post primary: 1 Primary and below: 1.1 (0.9–1.4)	R:1 U: 1.7 (1.3–2.1)	<25 ≥25: 2.6 (2.0–3.3)	Consumed alcohol (No): 1 (yes): 1.5 (1.2–1.9)	
Mayega et al 2012	Uganda 2012	35–39: 1 40–44: 1.4(1.0–2.1) 45–49: 2.5(1.7–3.7) 50–54: 3.0(2.0–4.5) 55–60: 4.5(2.9–7.0)			Rural :1 Peri-urban:2.4(1.6-3.7)	<25 1 ≥25: 2.8(2.0–4.0)	Knowledge about lifestyle diseases Very Low: 1 Low:1.1(0.8-1.6) Moderate:1.3(0.9-1.9) Good:2.7(1.6-4.6) Dietary diversity: Low: 1 Moderate:1.4(1.0-1.9) High:0.8(0.5–1.4	Attains WHO minimum PA level, Tobacco use, Harmful alcohol intake
Twinasiko et al 2018	Uganda	35-44.9: 1 45-54.9: 2.1(1.1-4.0) >55: 4.5(2.2-9.4)				Obesity (BMI≥30 kg/m^2) No: 1 Yes: 1.7(1.0-3.0)	Sedentary work style No :1 Yes: 2.7(1.5-5.1)	
Mulenga et al 2013	Zambia survey year n/a Kaoma	25-34: 0.4 (0.2-0.6) 35-44: 0.7 (0.5-1) ≥45: 1				<18.5:0.5 (0.3-0.7) 18.5-24.9:0.7 (0.5-1.0) 25.0-29.9:1.2(0.7-2.0) ≥30 : 1		
	Kassama	25-34: 0.5 (0.4-0.7)					Cigarette smoking : (Yes):1.2(1.0-1.5)	Heart rate

Author	Country and survey year	Multivariate analysis: Adjusted odd ratios (95% confidence intervals) (all figures rounded to one decimal point)						
		Age (Years)	**Gender**	**Education**	**Residence (rural/urban)**	**BMI (Kg/m^2)**	**Other significant variables included in final model**	**Other variables retained in final model**
		35-44: 0.8 (0.6-1.0) ≥45: 1						
Goma et al 2011	Zambia n/a	25-34: 1 35-44: 0.8(0.7-1.0) 45+: 2.8(2.3-3.3)	M:1 F: 0.8(0.7-1.0)			<18.5 : 1 18.5-24.9: 0.8 (0.6- 0.9) 25.0-29.9: 1.3 (1.1-1.6) 30+: 2.25 (1.7-2.9)	Time usually spent sitting or reclining on a typical day (hours) <1.5: 1 1.5-3.4: 1.1(0.9-1.3) 3.5+: 1.2(1.0-1.4) FBG (mmol/L) 3.3-5.5: 1 <3.3: 0.7(0.6-0.9) >5.5: 1.8(1.2-2.6)	Alcohol use
Siziya et al 2012	Zambia n/a	25-34: 0.5(0.5-0.6) 35-44: 0.6(0.5-0.7) ≥45: 1				< 18.5: 0.5(0.3-0.8) 18.5-24.9: 1.3(1.1-1.7) ≥30: 1		

AO= Abdominal obesity, FBG = Fasting blood glucose, WC=Waist circumference, WHR=Waist to hip ratio, PA= Physical activity, FHH=Family history of hypertension , DM = Diabetes mellitus, ISH= Isolated systolic hypertension, IDH= Isolated diastolic hypertension, SDH= systolic-diastolic hypertension

Age

As expected, age was a very strong predictor of hypertension in all the papers that included it in multivariate regression models (Tables 3.6 and 3.7). The odds of hypertension consistently increased with age after controlling for other variables. However, in Lusaka, Zambia, respondents aged 35-44 years were less likely to be hypertensive compared with those aged 25-34 years (AOR= 0.8, 95% CI:0.74-0.96) (Goma et al., 2011).

Gender

Many of the studies did not find a statistically significant association between gender and hypertension after controlling for other variables. However, gender was statistically significantly associated with hypertension in multivariate regression analysis in some of the studies but the direction of the association was inconsistent (Table 3.7).

Overweight and obesity

Overweight and/or obesity defined using body mass index (BMI) was a robust predictor of hypertension in all the studies that included it in multivariate regression analysis (Table 3.7). However, abdominal obesity defined by a raised waist-hip ratio and/or high waist circumference was significantly associated with hypertension in only a few of the studies. There was only one study conducted in a rural community where BMI was not associated with hypertension in univariate regression (Ntuli et al., 2015).

Area of residence

Area of residence was not controlled for in most of the studies. Even though few studies included residence in the multivariate regression model, it was associated with hypertension in the majority of these studies and the odds were generally higher among urban residents compared with rural residents (Tables 3.6 and 3.7). The odds of hypertension were consistently higher in urban areas in Benin, Ethiopia, Ghana, Uganda and Mozambique (Houehanou et al., 2015, Tesfaye et al., 2007, Abebe et al., 2015, Minicuci et al., 2014, Mayega et al., 2012, Musinguzi and Nuwaha, 2013, Musinguzi et al., 2014, Damasceno et al., 2009). Contrary to what was found in most of the studies, in my own analyses (Section 5.3 for more details), rural residence was significantly associated with hypertension among both men and women in The Gambia (Cham et al., 2018). However, urban/rural residence was not significantly associated with hypertension in a national survey in Rwanda (Nahimana et al., 2017) and subnational surveys in Uganda (Guwatudde et al., 2015), Angola (Pedro et al., 2018) and Northwest Ethiopia (Abebe et al., 2015).

Education, income, occupation and other socio economic factors

Education, occupation, income and other socio-economic variables were associated with hypertension in only a few of the studies where at least one of these variables was included in multivariate regression models (Tables 3.6 and 3.7).

Tobacco use, alcohol consumption, fruit and vegetable intake and physical activity

Modifiable life style risk factors such as smoking, alcohol consumption, physical inactivity, and low fruit and vegetable intake were not significantly associated with hypertension in almost all the studies that included them in the multivariate regression model (Table 3.6). The odds of hypertension were generally higher in those who engage in these risky behaviours in a few of the studies where an association was found.

Fasting blood glucose / Diabetes and other biochemical risk factors

A small proportion of the studies reviewed included fasting blood glucose (FBG) or history of diabetes, and history of hypertension in the multivariate regression model. Among the studies that included these variables, history of diabetes/raised FBG was significantly associated with higher odds of hypertension in six studies (Goma et al., 2011, Awoke et al., 2012, van de Vijver et al., 2013b, Joshi et al., 2014, Anteneh et al., 2015, Abebe et al., 2015).

Family history of hypertension was significantly associated with hypertension in two studies (Awoke et al., 2012, Helelo et al., 2014) while levels of heart rate were associated with hypertension in one study only (Mulenga et al., 2013). Generally the odds of hypertension were higher among those with these biological risk factors (Table 3.6).

3.7.5 Undiagnosed hypertension, treatment and control of hypertension sub-Saharan Africa

A number of studies reviewed reported on the proportion of hypertensive participants with undiagnosed hypertension: but only two reported on the factors associated with awareness or undiagnosed hypertension in multivariate regression (Damasceno et al., 2009, Cham et al., 2018). Amongst those classed as hypertensive, levels of awareness and treatment were low as a proportion of people with hypertension. Undiagnosed hypertension ranged from 36% in the Republic of Seychelles to 95% in Malawi (Table 3.3). The prevalence of hypertension in two studies in Nigeria were 48% (Okafor et al., 2014a) and 41% (Okafor et al., 2014b) respectively: but all the participants in these studies were undiagnosed, as those already diagnosed with hypertension and/or diabetes were excluded. The study in Sudan was also on undiagnosed hypertension and therefore all participants previously diagnosed with hypertension were excluded: a hypertension prevalence of 38% among those without diagnosed hypertension was reported (Bushara et al., 2015). Amongst those classed as hypertensive, levels of treatment and control were very low in all the studies where information on these was provided.

3.8 Discussion

3.8.1 Key findings of the systematic review on hypertension in SSA

This section summarises the key findings of the systematic review and makes a number of comparisons with countries outside SSA. Even though some systematic reviews and meta-analyses on the prevalence and awareness of hypertension have been reported in SSA (Ataklte et al., 2015, Addo et al., 2007, Twagirumukiza et al., 2011, Adeloye and Basquill, 2014), to my knowledge, this is the first study that focuses exclusively on studies conducted using the WHO STEPwise approach to NCDs, which are therefore more comparable regarding the methods used. A review report had been conducted for the 6th session of the African Union Conference of Ministers on NCDs (van de Vijver et al., 2013a). However, it was based on findings from the 2003 World Health Survey and STEP surveys conducted between 2003 and 2009 and is not as comprehensive as this systematic review. Most of the review articles on hypertension in Africa also reported on the prevalence and awareness of hypertension but this systematic review goes further to assess the factors associated with the prevalence of hypertension in SSA.

This review has revealed that the burden of hypertension is very high in SSA, with more than one-third of the participants in most of the studies being classed as hypertensive (e.g. SBP≥140mmHg and/or DBP≥90mmHg or currently on medication for hypertension). Most of the rates reported in this review are higher than those reported in other LMICs using the WHO STEPwise approach such as Myanmar (30%), Bangladesh (21%), Nepal (26%) and Cambodia (28%) (Bjertness et al., 2016, Zaman et al., 2015, Aryal et al., 2015, Gupta et al., 2013). They are also higher than those reported in high income countries where similar health examination approaches were used such as the USA (29%), England (30%) and Canada (20%) (Joffres et al., 2013, Falaschetti et al., 2014). What is even more alarming is that a high proportion of the persons classed as hypertensive in SSA are not aware of their condition. Even among the people who are aware of/ have been diagnosed with hypertension, levels of treatment and control are very low. Less than a quarter of the hypertensive participants in most of the studies in SSA reviewed were aware of their condition. This is extremely low compared with the awareness rates reported in Canada (83%), the USA (81%), and England (71%) (Joffres et al., 2013, Falaschetti et al., 2014). The proportion of hypertension that is undiagnosed in SSA was lowest in the Republic of Seychelles (36%), a level similar to that of England (35%) and Europe (30%) (Joffres et al., 2013, Falaschetti et al., 2014, Tolonen et al., 2016). The Republic of Seychelles is defined by the World Bank as a high income country and health care services are provided free of charge, demonstrating the correlations between the income level of a country, the costs of the health care services to patients, and the country's level of undiagnosed hypertension (World Bank, 2016, Bovet et al., 2009). The most significant predictors of hypertension in SSA are age, BMI and urban residence.

Age

As expected, age was significantly associated with hypertension in all the studies reviewed. This is consistent with findings from several other studies in other regions of the world including those that used the WHO STEPwise approach to sampling, data collection and analysis (Liang et al., 2016, Koh et al., 2016, Zarrinkoob et al., 2016, Kane et al., 2016, Zheng et al., 2014, Hendriks et al., 2012, Bjertness et al., 2016, Gupta et al., 2013). However, the prevalence of hypertension was high across all age groups in this systematic review.

Gender

Gender was not significantly associated with hypertension after controlling for factors such as age, BMI, smoking and other behavioural and biological risk factors in most of the studies reviewed; but an association was observed in some. Even in the studies where a significant association was observed, there was no consistent direction of the association between gender and hypertension. One of the studies in which women had an increased risk after controlling for potential confounders was based on self-reported hypertension only (Keetile et al., 2015). As revealed in several studies, women are more likely than men to report hypertension (Hussain et al., 2016, Moser et al., 2014, Gee et al., 2012, Stergiou et al., 2016). This could be because women have more contact with health services than men because of use of reproductive and child health care services (Cappuccio et al., 2004). Two of the studies in which females were at an increased risk of hypertension were conducted among older adults: 50 years and above (Minicuci et al., 2014) and 70 years and above (Dewhurst et al., 2013) respectively. The increased risk of hypertension observed among women in these studies could be associated with the effect of the menopause as there is evidence that the menopause can have an influence on blood pressure levels in women (Yanes et al., 2011, Kim et al., 2014, He et al., 2016). The prevalence of hypertension was also generally higher among younger men and older women. These patterns could be related to the unequal distribution of a number of behavioural risk factors for hypertension: levels of tobacco use and alcohol consumption were higher among males, whereas levels of overweight and obesity, and physical inactivity, were significantly higher among females.

Rural-Urban Residence

Another significant factor associated with hypertension was urban (versus rural) residence in most of the studies that included residence in multivariable regression analysis. This is consistent with findings from other studies in Myanmar, India and Nepal that used the WHO STEPS survey approach (Bjertness et al., 2016, Bhagyalaxmi et al., 2013, Aryal et al., 2015). Similar studies that did not use the WHO STEPS approach also found consistent findings. In a study in Thailand, long-term urban residents had significantly higher risk of hypertension (Zhao et al., 2014). Migrants who moved from rural to urban areas also had higher risk compared with long term rural residents. Similar findings were also found in a national household survey in Brazil (Muniz et al., 2012) and in Tibet (Zheng et al., 2012). The lower risk of hypertension among rural dwellers in SSA may be related to their occupation. In SSA, most of the rural dwellers are subsistence farmers, involved in laborious farming activities, while most jobs in urban areas are sedentary, which are associated with considerably lower levels of work-related physical activity (Misra and Khurana, 2008). Urban life also involves lower levels of walking (Renzaho, 2004). Diet may also partly explain the association between residence and hypertension. Many rural residents grow traditional staple foods, such as fruits and vegetables with low calories and fat (Renzaho, 2004, Scott et al., 2012). Urban residents, on the other hand, have increasing access to high fat and high calorie foods at subsidized and affordable prices, making them cheap substitutes for traditional staples and vegetables (Puoane et al., 2005, Stiglitz and Charlton, 2005, Misra and Khurana, 2008). Moreover, there is a link between the emergence of convenience stores and fast food outlets and the increasing burden of overweight and hypertension (Morland et al., 2006, Morland and Evenson, 2009, Odegaard et al., 2012, Bowman and Vinyard, 2004, Ulasi et al., 2011, Joubert et al., 2007). In the studies reviewed, the prevalence of risk factors such as overweight and obesity and physical inactivity are generally higher in urban areas. These are therefore plausible explanations for the higher burden of hypertension in urban areas.

Overweight and obesity

Overweight and obesity (measured by BMI in accordance with the WHO STEPS protocol) was a significant predictor of hypertension in all the studies that included BMI status in multivariate regression models. However, high waist circumference and/or a high waist-to-hip ratio (i.e. abdominal obesity) were not found to be associated with hypertension in most of the studies. The prevalence of hypertension at the national level was generally higher in those countries with a higher prevalence of overweight and obesity, especially among women.

Undiagnosed Hypertension

The burden of undiagnosed disease is extremely high in SSA and is unequally distributed between social groups, being higher among males and among rural residents. Levels of treatment and control among hypertensive survey participants in SSA were also very low compared with those found in higher income countries. A systemic review and meta-analysis on undiagnosed hypertension in SSA reported that of those with hypertension, only between 7% and 56% (pooled prevalence: 27%; 95% CI: 23%-31%) were aware of their hypertensive status before the surveys (Ataklte et al., 2015). Overall, 18% (95% CI: 14%-22%) of individuals with hypertension were receiving treatment across the studies, and only 7% (95% CI: 5%-8%) had controlled blood pressure. This could explain the increasing prevalence of hypertension-related complications such as stroke and heart failure and the high mortality rate associated with CVDs in SSA (Mensah, 2008). The high prevalence of undiagnosed hypertension in SSA could be related to the issues of poor access and low quality of care, lack of capacity and the financial costs associated with accessing health care services. Many African countries including The Gambia do not have a national or social insurance system and hence out of pocket payment (OOP) is the main source of funding for health care services (Hendriks et al., 2011). There is evidence that OOP including user fees is a major burden, especially among poorer households, and so the inability to pay OOP can limit access to health care services (Gilson and McIntyre, 2005). The influence of these factors are possibly evident in The Republic of Seychelles which has both health care services that are provided free of charge and low levels of undiagnosed hypertension.

3.8.2 Differences in the demographic structure of studies included

My systematic review presented prevalence estimates of hypertension and its associated risk factors in SSA. As in other systematic reviews (Addo et al., 2007, Ataklte et al., 2015), there were inevitably large variations between the included studies. Studies varied because of the criteria used to select participants (e.g. some were exclusively urban or rural; or national and sub-national) and also because of age differences. Differences in the age structure of the analytical samples inevitably underlies at least some of the differences in the prevalence estimates. The absence of age-specific estimates in the reports of most of the studies included meant that I could not perform any age-standardisation to overcome these age differences. However my inclusion criteria (e.g. the use of objective blood pressure measurements) may have minimised the differences between studies to some extent. Apart from age, differences in prevalence estimates may also reflect the great variation between and within countries in SSA; this variation reflects different stages of urbanisation and development.

3.8.3 Strengths and limitations of the systematic review

Only quantitative studies using the WHO STEPwise approach to sampling, data collection and analysis were included in this systematic review. This allows meaningful comparison across countries and regions. Some of the studies used a complex sampling strategy and the Kish method that allows the selection of only one eligible participant per household. This reduces biases introduced by sampling strategies that favour the selection of any available participant per household. Factors associated with hypertension in all the studies where a multivariate regression analysis was done were summarised. This gives an idea of the most important correlates/predictors of hypertension in SSA and can give policy direction for an effective preventive and control strategy in the region.

The systematic literature review is not without limitations. Only articles published in English were included and therefore what is reported could be an underestimate of the true burden of hypertension in SSA. However, some of the articles reviewed are from French and Portuguese speaking countries. All factsheets from the WHO website published in either English or French were reviewed because of the unique reporting format. In the STEP approach, behavioural risk factors such as smoking and alcohol consumption were assessed through interview questionnaire. Even though the questionnaire has been validated in different countries and settings, participants may provide a biased report of their smoking and drinking behaviours especially in communities where these are socially undesirable.

In all but one of the studies, blood pressure was measured on one occasion, which might have resulted in an overestimation of hypertension. Not all the studies used the recommended WHO STEP blood pressure measurement analysis method, which is based on the average of the last two of three measurements as outlined in the STEP manual (WHO, 2005b). The systematic review has revealed that age, urban residence, high BMI and gender are the most significant correlates/predictors of hypertension in SSA. Salt intake, which is one of the indicators of the Global Action Plan for the prevention and control of NCDs (WHO, 2013a), is a well-known risk factor for hypertension. However there is no information on salt intake in the articles reviewed. This is a limitation of my systematic review as salt intake is a major risk factor of hypertension, especially for people of African descent (Ukoh et al., 2004, Forrester, 2004, Somova and Mufunda, 1993, Mattes, 1984, De Wardener and MacGregor, 2002).

3.9 Conclusion

In summary, hypertension is a major burden in SSA and a high proportion of hypertension remains undiagnosed. Age, high BMI and urban (versus rural) residence are the strongest correlates/predictors of hypertension. Preventive strategies should be directed at discouraging harmful beliefs and practices on weight and the promotion of healthy diet and physical activity especially in urban areas.

4. Chapter 4: Materials and methods/ Data Source

4.1 Study setting and design

A secondary analysis of the 2010 WHO STEPwise survey data of The Gambia was conducted for this PhD. I obtained authorisation to use the data from the Programme Manager at the Non Communicable Disease Prevention and Control Unit of the Ministry of Health and Social Welfare in The Gambia. The study was a population based cross sectional survey conducted among adults aged 25-64 years living in The Gambia. The survey covered all the administrative areas/regions of the country and the sample is nationally representative.

As mentioned previously, the WHO STEPwise survey, otherwise known as WHO STEPS, is a standard population-based health examination survey approach to the surveillance of NCDs. It was initiated by the WHO in 2000 and is mostly conducted in LMICs (WHO, 2003, WHO, 2009, Armstrong and Bonita, 2003, Riley et al., 2016). Data is potentially collected in three main steps. STEP one involves the use of interview-based questionnaires, where information on sociodemographic and key behavioural risk factors are collected through face-to-face interviews (WHO, 2003). Information on previous history of diabetes and hypertension, and information on the treatment of these diseases is also collected. STEP two involves physical measurement including weight, height, waist circumference, blood pressure and pulse rate. Both the face-to-face interviews and the physical measurements in The Gambia were conducted by trained medical personnel at the participants' households. Biochemical measurement of fasting blood glucose and cholesterol is conducted in STEP three (WHO, 2009, Mindell et al., 2017). However the STEP survey in The Gambia was limited to STEPs one and two only because of the expensive costs and technical challenges of STEP 3.

4.2 Sampling framework and sample size

Participants were selected using a multi-stage stratified sampling technique based on the 2003 population census. The country is divided into eight local government areas (LGAs) and 4098 enumeration areas. The LGAs are Banjul (the capital), Kanifing Municipality (KM), West Coast Region (WCR), Lower River Region (LRR), North Bank Region (NBR), Central River Region North & South (CRRN & CRRS) and the Upper River Region (URR). Banjul and KM are purely urban, WCR and URR are partly urban and partly rural, while CRR, NBR and LRR are mainly rural. The LGA served as strata for the sampling; 264 enumeration areas (EAs) were selected across the country by simple random sampling. The number of EAs selected per strata (LGA) was proportional to the size of the population of the strata. From each of the EAs selected, 20 households were selected by simple random sampling. Only one eligible participant was enrolled from each selected household, using the Kish Method. Sampled participants who were not reached after three or more visits and those who declined were not replaced. The target sample was set at 5280. Overall, 4111 responded with a response rate of 78%.

4.3 Research Instrument/Survey tool

The survey was done using the eSTEPS, which is an electronic version of the WHO STEPwise paper-based questionnaire. Personal Digital Assistants (PDAs) programmed with eSTEPS software were used for data collection. It has an automatic skip pattern and allows errors to be checked as the interview is ongoing. It is therefore less prone to errors compared with the paper-based version. The generic WHO STEP questionnaire was slightly modified by a team of experts to suit the culture and norms of the country. Most of the variables modified by this process were socio-demographic variables such as ethnicity and education level.

4.4 Data Management

Although the data set is well recognised and the survey had good quality control measures, it required a lot of cleaning. I started exploring, cleaning and coding the raw data immediately after obtaining the authorisation to use it for my PhD research. I conducted the cleaning by comparing the raw data with the questionnaire used for fieldwork, as well as running frequencies and charts. I also made contact with those involved in collecting the data in The Gambia for clarification on some of the variables. I prepared a frequency table with almost all the socio demographic variables in the data and compared these with the 2003 and 2013 census data. The age, sex and geographical distribution of the data are very similar to the distributions provided in the two census reports. Preliminary analysis revealed that 232 of the total achieved sample (n=4111) were pregnant at the time of the survey and hence I excluded them because of the impact of pregnancy on anthropometric and blood pressure measurements.

Because of the complex nature of the survey design and in accordance with the WHO STEPS guidance (WHO STEP manual Section 4-3.13) (WHO, 2005b), sample-selection weights and post-stratification weights were applied. This was done to account for differences in the probability of selection and also to adjust for differences between the age-sex distribution of the achieved sample and that of the target population (using the 2003 population census of The Gambia as the target population) to make sure the sample was nationally representative. The computation of the weights was done by those involved in the data collection. I used the Primary Sampling Unit (PSU) to adjust for the complex survey design. This results in wider confidence intervals, due to the correlations (non independence) of participants within the same PSU.

Apart from the unweighted descriptive of study participants, all my analysis were weighted and adjusted for complex survey design using Stata.

4.5 Ethics statement

Ethical approval for the 2010 WHO STEP survey was obtained from The Gambia Government and Medical Research Council (GGMRC) joint ethics committee. An information sheet (in English) explaining the details of the survey was given to participants and it was explained in the local languages for those who were not literate. Participants gave verbal or written informed consent depending on whether they can read and write or not. My research involves secondary data analysis of the 2010 WHO STEP survey and I obtained authorisation to use the data from the Ministry of Health and Social Welfare of The Gambia.

5. Chapter 5: Prevalence and factors associated with hypertension in The Gambia

5.1 Introduction

This chapter describes the results of the analysis I conducted to address the second objective of my PhD research project. The background is as described in chapter 2 and as described in my published manuscript (Cham et al., 2018) based on the analysis I conducted in this chapter (See Appendix I).

5.2 Materials and methods

The study setting, design, sampling, participants, measurement protocol, data collection and data management are as described in chapter 4 sections 4.1 to 4.4.

5.2.1 Dependent /Outcome variable

The main outcome variable for Objective 2 was hypertension. This was categorised into the following:

1. **Measured hypertension:** defined as measured systolic blood pressure (SBP) ≥140mmHg and/or diastolic blood pressure (DBP) ≥90mmHg.
2. **Total hypertension (survey-defined)**: defined as measured SBP≥140mmHg and/or DBP ≥90mmHg and/or self-reported hypertension (as diagnosed by a doctor or other health professional, which included all participants receiving treatment).
3. **Undiagnosed hypertension**: Among people with total hypertension, I also looked at undiagnosed hypertension defined as people with total hypertension who were not aware of their status.

In addition to examining undiagnosed hypertension as a proportion of total hypertension, I also explored levels of treatment and control of hypertension among participants with history of hypertension. I defined treatment as the current use of antihypertensive medication prescribed by a health worker (nurse or doctor). Those on treatment who had SBP <140mmHg and DBP <90mmHg were defined as having their BP controlled.

5.2.2 Independent covariates /predictor variables

The covariates/predictor variables included sociodemographic variables such as age, gender, education, residence, as well as behavioural and biological risk factors such as smoking, physical inactivity, low fruit and vegetable intake, and generalised and abdominal obesity. Even though there is a variable with details on occupation in the data set, it categorised those employed only as 'government employed', 'non-government employed' or 'self-employed'. There were very few in the non-employed categories and the employed and self-employed categories do not give any indication of income or socio-economic status. Variables on household income and individual income had considerable missing data, hence I used education as the measure of socio-economic status.

Overweight and obesity: Body mass index (BMI) and waist circumference were used to determine overweight and obesity and abdominal obesity respectively. The WHO STEPS protocol requires objective measurements of height and weight and waist circumference (details of how these were measured is described in section 6.2.1). BMI was categorised into underweight (BMI<18.5Kg/m^2), normal weight (18.5-24.9Kg/m^2), overweight (25.0-29.9Kg/m^2) and obese (BMI ≥30.0Kg/m^2). Waist circumference was used to determine abdominal obesity based on the International Diabetes Federation thresholds (≥90 cm men; ≥80 cm women) (International Diabetes Federation, 2006). The definition of high WHR was based on WHO standards (high WHR defined as 0.90 in men and >0.85 in women) (WHO, 1999). WHtR was categorised into normal (≤ 0.5) and high (>0.5).

Smoking: Current tobacco smoking was used to determine smoking. The variable was categorised into never smokers, ex-smokers, and current smokers.

Low fruit and vegetable intake: This was defined as having less than five combined servings (400grams) of fruits and vegetables a day. This is the minimum recommended by the joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases and the American Heart Association Nutrition Committee (WHO/ FAO 2003, Lichtenstein et al., 2006).

Physical activity: The physical activity section of the WHO STEPS questionnaire is adopted from the Global Physical Activity (GPAQ) questionnaire. I assessed the level of physical activity (PA) to determine whether participants met the minimum WHO activity recommendations in a typical week. This is at least 75 minutes/week of vigorous intensity physical activity, 150 minutes/week of moderate intensity PA, or a combination of moderate and vigorous PA achieving at least 600 metabolic equivalents (METS)/week. METS is the ratio of a person's working metabolic rate to the resting metabolic rate and is used to assess intensity of PA (WHO, 2012a). I assessed the three domains of PA captured in the STEPS questionnaire: i.e. work (paid and/or unpaid work including household chores), transport to and from places, and recreational or leisure activity related.

Residence was determined by the local government area (LGA) of the respondents using the seven administrative regions in the country. For ease of analysis, I combined Banjul and Kanifing Municipality because of similar profiles (both urban). In addition, I explored rural/urban residence and categorised it into urban, semi-urban and rural using The Gambia Bureau of Statistics benchmarks (Gambia Bureau of Statistics, 2013).

Ethnicity. The ethnic groups defined in section 1.2.2 were used. There were eight categories in total: Mandinka, Fula, Wollof, Jola, Serahule, Serer, Manjago and Aku. For ease of analysis, I combined the minority groups (Serahule, Serer, Manjago and Aku) because of their small numbers.

Education. I derived the education variable from the question "*In total how many years have you spent at school or in full time study (excluding pre-school)*?" I then categorised the number of years into ≤ 6 years, 7-12 years and > 12 years.

5.2.3 Statistical analysis

Figure 5.1 is the conceptual framework that guided my statistical analysis for this chapter. I described respondents' sociodemographic characteristics as well as their behavioural and biological risk factors on both the weighted and unweighted data (Tables 5.1 (weighted and Table S12 (unweighted).

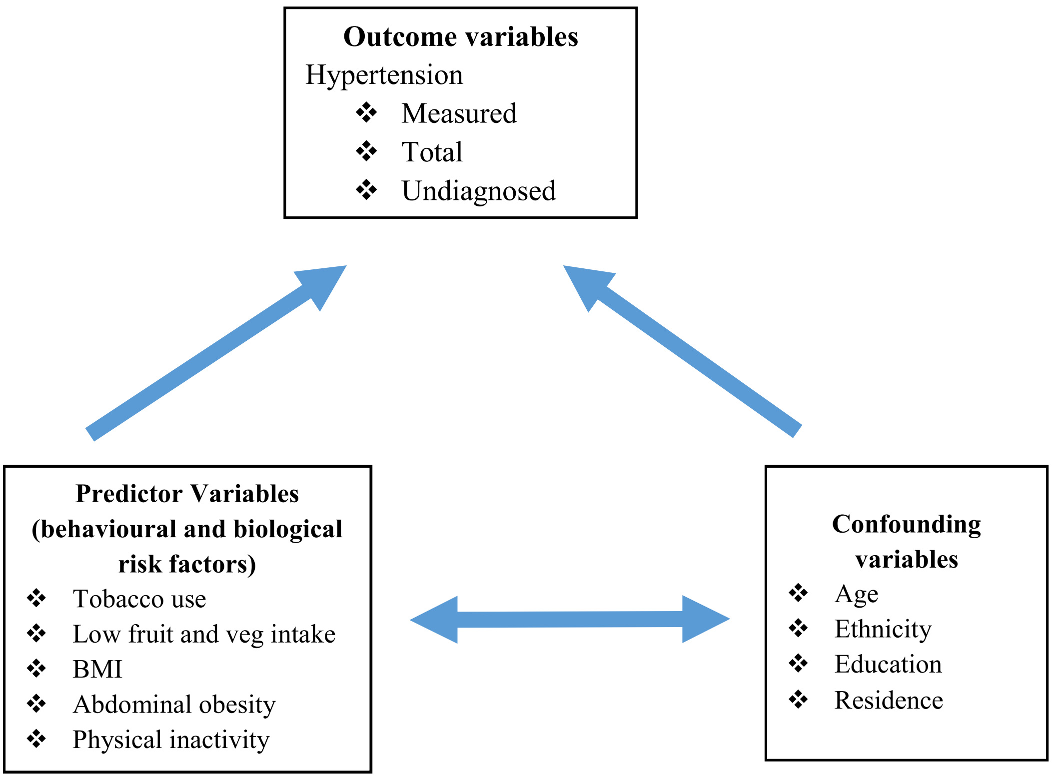


Figure 5.1: Flowchart on the conceptual framework showing the relationship between hypertension and predictor variables

I conducted weighted analysis on participants with three valid blood pressure measurements (n=3573 non-pregnant adults), using the mean of the second and third readings in my analysis. I report the prevalence of hypertension in the form of proportions with their corresponding 95% confidence intervals (CI). I carried out age-adjusted bivariate analysis for each covariate separately (except for age group as the independent variable), then multivariate logistic regression analysis to identify the subset of behavioural and biological risk factors associated with hypertension after adjustment for confounders such as age. Each model was stratified by gender because of known marked differences in hypertension in men and women (Adeloye and Basquill, 2014). I did not test any covariate by gender interaction terms as it was not a research aim to systematically test if the associations differed by gender. I conducted these models for each of the three definitions of hypertension as the outcome: total; measured; undiagnosed. The model for undiagnosed hypertension was conducted only among the subgroup of participants with hypertension. Due to the overlap of the two variables on residence (local government area; urban/rural), I repeated the fully adjusted models interchanging these variables. I did not include alcohol consumption in the multivariable regression model because 98% of respondents reported being lifetime abstainers of alcohol. Likewise, current smoking was not included in the models for women because of the low number of smokers. Statistical significance was set at $P<0.05$. I reran the regression models interchanging waist circumference with waist-to-hip ratio and waist-to-height ratio as the measure of abdominal obesity in turn. Waist-to-hip ratio and waist-to-height ratio were not significantly associated with hypertension. Waist circumference was significantly associated with hypertension and so was retained in the models as the single measure of abdominal obesity.

I explored variables that could potentially modify the association between hypertension and potential socio-demographic and biological risk factors by fitting interaction terms. There was no evidence of effect modification (all $p>0.05$), hence multivariate logistic regression models without interaction terms are reported. Apart from the description of the characteristics of study participants, all my analyses are weighted and suitably adjusted for the complex survey design and weighted for non-response, using Stata V14. Tests for multiple comparisons were not performed.

5.3 Results

As outlined in chapter 4, 5280 eligible respondents were sampled but 4111 participated. The analysis presented in this chapter is restricted to 3573 non-pregnant participants who had three valid BP measurements. Figure 5.2 outlines the number of participants excluded, with detail on the reasons for exclusion. The unweighted sociodemographic, behavioural and biological risk factors for the analytical sample are presented in Table S12. The mean age of the participants was 38±10.9 years. A high proportion of the participants (44%) were aged 25-34 years; similar with the distribution in the general adult population. Men were generally older, with a higher level of education than women (all $p < 0.001$). Seventy percent of the respondents had less than seven years of formal education, with a significant gender difference (62% men vs 76% women; $p<0.001$). There was no age difference by gender after weighting ($p= 0.953$, Table 5.1).

Most participants (98%) reported being lifetime abstainers of alcohol. The prevalence of current smoking was 16% and was significantly higher among men (33% vs 1%, $p<0.001$). Low intake of fruits and vegetables was very common, with no gender difference (78% for men and women). A very high proportion of the participants (85%) met the WHO minimum standards on physical activity. However, this was mainly transport and work-related physical activity. Only 12% engaged in any form of leisure activity related physical activity. The prevalence of both generalised (high BMI) and abdominal obesity (high waist circumference) as well as high waist-to-hip ratio and high waist-to-height ratio were higher among women (Table 5.1). Only 9% of the participants reported to never have had their blood glucose measured, with no significant gender difference. Among those who ever reported that their blood glucose had been measured, 10% reported being diagnosed with diabetes.

Figure 5.2: Flow diagram of study participants in the 2010 WHO STEP survey in The Gambia with number excluded from my analyses and reasons for exclusion

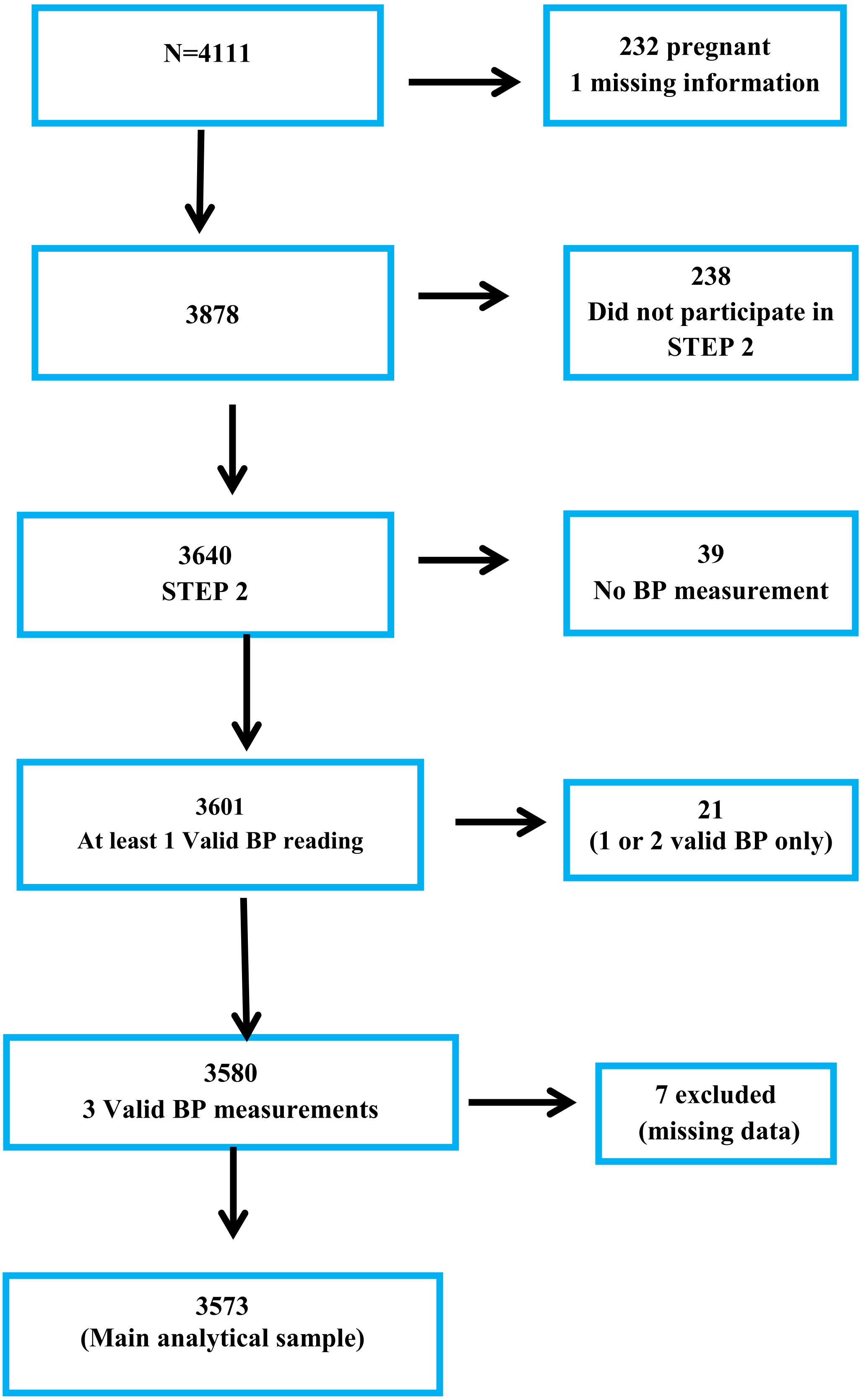


Table 5.1: Descriptive sociodemographic characteristics of a nationally-representative sample (The Gambia 2010)

Variables	Men %(95% CI) 1633	Women %(95% CI) 1940	Total %(95% CI) 3573
Gender			
Men			50.5(47.9-53.1)
Women			49.5(46.9-52.1)
Age group			
25-34	46.8(42.9-50.7)	46.0(43.0-49.1)	46.4(44.0-48.9)
35-44	26.3(23.9-28.8)	27.1(24.5-29.9)	26.7(24.9-28.6)
45-54	17.1(15.0-19.5)	17.4(15.5-19.4)	17.2(15.8-18.9)
55-64	9.8(8.2-11.8)	9.5(7.5-12.1)	9.7(08.2-11.4)
	P=0.953		
Mean age (years)	38.0(37.1-38.8)	37.4(36.8-38.1)	37.6(37.1-38.2)
Ethnicity			
Mandinka	42.8(37.3-48.3)	39.2(33.3-45.5)	41.0(35.9-46.3)
Wollof	16.0(11.9-21.2)	16.4(12.7-20.9)	16.1(12.5-20.7)
Fula	20.4(16.7-24.6)	18.1(14.8-22.0)	19.3(16.0-23.0)
Jola	12.0(8.1-17.5)	15.0(11.0-20.0)	13.49.7-18.3)
Others	8.7(6.5-11.5)	11.2(8.5-14.6)	10.1(7.8-12.6)
	P=0.082		
Education			
≤6 Years	54.6(50.2-59.0)	73.9(69.0-78.3)	63.9(59.7-67.8)
7-12 Years	31.9(28.5-35.4)	22.7(18.9-26.9)	27.5(24.5-30.6)
>12 Years	13.5(11.3-16.1)	3.4(2.3-5.0)	8.7(7.3-10.3)
	P<0.001		
Residence (LGA) [a]			
Banjul	7.6(2.4-21.5)	6.8(2.1-20.1)	7.2(02.4-20.2)
KMC	24.0(15.7-34.8)	28.9(19.5-40.6)	26.4(17.7-37.4)
WCR	35.3(24.1-48.5)	30.6(20.3-43.3)	33.0(22.4-45.7)
URR	8.9(4.1-18.0)	6.4(2.8-14.2)	7.7(3.5-15.9)
NBR	8.1(4.4-14.4)	10.2(5.6-18.0)	9.1(5.0-16.1)
CRRS	6.1(2.5-14.3)	6.4(2.6-14.6)	6.3(2.6-14.2)
CRRN	2.5(6.7-8.8)	2.8(0.7-9.8)	2.6(0.7-09.3)
LRR	7.5(3.2-16.6)	7.8(3.3-17.3)	7.7(3.3-16.6)
	P=0.115		
Residence (Rurality)			
Urban	58.0(48.6-66.8)	57.0(48.2-65.4)	57.5(48.7-65.9)
Semi urban	8.6(4.2-16.8)	6.7(3.0-14.1)	7.7(3.7-15.3)
Rural	33.4(27.2-40.2)	36.3(29.8-43.3)	34.8(28.8-41.4)
	P= 0.158		
Physical activity			
<600METS/week	11.8(8.0-17.0)	20.8(14.3-29.2)	16.3(11.3-22.9)
≥600METS/week	88.2(83.0-92.0)	79.2(70.8-85.7)	83.8(77.1-88.8)
	P<0.001		
Ever consumed alcohol			
Yes	4.1(2.8-5.9)	1.3(0.7-2.0)	2.7(2.0-3.7)
No	95.9(94.1-97.2)	98.7(98.0-99.2)	97.3(96.3-98.1)
	P<0.001		
Smoking			
Never smokers	57.5(52.4-62.4)	98.1(96.9-98.8)	77.6(74.1-80.7)
Current smokers	32.6(28.6-36.9)	1.2(0.7-1.8)	17.0(14.6-19.8)
Ex-smokers	9.9(7.12.6)	0.7(0.3-1.7)	5.4(4.1-7.0)
	P<0.001		
Servings of fruits and vegs/week			

Variables	Men %(95% CI) 1633	Women %(95% CI) 1940	Total %(95% CI) 3573
< 5/day	76.1(69.2-81.5)	76.4(69.5-82.2)	76.2(69.7-81.8)
≥5/day	23.9(18.2-30.8)	23.6(17.9-30.6)	23.8(18.2-30.4)
	P=0.879		
BP ever measured			
Yes	50.7(43.1-58.3)	68.3(61.2-74.6)	59.4(52.7-65.8)
No	49.3(41.7-56.9)	31.7(25.4-38.8)	40.6(34.2-47.3)
	P<0.001		
History of hypertension [b]			
Yes	10.5(8.1-13.5)	16.4(13.5-19.7)	13.9(11.7-16.3)
No	89.5(86.5-91.9)	83.6(80.3-86.5)	86.1(83.7-88.3)
	P=0.003		
Mean height (cm)	166.9(165.1-168.7)	160.6(159.6-161.6)	163.8(162.5-165.1)
Mean weight (kg)	65.2(64.1-66.3)	64.8(63.6-66.1)	65.0(64.0-66.0)
Mean waist circumference (cm)	72.1(69.2-75.0)	76.0(72.9-79.2)	74.0(71.2-76.9)
BMI[c]			
Underweight	9.8(7.6-12.4)	7.7(6.2-9.6)	8.7(7.2-10.5)
Normal	56.0(50.7-61.3)	46.6(42.8-50.5)	51.4(47.5-55.2)
Overweight	26.1(21.1-31.7)	28.9(25.9-32.1)	27.5(24.0-31.2)
Obese	8.1(6.0-10.0)	16.8(14.5-19.4)	12.4(10.4-14.8)
	P<0.001		
High waist circumference [d]			
Normal	88.9(85.7-91.5)	52.8(46.0-59.4)	71.2(66.6-75.3)
High	11.1(8.6-14.3)	47.2(40.6-54.0)	28.9(24.7-33.4)
	P<0.001		
Mean SBP (mmHg)	130.5(129.2-131.7)	130.1(128.5-131.8)	130.3(129.2-131.5)
Mean DBP (mmHg)	79.9(79.0-80.8)	80.6(79.6-81.5)	80.2(79.5-81.0)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a]KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRRN = Central River Region North, CRRS=Central River Region South; URR =Upper River Region

[b]- Self-reported (diagnosed) hypertension among those who ever had their BP measured
[c] Based on WHO standards
[d]Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

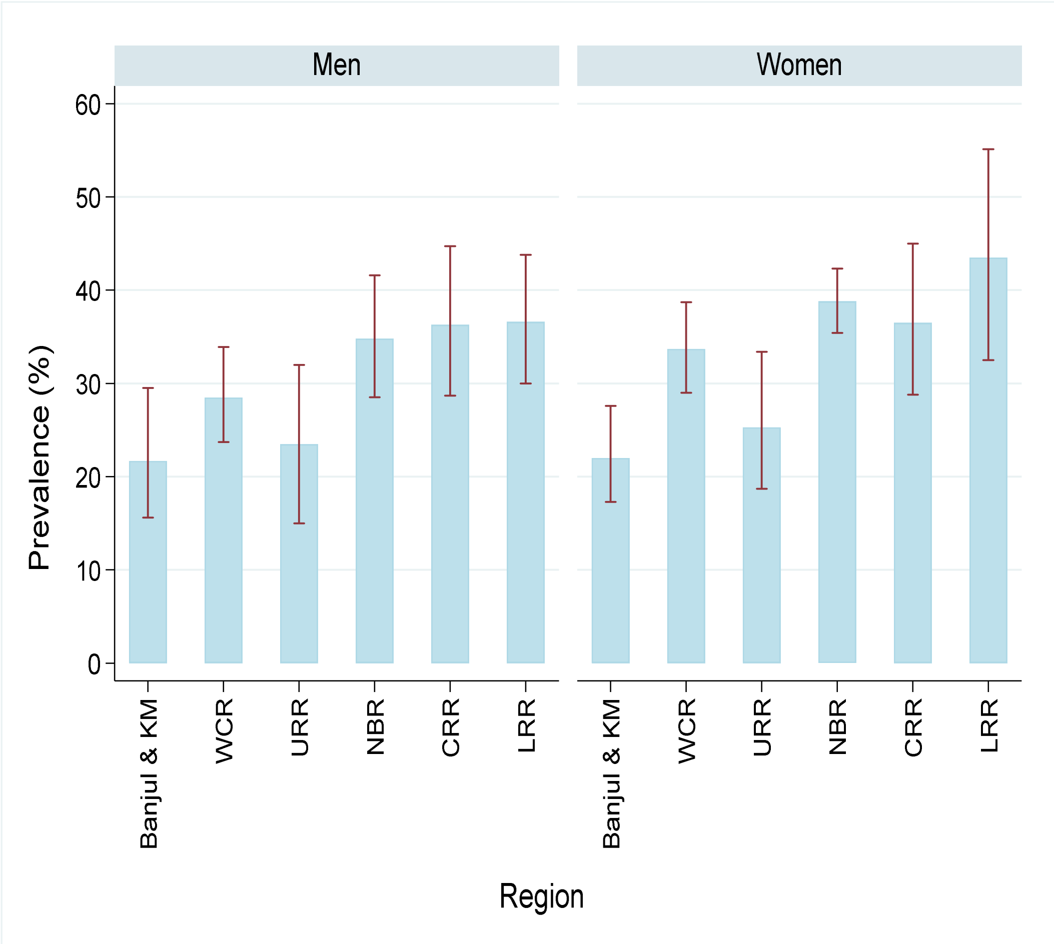
NB: The p value indicates the statistical significance of the difference in proportions between men and women obtained using Pearson's chi-squared test

5.3.1 Prevalence and awareness of hypertension in The Gambia

Sixty percent of adults reported to ever have had their blood pressure measured and it was significantly higher in women (68% vs 51%, p<0.001) (Table 5.1). The weighted mean systolic and diastolic blood pressures were 130.3mmHg (95% CI: 129.2-131.5) and 80.2mmHg (79.5-81.0) respectively (Table 5.1). More than one-quarter (27%, 95%CI: 24.1-29.2) of the participants had raised measured BP; 29% (95% CI: 26.6-31.8) had total hypertension (i.e. measured and/or self-report) (data not shown). The prevalence of total hypertension was also very high in the youngest age group (25-34) among both men (18%, CI: 13.9-21.8) and women (17%, CI: 13.4-21.1). The prevalence of undiagnosed hypertension was also highest in this age group.

Table 5.2 shows the prevalence of total hypertension and the proportion of total hypertension that is undiagnosed by gender. The prevalence of hypertension was lower in Banjul and Kanifing, which are purely urban, and was higher in the more rural LGAs (Table 5.2; LGA arranged by degree of rurality). This was also the case when rurality was used to denote residence. Figure 5.3 shows the prevalence of total hypertension by region separately for men and women.

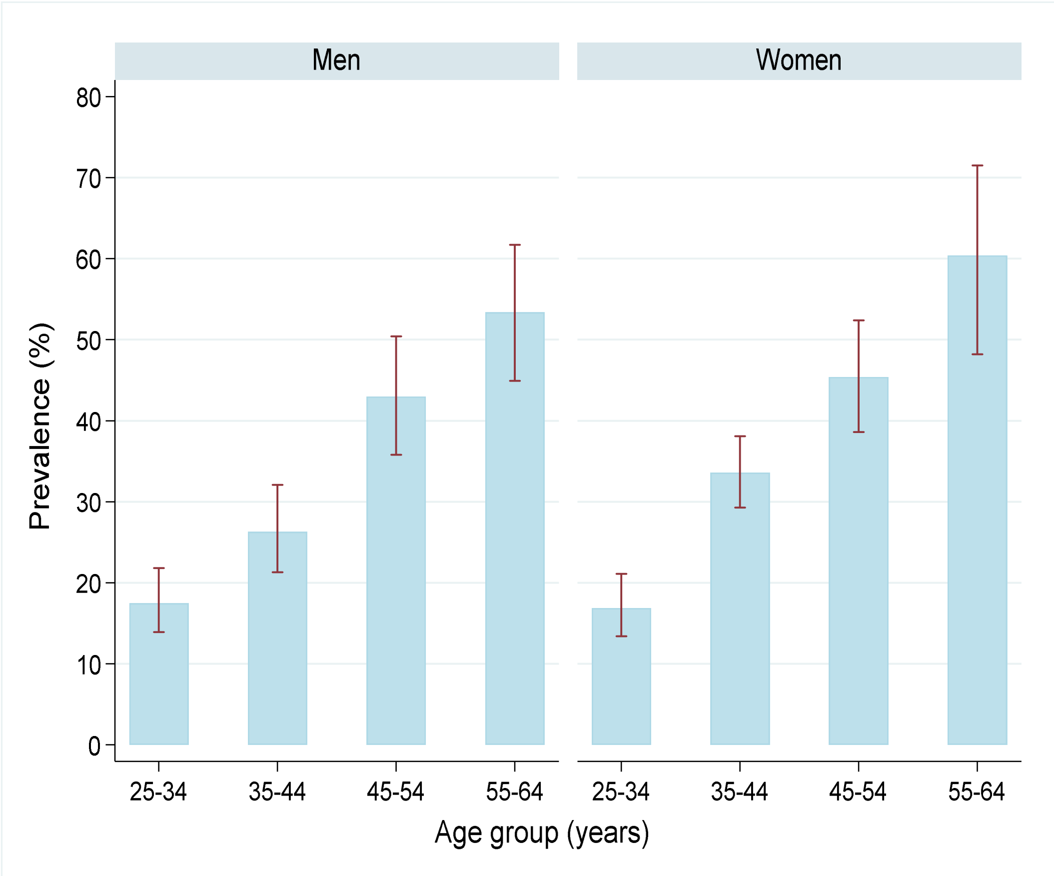
Figure 5.3: Prevalence of total hypertension by region (The Gambia, 2010)



Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

The increase in the prevalence of total hypertension with increasing age for men and women is shown in Figure 5.4. The prevalence of hypertension was very high among the obese (both generalised and abdominal obesity), among those with a lower level of education, and among ex-smokers. I found similar findings with measured hypertension (Table S13).

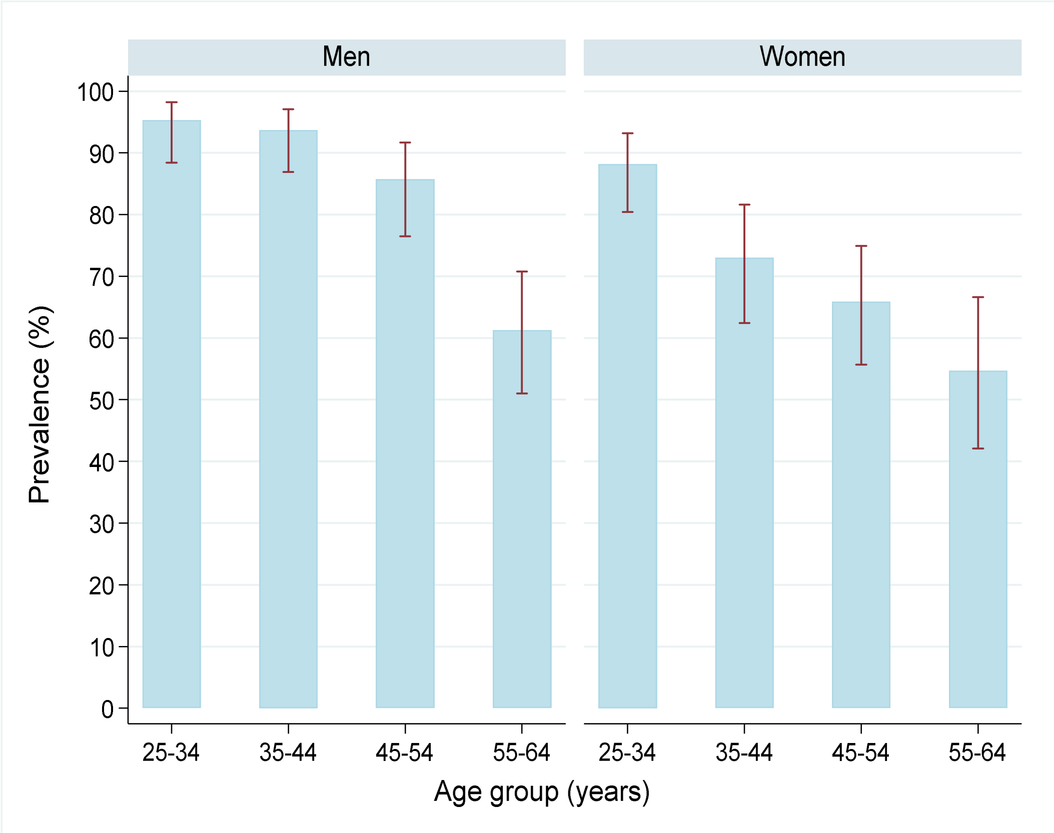
Figure 5.4: Prevalence of total hypertension by age (The Gambia, 2010)



Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

Despite the high prevalence of hypertension, levels of awareness among those with hypertension was very low. More than three-quarters (79%, 74.5-82.2) of those with total hypertension were undiagnosed (unaware of their status); this was significantly higher in men compared with women (86%, 81.7-89.4 vs 71%, 65.2-76.9; $p<0.001$) and was higher at younger ages (Table 5.2). Among the BMI groups, the prevalence of awareness was higher among hypertensive who were obese in both men and women (Table 5.2). The prevalence of undiagnosed hypertension (among those with total hypertension) by age is shown in Figure 5.5.

Figure 5.5 Proportion of total hypertension that is undiagnosed by age (The Gambia, 2010)



Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

Table 5.2: Prevalence of hypertension and proportion undiagnosed by selected socio-demographic and health factors (The Gambia, 2010) [a, b]

	Prevalence of Total hypertension				Proportion of total hypertension that is undiagnosed			
	Men n=1633		Women n=1940		Men n=491		Women n=509	
Variable	**Hypertensive % (95% CI)**	**χ^2 P value**	**Hypertensive % (95% CI)**	**χ^2 P value**	**Undiagnosed % (95% CI)**	**χ^2 P value**	**Undiagnosed % (95% CI)**	**χ^2 P value**
Total	27.7(24.5-31.2)		30.5(27.4-33.8)		86.0(81.7-89.4)		71.4(65.2-76.9)	
Age Group								
25-34	17.5(13.9-21.8)	**<0.001**	16.9(13.4-21.1)	**<0.001**	95.3(88.4-98.2)	**<0.001**	88.2(80.4-93.2)	**<0.001**
35-44	26.3(21.3-32.1)		33.6(29.3-38.1)		93.7(86.9-97.1)		73.0(62.4-81.6)	
45-54	43.0(35.8-50.4)		45.4(38.6-52.4)		85.7(76.5-91.7)		65.9(55.7-74.9)	
55-64	53.4(44.9-61.7)		60.4(48.2-71.5)		61.3(51.0-70.8)		54.7(42.1-66.6)	
Ethnicity								
Mandinka	25.8(21.4-30.9)	0.182	34.2(30.0-38.7)	0.154	84.4(78.3-89.0)	0.240	73.1(64.6-80.2	0.464
Wollof	32.7(25.7-40.6)		29.0(22.6-36.3)		82.1(67.8-90.9)		62.7(45.9-76.9)	
Fula	26.4(21.2-32.3)		29.4(24.1-35.4)		85.3(76.7-91.1)		67.5(56.9-76.5)	
Jola	25.1(18.1-33.6)		24.9(19.6-31.1)		95.2(87.6-98.2)		79.5(61.8-90.3)	
Others	34.2(26.7-42.6)		29.3(21.4-38.6)		85.9(78.9-96.0)		74.0(54.7-87.1)	
Residence (LGA) [c]								
Banjul & KM	21.7(15.6-29.5)	**0.019**	22.0(17.3-27.6)	**<0.001**	87.6(76.5-93.8)	0.759	75.0(62.1-84.6)	0.514
WCR	28.5(23.7-33.9)		33.7(29.0-38.7)		88.0(82.5-92.0)		71.0(57.7-81.4)	
URR	23.5(15.0-3.8)		25.3(18.7-33.4)		86.8(65.1-95.9)		57.8(35.8-77.1)	
NBR	34.8(28.5-41.6)		38.8(35.4-42.3)		81.0(73.7-86.7)		74.0(64.4-81.7)	
CRR	36.3(28.7-44.7)		36.5(28.8-45.0)		85.0(58.0-95.9)		76.2(62.3-86.2)	
LRR	36.6(30.0-43.8)		43.5(32.5-55.1)		80.4(71.0-87.2)		62.4(46.6-75.9)	
Residence(Rurality)								
Urban	23.9(19.6-28.8)	**0.004**	26.1(22.2-30.4)	**0.002**	88.0(81.8-92.3)	0.542	69.1(59.4-77.3)	0.191
Semi urban	29.5(22.1-38.2)		42.1(29.7-55.5)		81.9(64.1-92.0)		62.2(54.2-69.6)	
Rural	33.9(29.6-38.6)		35.4(31.7-39.3)		84.5(77.5-89.6)		76.0(66.0-83.8)	
Education								
≤6 Years	31.3(27.7-35.0)	**0.026**	35.5(32.2-39.0)	**0.002**	81.3(75.5-86.0)	**0.024**	70.1(63.2-76.2)	0.522
7-12 Years	24.7(19.4-31.0)		20.9(15.1-28.2)		94.7(87.5-97.8)		62.5(45.6-76.7)	
>12 Years	20.5(13.7-29.6)		16.7(8.6-29.9)		81.2(59.6-92.7)		68.0(36.9-88.5)	

	Prevalence of Total hypertension				Proportion of total hypertension that is undiagnosed			
	Men n=1633		Women n=1940		Men n=491		Women n=509	
Variable	**Hypertensive % (95% CI)**	**χ^2 P value**	**Hypertensive % (95% CI)**	**χ^2 P value**	**Undiagnosed % (95% CI)**	**χ^2 P value**	**Undiagnosed % (95% CI)**	**χ^2 P value**
Smoking								
Never smokers	25.1(21.3-29.3)	**0.001**			88.3(83.1-92.0)	**0.004**		
Current smokers	26.7(22.2-31.6)				89.7(82.7-94.1)			
Ex-smokers	46.5(34.7-58.6)				71.0(55.0-83.1)			
Servings of fruits and vegs								
< 5/day	26.6(22.7-30.8)	0.375	31.6(27.8-35.6)	0.529	85.4(80.1-89.4)	0.358	70.6(63.4-76.8)	0.091
≥ 5/day	29.8(23.8-36.6)		29.1(23.2-35.8)		89.9(80.8-95.0)		80.3(69.8-87.8)	
BMI[d]								
Under-weight	25.3(18.3-33.9)	0.831	22.5(16.5-29.9)	**<0.001**	86.9(73.7-94)	**<0.001**	76.9(49.3-91.9)	**0.023**
Normal weight	27.4(23.9-31.2)		26.3(22.3-30.7)		91.1(87.4-93.8)		79.3(71.9-85.1)	
Over-weight	29.8(22.6-38.1)		32.8(27.2-38.8)		80.6(72.0-87.1)		69.1(59.9-77.0)	
Obese	27.3(18.2-38.8)		43.5(35.1-52.3)		65.8(46-81.2)		59.1(45.3-71.5)	
High Waist circumference [e]								
Normal	25.3(21.9-29.0)	**<0.001**	23.7(20.2-27.5)	**<0.001**	87.8(83.3-91.2)	0.144	76.0(66.3-83.6)	0.208
High	43.8(36.0-52.0)		38.5(32.1-43.0)		80(67.5-88.5)		66.6(58.0-74.3)	

[a] Total hypertension defined as measured SBP≥140mmHg and/or DBP ≥90 mmHg and/or self-reported hypertension; Undiagnosed hypertension defined as proportion of hypertensive not aware of their condition prior to the survey

[b] Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[c] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region N= unweighted sample/observations

[d]Based on WHO standards

[e]Based on the definition of the International Diabetes Federation (≥90 cm men or ≥80 cm women)

The p value indicates the statistical significance of the difference in proportions between the groups obtained using Pearson's chi-squared test

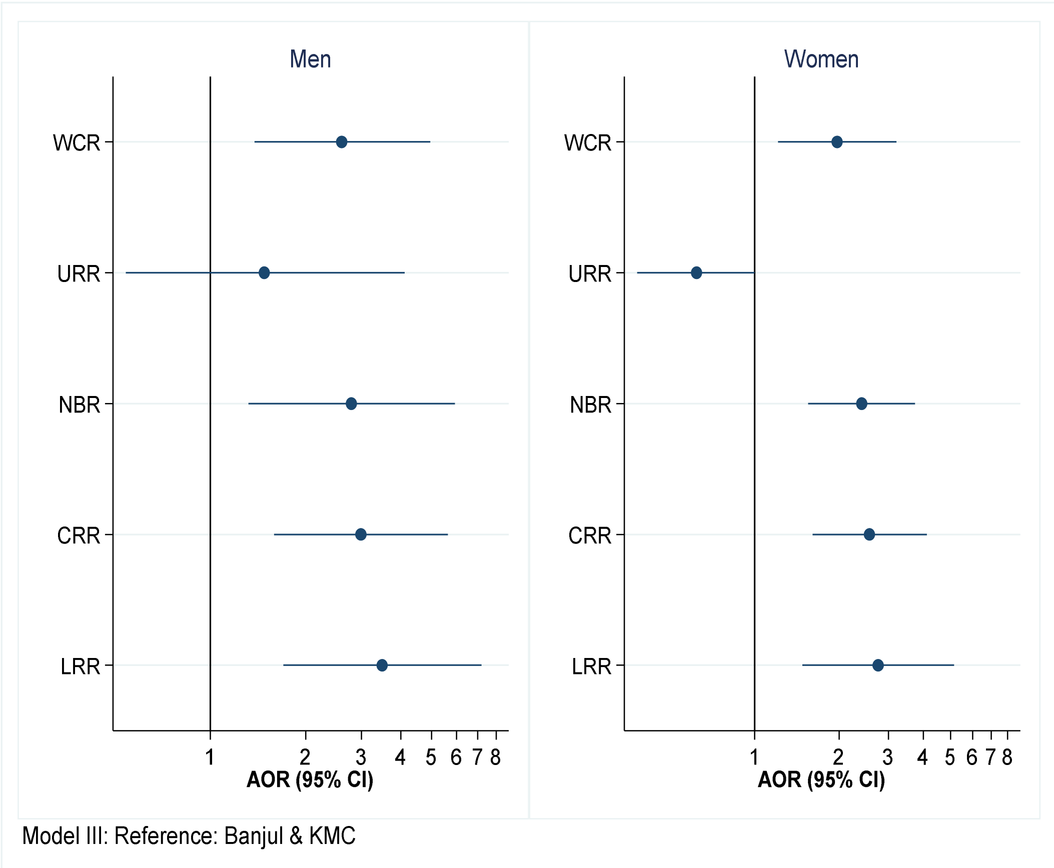
5.3.2 Treatment and control of Hypertension in The Gambia

Half (49%) of the participants with self-reported diagnosed hypertension (n=314) were on treatment (data not shown). However, the proportion on treatment was significantly higher in the urban regions and decreased by degree of rurality (Banjul and Kanifing Municipality 82%; Upper River Region 63%, West Coast Region 48%, North Bank Region 35%, Central River Region 24% and Lower River Region 22% ; $p<0.0001$). Only 24% of those on treatment had their BP controlled (to SBP<140mmHg and DBP<90mmHg), with no gender difference (26% men vs 23% women, $p=0.787$). Overall, only 14% of all hypertensive adults (defined according to total hypertension as described above) were on treatment and only 4% had their level of BP controlled.

5.3.3 Factors associated with hypertension in The Gambia

Age, residence, generalised and abdominal obesity, smoking (men only), physical inactivity (women only) and ethnicity (women only) were strongly associated with the odds of having measured and total (measured and/or self-reported) hypertension after mutually adjusting for these and other covariates (Tables 5.3 and 5.4). As expected, the odds of hypertension increased with age. Consistent with the bivariate analysis, the association between LGA of residence and the odds of hypertension increased with the degree of rurality. Compared with those from urban LGAs (Banjul and Kanifing Municipality), participants from one of the most rural LGAs (Lower River Region) had significantly higher odds of hypertension in fully-adjusted analyses among both men (AOR 3.2, 1.6-6.4) and women (AOR 2.5, 1.3-4.6). The odds of hypertension were also significantly higher in the other rural regions such as Central River Region and North Bank Region compared with the urban regions (Banjul and Kanifing Municipality) (Figure 5.6). The odds of hypertension were also higher for the West Coast Region, which is partly urban and partly rural compared with Banjul and Kanifing Municipality. Similarly, in models where rurality was used instead of LGA to explore differences by residence, participants from semi-urban and rural areas had higher odds of both measured and total hypertension than urban residents (Tables 5.3 and 5.4).

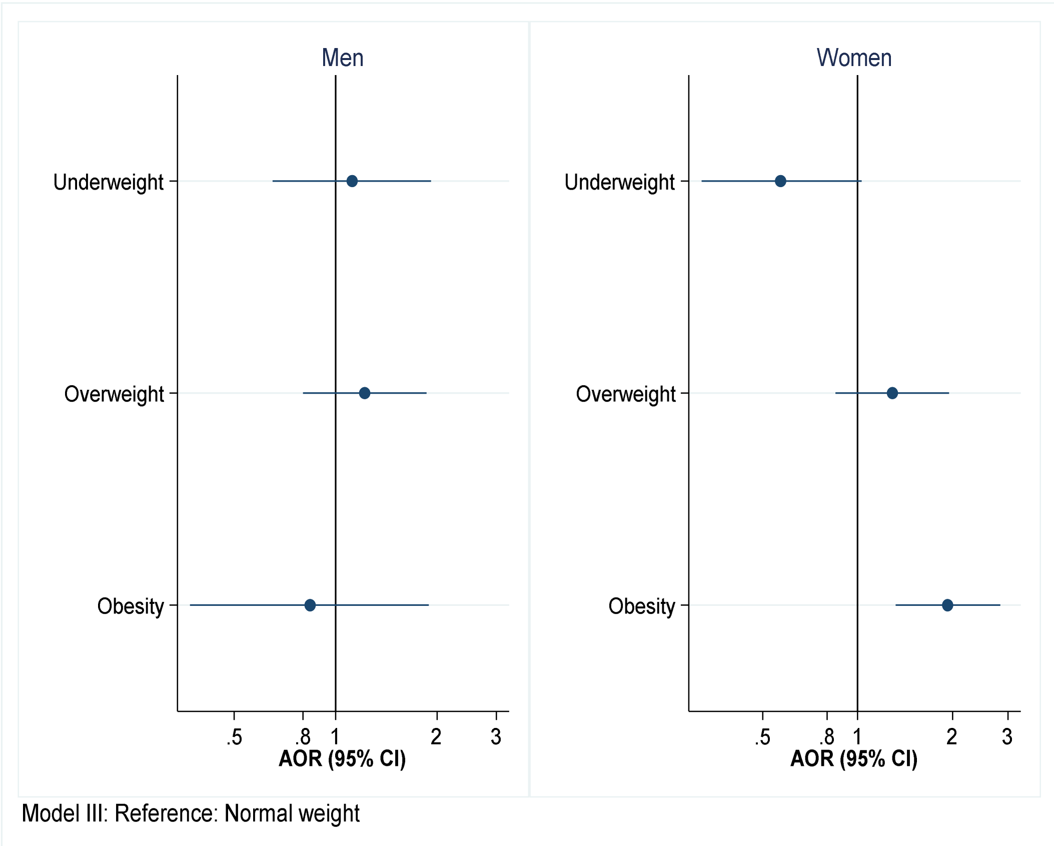
Figure 5.6 Association between region and total hypertension (The Gambia, 2010)



Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

Abdominal obesity (high waist circumference) was significantly associated with hypertension among both men and women. However, generalised obesity (high BMI) was significantly associated with obesity among women only (Figure 5.7). Physically inactive women also had higher odds of hypertension compared with active women but the association in men was not statistically significant (Tables 5.3 and 5.4).

Figure 5.7 Association between generalised obesity and total hypertension (The Gambia, 2010)



Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.
Models adjusted for age, ethnicity, education, residence, physical activity, smoking, fruit and vegetable intake and waist circumference

5.3.4 Factors associated with undiagnosed hypertension in The Gambia

Among all those with hypertension, men (AOR 2.6, 1.6-4.3) and younger participants (AOR 8.0, 3.6-18.0) had higher adjusted odds of undiagnosed hypertension compared with women and older adults respectively. Undiagnosed hypertension was also more common among the Jola participants, especially men, compared with other ethnic groups. However, the odds of undiagnosed hypertension were lower among the obese (AOR 0.2, 0.1-0.4) and ex-smokers (AOR 0.4, 0.2-0.9) compared with those with a normal weight and non-smokers respectively. Similar findings were found after stratifying my analyses by gender (Table 5.5). To examine the robustness of the results, I also conducted multinomial logistic regression analysis on hypertension with three categories (normal, diagnosed and undiagnosed); the findings were similar to those shown here (data not shown). Likewise, I also conducted linear regression analysis on the levels of systolic and diastolic blood pressure with similar findings (Appendix IV, Table S14 and S15).

Table 5.3: Multivariate logistic regression on factors associated with measured blood pressure (SBP≥140mmHg and/or DBP ≥90 mmHg) (The Gambia, 2010)

Categories	Men			Women		
	Model I[x]	Model II [y]	Model III [z]	Model I[x]	Model II [y]	Model III [z]
	[a]OR(95% CI)	AOR (95% CI)	AOR (95% CI)	[a]OR(95% CI)	AOR(95% CI)	AOR (95% CI)
Age group						
25 -34	Reference	Reference	Reference	Reference	Reference	Reference
35-44	1.54(1.09-2.17) *	1.64(1.07-2.52) *	1.44(0.95-2.20)	2.49(1.75-3.56) ***	2.40(1. 59-3.62)***	2.31(1. 51-3.53)***
45-54	3.41(2.26-5.13) ***	4.04(2.49-6.54) ***	3.47(2.15-5.58) ***	3.74(2.54-5.52) ***	2.73(1.74-4.28)***	2.74(1.75-4.29)***
55-64	4.85(2.93-8.04) ***	6.18(3.44-11.11) ***	5.56(3.17-9.78) ***	7.55(4.25-13.41) ***	7.81(4.50-13.56)***	7.73(4.34-13.75)***
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	1.33(0.88-2.02)	1.22(0.76-1.94)	1.10(0.72-1.69)	0.76(0.51-1.11)	0.88(0.59-1.33)	0.84(0.57-1.24)
Fula	1.01(0.68-1.50)	1.04(0.65-1.66)	0.98(0.62-1.53)	1.11(0.78-1.57)	0.92(0.59-1.42)	0.84(0.54-1.28)
Jola	0.92(0.57-1.48)	0.85(0.53-1.39)	0.84(0.54-1.30)	0.74(0.49-1.10)	0.77(0.50-1.20)	0.73(0.46-1.17)
Others	1.34(0.89-2.00)	1.41(0.86-2.31)	1.32(0.80-2.15)	0.83(0.52-1.31)	1.10(0.61-1.20)	0.95(0.53-1.72)
Years in school						
>12 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	1.77(1.03-3.05)*	1.54(0.91-2.63)	1.49(0.89-2.51)	1.09(0.46-2.54)	1.04(0.42-2.60)	0.94(0.39-2.28)
≤6 Years	1.52(0.89-2.58)	1.04(0.60-1.83)	1.16(0.68-2.00)	1.59(0.76-3.29)	1.43(0.61-3.35)	1.29(0.56-3.01)
Residence (LGA)						
Banjul &KM	Reference	Reference		Reference	Reference	
WCR	1.67(1.03-2.73)*	2.60(1.38-4.95)**		1.44(0.91-2.27)	1.97(1.21-3.21)**	
URR	1.22(0.61-2.45)	1.48(0.54-4.11)		1.04(0.54-2.04)	0.62(0.38-1.00)	
NBR	1.82(1.12-2.98)**	2.79(1.32-5.93)**		2.01(1.35-2.99)***	2.41(1.55-3.74)***	
CRR	2.08(1.27-3.42)**	2.99(1.59-5.63)***		1.95(1.29-2.97)**	2.57(1.61-4.12)***	
LRR	2.12(1.33-3.36)**	3.49(1.70-7.19)***		2.33(1.29 -4.18)**	2.76(1.48-5.16)**	
Residence (rurality)						
Urban	Reference		Reference	Reference		Reference
Semi urban	1.36(0.83-2.24)		1.78(1.04-3.07)*	1.91(1.14-3.20)**		2.00(1.22-3.27)**
Rural	1.54(1.12-2.13)**		1.58(1.09-2.29)*	1.54(1.12-2.14)**		1.76(1.16-2.66)**
Physical activity						
≥600 METS/week	Reference	Reference	Reference	Reference	Reference	Reference
<600 METS/week	0.82(0.54-1.26)	0.80(0.40-1.58)	0.73(0.37-1.42)	0.94(0.60-1.47)	1.73(1.14-2.63)**	1.62(1.06-2.46)*

Categories	Men			Women		
	Model I^{x}	**Model II^{y}**	**Model III^{z}**	**Model I^{x}**	**Model II^{y}**	**Model III^{z}**
	^{a}OR(95% CI)	**AOR (95% CI)**	**AOR (95% CI)**	**^{a}OR(95% CI)**	**AOR(95% CI)**	**AOR (95% CI)**
Smoking						
Non smoker	Reference	Reference	Reference	Reference	Reference	Reference
Current smoker	1.06(0.76-1.46)	1.01(0.71-1.44)	1.09(0.76-1.54)	^		^
Ex-smoker	1.88(1.10-3.21)*	1.73(0.96-3.15)	1.93(1.06-3.55)*		-	-
Servings of fruits and vegs						
≥5 servings/day	Reference	Reference	Reference	Reference	Reference	Reference
<5 Servings/day	0.85(0.59-1.24)	0.75(0.49-1.16)	0.80(0.52-1.25)	1.18(0.78-1.79)	1.18(0.79-1.75)	1.25(0.85-1.85)
BMI						
Normal	Reference	Reference	Reference	Reference	Reference	Reference
Underweight	0.99(0.60-1.62)	1.02(0.60-1.74)	1.12(0.65-1.92)	0.71(0.44-1.14)	0.55(0.30-0.99)*	0.57(0.32-1.03)
Overweight	1.14(0.77-1.67)	1.65(1.09-2.48)*	1.22(0.80-1.86)	1.26(0.89-1.78)	1.43(0.93-2.20)	1.29(0.85-1.95)
Obese	0.95(0.54-1.66)	1.16(0.52-2.63)	0.84(0.37-1.89)	1.58(1.07-2.35)*	2.10(1.44-3.06)***	1.93(1.32-2.84)***
High Waist circumference						
Normal	Reference	Reference	Reference	Reference	Reference	Reference
High	1.87(1.22-2.89)**	1.45(0.88-2.39)	1.79(1.11-2.89)*	1.43(1.07 -1.93)*	1.10(0.77-1.58)	1.34(0.95-1.90)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.
Model I^{x} adjusted for age only, Model II^{y} adjusted for all variables except rurality, Model III^{z} adjusted for all variables except local government area
^{a}OR= odds ratio adjusted for age (except for age group as the independent variable), AOR= Adjusted odds ratio (fully adjusted)
*p<0.05, **p≤0.01, *** p≤0.001 ^-removed because of small numbers LGA = local government area METS =Metabolic equivalents

Table 5.4: Multivariate logistic regression on factors associated with total hypertension (SBP≥140mmHg and/or DBP ≥90 mmHg and/or self-reported hypertension) (The Gambia, 2010)

Variable	Men			Women		
	Model I[x]	Model II [y]	Model III [z]	Model I[x]	Model II [y]	Model III [z]
	[a]OR(95% CI)	AOR(95% CI)	AOR(95% CI)	[a]OR(95% CI)	AOR(95% CI)	AOR(95% CI)
Age group						
25 -34	Reference	Reference	Reference	Reference	Reference	Reference
35-44	1.68(1.22-2.33)**	1.75(1.15-2.67)**	1.54(1.02-2.34)*	2.48(1.78-3.45)***	2.23(1.53-3.28)***	2.16(1.47-3.16)***
45-54	3.55(2.40-5.25)***	4.25(2.68-6.78)***	3.66(2.32-5.76)***	4.08(2.78-5.99)***	3.09(1.97-4.84)***	3.09(1.99-4.82)***
55-64	5.39(3.34-8.70)***	6.75(3.78-12.03)***	6.11(3.48-10.73)***	7.49(4.26-13.20)***	8.38(4.88-14.39)***	8.13(4.62-14.33)**
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	1.27(0.87-1.85)	1.22(0.77-1.95)	1.10(0.72-1.68)	0.71(0.50-1.02)	0.84(0.57-1.26)	0.79 (0.55-1.14)
Fula	1.00(0.69-1.45)	1.03(0.64-1.66)	0.96(0.61-1.52)	0.94(0.68-1.30)	0.79(0.51-1.22)	0.73(0.48-1.14)
Jola	0.90(0.56-1.44)	0.85(0.53-1.39)	0.86(0.55-1.34)	0.62(0.43-0.90)**	0.57(0.38-0.86)**	0.59(0.38-0.91)**
Others	1.36(0.93-1.97)	1.46(0.90-2.37)	1.36(0.85-2.19)	0.73(0.47-1.13)	0.86(0.48-1.55)	0.75(0.42-1.33)
Years in school						
>12 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	1.94(1.11-3.38)*	1.72 (0.99-3.02)	1.66(0.96-2.88)	1.37(0.59-3.16)	1.32(0.53-3.27)	1.16(0.49-2.76)
≤6 Years	1.69(0.99-2.89)	1.15 (0.66-2.00)	1.29(0.76-2.20)	1.95(0.92-4.11)	1.76(0.74-4.20)	1.57(0.67-3.67)
Residence (LGA)						
Banjul and KM	Reference	Reference		Reference	Reference	
WCR	1.77(1.09-2.87)*	2.58(1.38-4.82)**		1.79(1.19-2.70)**	2.36(1.49-3.75)***	
URR	1.32(0.64-2.72)	1.45(0.55-3.85)		1.25(0.74-2.11)	1.00(0.50-2.04)	
NBR	1.88(1.14-3.10)**	2.74(1.33-5.67)**		2.00(1.38-2.90)***	2.19(1.41-3.41)***	
CRR	2.31(1.33-4.03)**	2.74(1.46-5.13)**		2.00(1.34-2.98)***	2.61(1.66-4.11)***	
LRR	2.11(1.31-3.42)**	3.17(1.56-6.44)**		2.27(1.32-3.89)**	2.46(1.33-4.55)**	
Residence (rurality)						
Urban	Reference		Reference	Reference		Reference
Semi urban	1.37(0.86-2.18)		1.75(1.04-2.95)*	1.77(1.09-2.89)*		1.76(1.08-2.87)*
Rural	1.54(1.11-2.15)**		1.42(0.99-2.04)	1.45(1.08-1.94)**		1.61(1.12-2.31)**
Physical activity						
≥600 METS pw	Reference	Reference	Reference	Reference	Reference	Reference

Variable	Men			Women		
	Model I^x	Model II ^{y}	Model III ^{z}	Model I^x	Model II ^{y}	Model III ^{z}
	^{a}OR(95% CI)	AOR(95% CI)	AOR(95% CI)	^{a}OR(95% CI)	AOR(95% CI)	AOR(95% CI)
<600 METS pw	0.77(0.50-1.19)	0.73(0.37-1.45)	0.67(0.35-1.30)	0.90(0.57-1.42)	1.82(1.21-2.73)**	1.68(1.13-2.87)**
Smoking						
Non smoker	Reference	Reference	Reference	Reference	Reference	Reference
Current smoker	1.15(0.86-1.53)	1.12(0.82-1.53)	1.21(0.88-1.66)	^	-	-
Ex-smoker	2.21(1.31-3.72)**	1.83(1.00-3.33)*	2.02(1.10-3.74)*	-		
Servings of fruit & vegs						
≥5 day	Reference	Reference	Reference	Reference	Reference	Reference
<5 /day	0.81(0.55-1.18)	0.75(0.48-1.17)	0.79(0.51-1.24)	1.10(0.73-1.66)	1.05(0.72-1.53)	1.05(0.73-1.50)
BMI						
Normal	Reference	Reference	Reference	Reference	Reference	Reference
Underweight	0.95(0.58-1.55)	0.99 (0.57-1.69)	1.08(0.63-1.86)	0.72(0.44-1.18)	0.52(0.30-0.94)*	0.56(0.31-1.01)
Overweight	1.09(0.75-1.58)	1.60 (1.10-2.32)*	1.17(0.79-1.73)	1.23(0.89-1.72)	1.44(0.97-2.13)	1.26(0.85-1.85)
Obese	0.88(0.50-1.53)	1.11(0.52-2.35)	0.79(0.37-1.70)	1.78(1.15-2.76)**	2.54(1.71-3.78)***	2.22(1.50-3.29)***
High Waist circumference						
Normal	Reference	Reference	Reference	Reference	Reference	Reference
High	1.89(1.27-2.81)**	1.61(1.01-2.54)*	2.00(1.27-3.09)**	1.56(1.16-2.11)**	1.19(0.83-1.70)	1.47(1.02-2.12)*

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.
Model I^x adjusted for age only, Model II ^{y} adjusted for all variables except rurality, Model III ^{z} adjusted for all variables except local government area
^{a}OR= odds ratio adjusted for age (except for age group as the independent variable), AOR= Adjusted odds ratio (fully adjusted)
*p<0.05, **p≤ 0.01, *** p≤ 0.001 ^-removed because of small numbers LGA = local government area METS =Metabolic equivalents

Table 5.5: Multivariate logistic regression on factors associated with undiagnosed hypertension among participants with total hypertension (The Gambia, 2010)

Variable	Men			Women		
	Model I[x]	Model II [y]	Model III [z]	Model I[x]	Model II [y]	Model III [z]
	[a]OR(95% CI)	AOR(95% CI)	AOR(95% CI)	[a]OR(95% CI)	AOR(95% CI)	AOR(95% CI)
Age group						
25 -34	12.75(4.37-37.2)***	16.01(5.56-46.07)**	15.38(4.51-52.38)***	6.23(2.59-14.99)***	4.97(1.77-13.95)**	5.50(1.83-16.52)***
35-44	9.44(4.41-20.19)***	9.75(3.75-25.38)***	9.09(3.57-23.16)***	2.25(1.19-4.26)*	2.10(0.95-4.62)	2.22(0.96-5.12)
45-54	3.78(1.74-8.22)***	6.71(3.00-15.00)***	6.71(3.00-15.00)***	1.61(0.89-2.89)	1.43(0.77-2.63)	1.52(0.79-2.92)
55-64	Reference	Reference	Reference	Reference	Reference	Reference
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	0.89(0.35-2.24)	2.09(0.74-5.89)	2.74(1.09-6.92)*	0.65(0.28-1.54)	0.64(0.27-1.54)	0.95(0.41-2.19)
Fula	1.24(0.59-2.59)	0.97(0.34-2.75)	1.07(0.46-2.48)	0.63(0.35-1.12)	0.62(0.26-1.46)	0.77(0.36-1.64)
Jola	4.08(1.30-12.76)*	6.85(1.49-31.47)	5.44(1.30-22.71)*	1.39(0.56-3.44)	1.15(0.45-2.94)	1.16(0.49-2.74)
Others	2.04(0.65-6.43)	3.54(0.78-16.14)	3.63(0.77-17.23)	1.13(0.41-3.09)	1.77(0.56-5.55)	2.12(0.75-6.00)
Years in school						
>12 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	2.37(0.61-4.33)	1.45(0.32-6.62)	1.49(0.33-6.74)	0.70(0.17-2.81)	1.11(0.16-7.81)	1.17(0.20-6.80)
≤6 Years	1.63(0.68-8.29)	1.12(0.37-3.40)	1.42(0.48-4.22)	1.43(0.50-4.11)	1.82(0.42-7.83)	1.56(0.39-6.29)
Residence (LGA)						
Banjul &KM	Reference	Reference		Reference	Reference	
WCR	0.94(0.36-2.42)	0.89(0.35-2.30)		0.81(0.36-1.86)	0.60(0.20-1.78)	
URR	0.85(0.18-4.00)	0.77(0.05-11.89)		0.42(0.14-1.24)	4.45(0.58-33.89)	
LRR	0.93(0.32-2.68)	1.37(0.44-4.22)		0.69(0.29-1.67)	0.45(0.13-1.56)	
NBR	0.92(0.35-2.38)	1.28(0.39-4.25)		1.13(0.53-2.41)	0.75(0.24-2.35)	
CRR	1.13(0.21-5.99)	3.30(0.77-14.08)		1.18(0.49-2.82)	1.67(0.45-6.21)	
LRR	0.93(0.32-2.68)	1.37(0.44-4.22)		0.69(0.29-1.67)	0.45(0.13-1.56)	
Residence (rurality)						
Urban	Reference		Reference	Reference		Reference
Semi urban	0.75(0.24-2.32)		0.94(0.30-2.92)	0.89(0.49-1.60)		1.51(0.82-2.78)
Rural	1.10(0.50-2.45)		1.01(0.47-2.19)	1.56(0.83-2.92)		1.69(0.84-3.42)
Physical activity						
≥600 METS pw	Reference	Reference	Reference	Reference	Reference	Reference
<600 METS pw	1.93(0.67-5.52)	1.50(0.35-6.48)	1.72(0.42-6.97)	0.83(0.39-1.77)	0.57(0.25-1.29)	0.77(0.35-1.69)

Variable	Men			Women		
	Model I^x	Model II ^{y}	Model III ^{z}	Model I^x	Model II ^{y}	Model III ^{z}
	[a]OR(95% CI)	AOR(95% CI)	AOR(95% CI)	[a]OR(95% CI)	AOR(95% CI)	AOR(95% CI)
Smoking						
Non smoker	Reference	Reference	Reference	Reference	Reference	Reference
Current smoker	1.15(0.56-2.380	0.97(0.39-2.43)	1.05(0.44-2.55)	^	^	^
Ex-smoker	0.38(0.18-0.88)*	0.51(0.18-1.37)	0.56(0.24-1.28)			
Servings of fruit and vegs						
≥5 /day	Reference	Reference	Reference	Reference	Reference	Reference
<5 /day	0.90(0.34-2.37)	0.95(0.32-2.85)	1.09(0.38-3.09)	0.61(0.32-1.19)	0.73(0.25-2.08)	0.71(0.28-1.75)
BMI[c]						
Normal	Reference	Reference	Reference	Reference	Reference	Reference
Underweight	0.57(0.23-1.48)	0.77(0.26-2.24)	0.75(0.25-2.20)	0.96(0.28-3.33)	1.95(0.51-7.58)	1.66(0.44-6.22)
Overweight	0.35(0.18-0.65)***	0.41(0.14-1.20)	0.40(0.14-1.10)	0.59(0.34-1.04)	0.51(0.20-1.27)	0.53(0.23-1.22)
Obese	0.16(0.06-0.46)***	0.11(0.02-0.53)**	0.10(0.03-0.38)***	0.40(0.20-0.80)**	0.29(0.12-0.69)**	0.35(0.14-0.87)*
High Waist circumference [d]						
Normal	Reference	Reference	Reference	Reference	Reference	Reference
High	0.55(0.24-1.28)	1.50(0.34-6.48)	1.29(0.37-4.51)	0.85(0.46-1.56)	1.26(0.62-2.61)	1.03(0.52-2.03)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.
Model I^x adjusted for age only, Model II ^{y} adjusted for all variables except rurality, Model III ^{z} adjusted for all variables except local government area
[a]OR= odds ratio adjusted for age (except for age group as the independent variable), AOR= Adjusted odds ratio (fully adjusted)
*p<0.05, **p≤ 0.01, *** p≤ 0.001 ^Not included in the model because of small numbers LGA = local government area
METS =Metabolic equivalents
[b] Undiagnosed hypertension defined as proportion of hypertensive not aware of their condition prior to the survey
[c] Based on WHO standards
[d] Based on the definition of the International Diabetes Federation (≥90 cm men or ≥80 cm women

5.4 Discussion

5.4.1 Key findings on hypertension in The Gambia

This study has confirmed that the prevalence of hypertension is very high in The Gambia (28% and 31% for men and women aged 25-64 years, respectively), and has revealed a greater burden in rural areas. Of great concern is the high proportion (79%) of the hypertensive cases that are undiagnosed.

The prevalence of hypertension among the youngest age group (25-34 years) was very high among both men (18%, CI: 13.9-21.8) and women (17%, CI: 13.4-21.1) in The Gambia. Younger adults were also the most likely to have their hypertension undiagnosed. High prevalence of hypertension among the younger adults is not unique to The Gambia as similar findings were found in other studies in SSA. The prevalence of hypertension among young adults 25-34 years in a national survey in Malawi was 21% (18.4-24.7) (Msyamboza et al., 2012). Prevalence of 18% and 15% were reported in a sub-national and national survey respectively in Ethiopia (Demisse et al., 2017, Gebreyes et al., 2018). A national survey in Mozambique also reported a prevalence of 32% (25.0-38.6) among men 25-34 years in urban areas and 33% (26.4-39.2) among those in rural areas (Damasceno et al., 2009), and 18%(12.7-25.5) and 11%(5.9-16.2) among women in urban and rural areas respectively. These findings show that hypertension is not only a burden among older people in The Gambia and many other countries in SSA but is also a burden among younger adults. I discuss the importance of these high levels of hypertension among young adults in The Gambia as a priority for future research in the Discussion to my thesis (section 9.5).

Rural residence was significantly associated with both total and measured hypertension after adjusting for other covariates. This association remained strong in all models regardless of whether LGA or rurality was used as the variable to indicate residence. This is contrary to what has been found in most other studies in SSA (Chapter 3 section 3.7.4): urban residence was consistently associated with higher levels of hypertension in similar STEP surveys conducted in Benin (Houehanou et al., 2015), Ethiopia (Tesfaye et al., 2007), Ghana (Minicuci et al., 2014), Mozambique (Damasceno et al., 2009), and Uganda (Musinguzi and Nuwaha, 2013). However, there was no statistically significant difference in levels of hypertension between urban and rural residence in a similar study in Rwanda (Nahimana et al., 2017) and in subnational studies in Uganda (Guwatudde et al., 2015), Angola(Pedro et al., 2018) and Ethiopia (Abebe et al., 2015). A study that focused on generally lean children under 18 years and adults 18 and above in the Lower River Region in The Gambia (the region with the highest prevalence in my study) reported a high BP prevalence of 8% (95% CI: 7.4-9.2) among children under 18 years and 18% (95% CI: 16.8-19.9) among adults 18 and above (Jobe et al., 2017). Levels of undiagnosed hypertension did not vary significantly by residence in my study; the association with rural Gambia was for the outcome of total hypertension, not an artefact of differential access to healthcare, diagnosis or treatment. However, this null finding should be interpreted with caution due to the smaller samples used for analysing differences in undiagnosed hypertension (n=491 men; n=509 women) and hence I might not have been able to detect statistically significant differences in levels of undiagnosed hypertension by residence because of low statistical power.

This unique finding of higher odds of hypertension in rural areas in The Gambia could be associated with various factors. The more rural LGAs are the poorest in The Gambia:

poverty levels range from 63%-94%, compared with 8% in Banjul (the capital) (Gambia Bureau of Statistics, 2009). Rural residents in The Gambia also have lower education levels (Gambia Bureau of Statistics, 2013). Even though people from higher wealth quintiles had higher risks of hypertension in a number of previous studies (Olack et al., 2015, Murphy et al., 2013), there is evidence for associations between low socio-economic status and risk of CVDs including hypertension (Son, 2002, Kim et al., 2016).

The lower risk of hypertension among rural dwellers observed in other countries in SSA may be related to their occupation. Generally in SSA, rural dwellers are subsistence farmers, involved in laborious farming activities, while most jobs in urban areas are sedentary, leading to less opportunity for work-related physical activity (Misra and Khurana, 2008). However, in The Gambia, even though agriculture is the main economic activity in rural areas, it is becoming more mechanised. The farming season is also very short (May–October). Therefore, although farmers may be active on their farmlands during the farming season, they may be sedentary for the greater part of the year. The data used in the present study was collected from January to March, a time when farmers are more likely to be sedentary. On the other hand, many adults in urban areas work in the construction, fishing and manufacturing industries, which are labour intensive (Gambia Bureau of Statistics, 2017) but not seasonal. This is evident in the data, as 85% of the participants met the WHO minimum recommendation on physical activity (≥600 METS/week), most of which was work-and transport-related. There is also some controversy on the benefits of work-related physical activity. A number of physical activity researchers have suggested that occupational physical activity does not confer the cardiovascular health benefits that recreational/leisure time physical activity does and might even be detrimental to health (Holtermann et al., 2018, Li et al., 2013). Only 12% of the participants in my study engaged in any form of recreational physical activity and this was lowest in rural areas compared with urban and semi-urban areas (data not shown). Another plausible explanation could be diet, especially possible higher levels of salt consumption in rural areas. Peanuts are produced in The Gambia for export and local consumption. They can also be salted, roasted and used as snacks, which is very common in rural Gambia. High salt intake is a well-known major risk factor for hypertension, especially among people of African descent (Ukoh et al., 2004, Forrester, 2004, Somova and Mufunda, 1993, De Wardener and MacGregor, 2002, Cappuccio and Miller, 2016). A recent analysis of the INTERMAP study (International Study on Macro/Micronutrients and Blood Pressure), in which participants were sampled from Japan, China, the UK and the USA, demonstrated a strong association between high salt intake and high BP and revealed that even a healthy diet does not offset this association (Stamler et al., 2018).

Other important associations with hypertension found in this study are overweight and obesity, being an ex-smoker, physical inactivity, and ethnicity. In line with an earlier study in The Gambia (van der Sande et al., 2001b), higher BMI and high waist circumference were significantly associated with hypertension, but not a higher waist-to-hip ratio. The higher odds of hypertension among the overweight and obese (versus those with normal weight) especially among women are consistent with findings from similar studies in SSA (Pires et al., 2013, Keetile et al., 2015, Minicuci et al., 2014, Olack et al., 2015, Guwatudde et al., 2015). There is growing evidence on the increasing burden of obesity in SSA; The Gambia is not an exception. This could be related to the perception of many SSA communities that being overweight is associated with good life and high status, especially among women (Simmons, 2006, Scott et al., 2012). Ex-smokers had higher odds of hypertension after adjusting for other covariates compared with never- and current-smokers. Smoking is also a well-known major risk factor for CVD and it is likely that many ex-smokers had been advised to quit smoking for health reasons, including possibly because they were hypertensive. Jola women had lower odds of hypertension compared with women in other ethnic groups. Unlike other tribes, the Jolas have retained most of their traditional beliefs and practices (Colley, 2016), especially on diet, which could explain the lower odds of hypertension among the Jola women.

5.4.2 Undiagnosed hypertension, treatment and control

Almost four-fifths of hypertension in The Gambia is undiagnosed. This is consistent with findings from a national survey in Eritrea (80%) (Mufunda et al., 2006), lower than in Mozambique (85%) (Damasceno et al., 2009) and Malawi (95%) (Msyamboza et al., 2012), and higher than in The Republic of Seychelles (36%) (Bovet et al., 2009) (Chapter 3 section 3.7.3). Half (49%) of those in The Gambia with self-reported hypertension were on treatment, consistent with treatment levels in Mozambique (Damasceno et al., 2009) but much lower than in The Republic of Seychelles (93%) (Bovet et al., 2009). Although prevalence levels of hypertension are higher in rural areas, levels of treatment among people with hypertension, and levels of control among those on treatment, were very low among rural residents in The Gambia.

The major associations with undiagnosed hypertension among those with hypertension were age, gender, obesity, being an ex-smoker and ethnicity (Table 5.6). Younger participants with hypertension had higher odds of being undiagnosed. Younger adults are less likely to visit a clinic and have their BP monitored and perhaps healthcare staff are less likely to consider hypertension as a potential issue in younger adults. Men also had higher odds of having their hypertension being undiagnosed. Women have more contact with health services because of reproductive and child health care services, and this potentially explains their higher levels of diagnosed hypertension (Cappuccio et al., 2004). The odds of undiagnosed hypertension were extremely high among the Jolas, especially among men. Jolas are the most traditional ethnic group (Colley, 2016) and hence less likely to visit orthodox medical clinics. The odds of undiagnosed hypertension were lower among the obese and ex-smokers. There is evidence suggesting that being overweight/obese acts as a visual trigger for healthcare workers to check such patients' blood pressure and hence the overweight/obese are more likely to be diagnosed, if hypertensive, than those with normal weight (Flegal et al., 2013, Kit et al., 2012).

5.4.3 Social and economic consequences

The high burden of hypertension among adults in The Gambia poses economic and social consequences. What makes it even more worrying is the high proportion of hypertension that is undiagnosed. Recent data have shown that hypertension is among the leading causes of death and disability in The Gambia (IHME, 2019). As evident in the literature, hypertension is a risk factor of stroke and heart attack. A study in Southwest Nigeria revealed that 10% of the medical admissions within one year at the Federal Medical Centre in Abeokuta had acute heart failure and that 79% of the admissions were related to hypertension (Ogah et al., 2014). This incurred considerable costs to the affected patients, their families and the states. The study revealed that most of the patients affected were young and that the condition also affected their productivity (Ogah et al., 2014). With the high prevalence of undiagnosed, untreated and uncontrolled hypertension among adults in The Gambia, premature death and disability from stroke and heart attacks are expected to rise. Premature death and disability associated with hypertension can incur losses to government and societies, as it affects productive members of society. It can lead to an increase in the number of widow(er)s and orphans in the society and drive families into abject poverty, especially when the breadwinner of a family is affected.

Globally, direct costs attributable to sub-optimal blood pressure control was 372 billion US dollars in 2001, representing 10% of overall health care expenditure globally in that year (Gaziano et al., 2009). A recent systematic review in LMICs has shown that the annual cost of CVDs including hypertension significantly exceeded per capita health expenditure in most LMICs (Gheorghe et al., 2018). The economic loss due to CVDs in SSA exceeds nine billion dollars. Unfortunately, the economic burden of CVDs in LMICs does not appear to be aligned with policy priorities in these countries because of the long existing burden of infectious diseases (Gheorghe et al., 2018). A recent study that focused on the cost of hypertension care in public health care facilities in Kenya revealed hypertension patients incur substantial direct healthcare costs (e.g medication), direct non-healthcare costs (e.g. transportation cost to access healthcare) and indirect costs (e.g waiting time, and the resultant productivity hours lost among the employed) (Oyando et al., 2019). Hypertension therefore poses a public health, social and economic burden to individuals, families, governments and society as a whole (Miranda et al., 2008). This can pose a barrier to poverty alleviation and to sustainable development, and hence can hinder the attainment of the United Nations SDGs (WHO, 2014a, Clark, 2013, Lal et al., 2013, WHO, 2017a).

5.4.4 Strengths and limitations of this study

This study provides the most recent nationally-representative data on hypertension and its associated risk factors in The Gambia. A complex sampling strategy and the use of the Kish method to select the eligible participant per household reduces biases introduced by sampling strategies that favour the selection of any available participant per household. The data was collected by health workers at the residence of the participants in a very relaxed environment hence minimising the effect of "*white coat*" bias. Data collection did not take place during the holy month of Ramadan unlike the previous national study (van der Sande et al., 1997). There is evidence suggesting the burden of undiagnosed hypertension is high in SSA but data on the associations is very limited. To increase the evidence base, this study outlines the major associations with undiagnosed hypertension, which can be applied in policy-making in The Gambia and other countries in SSA.

The main limitation of this study is that the design was cross-sectional, making it difficult to establish causality. BP was measured on only one occasion as opposed to the recommendation of measurements on at least two different occasions. Therefore the prevalence of hypertension may be overestimated. However, this potential bias was minimised to some extent by using the mean of the last two of three BP measurements. Salt intake, which is one of the indicators of the Global Action Plan for the prevention and control of NCDs (WHO, 2013a), is a known risk factor of hypertension but was not part of the STEP instrument at the time of data collection. Some of the participants had missing BP measurements and hence were excluded (Appendix IV, Table S16). The number affected was very small but could have biased the estimates.

5.5 Conclusion

Almost one third of Gambian adults are hypertensive and 80% are undiagnosed and untreated. Contrary to what has been found in similar studies in SSA, where levels of hypertension are highest in urban areas, I found rural residence to be strongly associated with hypertension in The Gambia. This unexpected finding of higher hypertension in rural areas generates new hypotheses on diet and socio-cultural practices that should be explored in future research. More action is also needed from all stakeholders, including policy makers and international organisations, to mitigate this burden.

6. Chapter 6: Underweight, Overweight and obesity among adults in The Gambia

6.1 Introduction

This chapter describes the results of the analysis I conducted to address the third objective of my PhD research project, i.e the prevalence of underweight, overweight and obesity and their associated risk factors in The Gambia.

Non-communicable diseases (NCDs) are increasing in sub-Saharan Africa (SSA) (Dalal et al., 2011, WHO, 2017a). NCDs account for 70% of global deaths; 80% occur in low- and middle-income countries (WHO, 2017a). A pooled analysis of 1698 population-based measurement studies comprising 19 million participants from 200 countries revealed an increasing trend of obesity globally (NCD Risk Factor Collaboration, 2016). If these trends continue, meeting the WHO global NCD target of halting the rise of obesity by 2025 is almost impossible. A great concern is the rapid increase of obesity in SSA. These countries face the challenge of the double burden of communicable and non-communicable diseases, including the double burden of underweight/malnutrition and obesity (Boutayeb, 2006, Nyirenda, 2016). However, less than 3% of global aid is directed towards NCD prevention and control (Nugent and Feigl, 2010).

A pooled analysis of population-based studies from 1980-2014 in Africa demonstrated a significant increase in age-standardised mean BMI across the African continent (NCD Risk Factor Collaboration –Africa Working Group, 2017). A recent analysis of Demographic and Health Surveys conducted between 1991 and 2014 in 24 African countries revealed a significant increase in obesity among women in these countries; rates in some countries tripled (Amugsi et al., 2017). There is evidence suggesting obesity is increasing more quickly in developing countries, especially in SSA, compared with developed countries (Popkin and Slining, 2013, Owolabi et al., 2017). This is associated with a range of factors including epidemiological and nutritional transition, adoption of western life styles, decreased physical activity, low fruit and vegetable consumption, increased consumption of processed foods, and urbanisation (Ojofeitimi et al., 2007, Doku and Neupane, 2015, Biadgilign et al., 2017, Bosu, 2015).

A study using data from 1942 to 1997 on the causes of death in The Gambian capital Banjul documented the double burden of non-communicable diseases with communicable diseases and malnutrition (van der Sande et al., 2001a). In a nationwide assessment among Gambians aged 16 years and above in 1996, 18% were underweight, 8% overweight and 2% obese (van der Sande et al., 1997). A related study in urban and rural communities in The Gambia revealed that 18% of participants were underweight and 4% were obese, with a higher prevalence of obesity (33%) among urban women aged 35 years and above (van der Sande et al., 2001b). Both studies confirm the persistence of the double burden of underweight and overweight in The Gambia, although obesity prevalence was low (but increasing) in those surveys.

The double burden of communicable and non-communicable diseases poses a challenge to governments and families in SSA; The Gambia is no exception. In the previous chapter, I revealed a high prevalence of hypertension in The Gambia, with a greater burden in rural areas and among the obese (more details in Chapter 5 and the related manuscript (Cham et al., 2018)). Moreover, this demographic double burden has significant implications for wider development concerns. It poses a barrier to poverty alleviation and can hinder the attainment of the UN SDGs, particularly Target 3.4, which calls for a reduction in premature mortality due to NCDs by one-third by 2030 (Clark, 2013, Lal et al., 2013, WHO, 2017a). The aim of this chapter is to assess the burden of underweight, overweight and obesity among adults in The Gambia aged 25-64 years.

6.2 Methods

6.2.1 Participants and data collection

This chapter is based on secondary analysis of data from the most recent nationally representative population based health examination survey conducted in The Gambia. I have described the study setting and design, sampling, research instruments, data management and definition of variables in Chapters 4 (sections 4.1-4.5) and 5 (section 5.2.2). Briefly, data were collected from a random sample of adults aged 25-64 years in The Gambia from January to March 2010 using the WHO STEPwise approach (WHO, 2003a). The anthropometric and BP measurements were performed by field workers at participants' residences. Weight, height and waist circumference were measured using WHO STEP protocols (WHO, 2003a). The measurements were conducted using standard scales with participants wearing light clothing with foot and head wear removed. Weight was measured to the nearest 0.1kg using digital bathroom scales. Height was measured to the nearest 0.1cm in the standing position, using standard portable stadiometers. Waist circumference was measured (once) to the nearest 0.1cm using a tape measure and was taken midway between the lowest rib and the iliac crest.

6.2.2 Dependent/Outcome variables

The first outcome variable was generalised obesity, defined using body mass index (BMI). I calculated BMI by dividing weight (in kg) by height squared (m^2). I categorised BMI into underweight (BMI <18.5kg/m^2), normal/desirable weight (18.5-24.9kg/m^2), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2), using the WHO thresholds (WHO, 2000). Secondly, I used abdominal obesity as the outcome, defined using the International Diabetes Federation thresholds (high waist circumference, indicating abdominal obesity, defined as ≥90 cm in men and ≥80 cm in women) (International Diabetes Federation, 2006).

In addition, I also explored the prevalence of high waist-to-hip ratio (WHR) and high waist-to-height ratio (WHtR). I calculated WHR by dividing waist circumference by hip circumference, while WHtR was obtained by dividing participant's waist circumference by their height. The definition of high WHR was based on WHO standards (high WHR defined as >0.90 in men and >85 in women) (WHO, 1999). WHtR was categorised into normal (≤ 0.5) and high (>0.5).

6.2.3 Independent covariates/predictor variables

The predictor variables included sociodemographic and behavioural risk factors including self-reported age-group, ethnicity, education, residence, fruit and vegetable intake, physical inactivity, and smoking (categories shown in Table 6.1).

6.2.4 Data management and analysis

The analytical sample in this chapter was restricted to non-pregnant participants with valid physical measurements of weight and height for generalised obesity (n=3533); waist circumference for abdominal obesity (3418); waist-hip-ratio (n=3416) and waist-to-height ratio (n=3418). There were fewer participants with weight and height measurements compared with blood pressure measurements in the dataset. Moreover, there were fewer participants with waist and hip circumference measurement compared with weight and height. These could be related to the culturally sensitive nature and challenges in obtaining these anthropometric measurements in Gambian settings. I conducted complete case analysis as fewer than 1% of those with valid weight, height and waist circumference measurements had missing information on other variables. I described the participants' sociodemographic characteristics as well as their behavioural risk factors using both the weighted and unweighted data. I reported the prevalence of BMI categories and abdominal obesity categories as proportions with their corresponding 95% confidence intervals (CI). I conducted multivariable multinomial logistic regression analysis to identify factors associated with being underweight, overweight and obese separately, comparing each of these categories with the reference group of normal weight. Age-adjusted and fully-adjusted relative risk ratios (ARRR), with their corresponding 95% CIs, are reported. In accordance with the guidance in the Stata reference manual for the 'mlogit' command, I present the associations as ratios of relative risks. All my analyses were stratified by gender, as I expected that the associations between the predictors and outcomes may differ by gender. I did not include smoking (in women) and alcohol consumption (both sexes) in the regression models because few women were current smokers and few adults (<3%) reported consuming alcohol.

As with the previous chapter (hypertension), due to the collinearity of the two variables on residence (i.e. local government area and urban/rurality), fully-adjusted models were repeated interchanging these variables. I explored variables that could modify the association between the predictor variables and BMI categories in my regression models by fitting interaction terms. I conducted a joint test for the interaction effect between education and residence as well as physical inactivity and residence. There was no evidence of modification (all p>0.05) and hence multinomial logistic regression models without interaction terms are reported. As in other studies, I did not include abdominal obesity as a predictor variable in my multinomial logistic regression models using BMI status as the outcome variable because of the collinearity of waist circumference and BMI (Han et al., 1995).

I explored the factors associated with abdominal obesity as the outcome by running multivariable binary logistic regression analysis. I carried out age-adjusted bivariate analysis for each covariate separately (except for age group as the independent variable), then undertook multivariable logistic regression analysis to identify factors associated with being abdominally obese. I did not include BMI as a predictor for abdominal obesity because of the collinearity of waist circumference and BMI. The list of covariates was the same for both outcomes. Age-adjusted (OR) and fully-adjusted odds ratios (AOR) with corresponding 95% CI are reported for the binary outcome of abdominal obesity. Apart from the description of the characteristics of study participants (Table S17), all my analyses are weighted and adjusted for the complex survey design and were weighted for non-response, using Stata 15.

6.3 Results

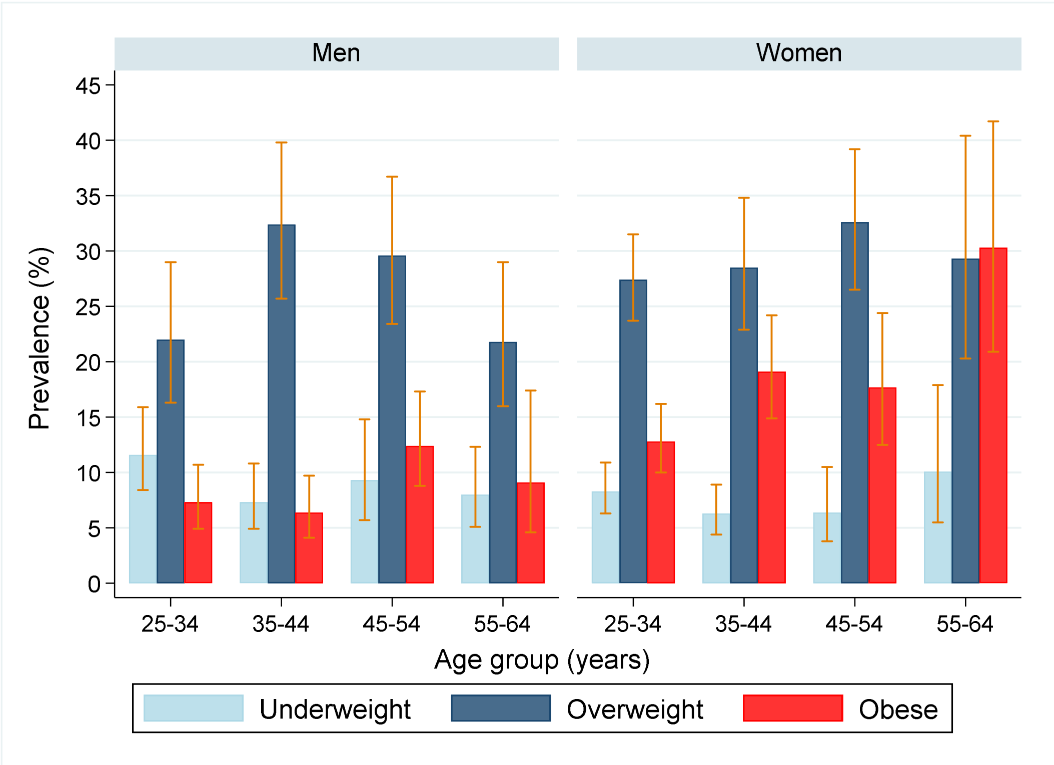
6.3.1 Characteristics of participants

The unweighted and weighted descriptions of respondents' socio-demographic, behavioural and biological characteristics are presented in Tables S17 (unweighted) and 6.1(weighted) respectively. The unadjusted mean age was 38.3±10.9 years. More than two-fifths of the participants (44%) were in the younger age-group (25-34 years), particularly among women (53% vs 33% of men). However, there was no age difference by gender after weighting and adjusting for the complex survey design (P=0.937, Table 6.1). The adjusted mean BMI was 24.6 kg/m^2 (95% CI 24.1-25.1) and the mean waist circumference was 74.0cm (71.1-76.9). Average levels of BMI and waist circumference were higher among women.

6.3.2 Prevalence of underweight, overweight and obesity

The prevalence of BMI categories by selected socio-demographic and behavioural characteristics are presented for men and women in Tables 6.2a and 6.2b respectively (and are shown by age in Figure 6.1). More than half the men had a normal/desirable weight (56%, 95% CI 50.8-61.4) and one in ten was underweight (10%, 7.6-12.4). The prevalence of overweight and obesity in men were 26% (21.1-31.6) and 8% (6.0-11.0) respectively (Table 6.2a). Close to half of the women were either overweight (29%, 25.8-31.9) or obese (17%, 14.7-19.7), while 8% (6.1-9.5) were underweight (Table 6.2b). The prevalence of overweight and of obesity were substantially higher among urban residents, those with a higher level of education, the physically inactive, and those with a high waist circumference in both men and women. More than 60% of the residents in the capital (Banjul) and the nearby towns (Kanifing Municipality) were either overweight or obese. Obesity was also high among never and ex-smokers in men. The prevalence of abdominal obesity was 10% (CI: 7.8-13.4) in men and 46% (CI: 39.3-52.6) in women (Appendix IV Table S18).

Figure 6.1 Prevalence of underweight, overweight and obesity by age and gender (The Gambia, 2010)



Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

Table 6.1: Characteristics of study participants by selected demographic, behavioural and biological risk factors (The Gambia, 2010)

Variable	Men %(95% CI) 1611	Women %(95% CI) 1922	Total %(95% CI) 3533
Gender			
Men			50.2(47.6-52.9)
Women			49.8(47.1-52.4)
Age Group			
25 -34	46.8(42.8-50.8)	45.9(42.8-49.1)	46.3(43.9-48.8)
35-44	26.5(24.0-29.2)	27.0(24.3-29.8)	26.7(24.9-28.7
45-54	16.8(14.7-19.2)	17.6(15.7-19.6)	17.2(15.8-18.7)
55-64	9.9(8.2-11.9)	9.6(7.5-12.1)	9.7(8.2-11.5)
	P<0.937		
Mean age	37.8(37.0-38.6)	37.6(36.8-38.3)	37.7(37.1-38.2)
Marital Status			
Never married	22.6(20.1-25.2)	7.3(5.7-9.4)	15.0(13.4-16.7)
Married	66.4(59.8-72.3)	70.8(63.2-77.4)	68.6(61.9-74.6)
Separated/divorced	2.3(1.7-3.3)	4.8(3.8-6.0)	3.5(2.9-4.4)
Widowed	0.3(0.1-0.9)	5.5(4.2-7.3)	2.9(2.2-3.8)
Cohabiting	8.4(4.3-15.9)	11.6(5.9-21.5)	10.0(5.2-18.5)
	P<0.001		
Ethnicity			
Mandinka	42.1(36.9-47.6)	39.3(33.4-45.6)	40.7(35.6-46.0)
Wollof	16.2(12.1-21.4)	16.1(12.4-20.5)	16.2(12.5-20.7)
Fula	20.7(17.1-25.0)	18.5(15.1-22.4)	19.6(16.4-23.3)
Jola	12.2(8.2-17.8)	15.1(11.1-20.2)	13.6(9.8-18.6)
Other	8.7(6.6-11.5)	11.1(8.5-14.4)	9.9(7.8-12.5)
	P=0.104		
Years spent in school			
≤6 Years	55.0(50.5-59.5)	74.3(69.4-78.6)	64.3(60.1-68.2)
7-12 Years	31.5(28.1-35.2)	22.4(18.7-26.6)	27.1(24.2-30.3)
>12 Years	13.4(11.2-16.0)	3.4(2.3-4.9)	8.6(7.2-10.2)
	P<0.001		
Residence (Local government area) [a]			
Banjul	7.8(2.5-21.9)	7.1(2.2-21.0)	7.5(2.4-20.7)
KMC	23.2(15.1-33.9)	28.2(18.9-39.8)	25.7(17.2-36.6)
WCR	35.7(24.3-48.8)	30.9(20.6-45.5)	33.3(22.6-46.0)
LRR	7.6(3.3-16.8)	7.9(3.4-17.6)	7.8(3.4-16.9)
NBR	8.2(4.4-14.6)	10.3(5.6-18.11)	9.2(5.1-16.3)
CRRN	2.5(0.7-8.9)	2.8(0.7-9.9)	2.7(0.7-9.4)
CRRS	6.1(2.5-14.2)	6.4(2.6-14.7)	6.3(2.6-14.2)
URR	8.9(4.1-18.2)	6.4(2.8-14.1)	7.7(3.5-16.0)
	P=0.131		
Residence (Rurality)			
Urban	57.7(48.2-66.6)	56.8(47.8-65.4)	57.2(48.3-65.7)
Semi urban	8.7(4.3-17.0)	6.8(3.1-14.4)	7.8(3.7-15.5)
Rural	33.6(27.4-40.5)	36.4(29.8-43.6)	35.0(28.9-41.7)
	P=0.187		
Physical Activity [b]			
≥600METS/week	88.9(84.0-92.5)	80.2(72.1-86.4)	84.6(78.2-89.3)
< 600METS/week	11.1(7.5-16.1)	19.8(13.6-27.9)	15.4(10.7-21.8)
	P<0.001		
Smoking			
Never smokers	57.3(52.3-62.1)	98.1(96.9-98.8)	77.6(74.2-80.6)

Variable	Men %(95% CI) 1611	Women %(95% CI) 1922	Total %(95% CI) 3533
Current smokers	33.0(29.0-37.2)	1.2(0.7-1.8)	17.2(14.8-19.8)
Ex-smokers	9.8(7.7-12.4)	0.8(0.3-1.7)	5.3(4.1-6.9)
	P<0.001		
Servings of fruits and vegetables			
≥5 /day	24.0(18.2-30.9)	23.8(18.1-30.6)	23.9(18.4-30.4)
< 5/day	76.0(69.1-81.9)	76.2(69.4-81.9)	76.1(69.6-81.6)
	P= 0.934		
BMI[c]			
Underweight	56.2(50.8-61.4)	46.6(42.8-50.5)	51.4(47.6-55.2)
Normal	9.7(7.6-12.4)	7.6(6.19.5)-	8.7(7.2-10.4)
Overweight	26.0(21.1-31.6)	28.8(25.8-31.9)	27.4(24.0-31.1)
Obese	8.1(6.0-11.0)	17.0(14.7-19.7)	12.6(10.5-14.9)
	P<0. 001		
Mean height (cm)	166.9(165.1-168.7)	160.5(159.5-161.5)	163.7(162.4-165.0)
Mean weight (kg)	65.2(64.1-66.3)	65.5(63.8-67.3)	65.4(64.2-66.5)
Mean BMI(kg/m^2)	23.6(23.1-24.1)	25.6(24.9-26.3)	24.6(24.1-25.1)
Waist circumference [d]			
Normal	89.7(86.7-92.2)	54.2(47.4-60.7)	72.3(67.8-76.3)
High	10.3(7.8-13.4)	45.9(39.3-52.6)	27.7(23.7-32.2)
Mean waist circumference	72.1(65.1-75.0)	76.0(72.9-79.1)	74.0(71.1-76.9)
Waist-to-Hip Ratio [e]			
Normal	83.2(79.4-86.4)	60.6(54.8-66.1)	72.1(68.1-75.8)
High	16.8(13.6-20.6)	39.4(33.9-45.2)	27.9(24.2-31.9)
	P<0.001		
Waist-Height Ratio			
Normal (≤0.5)	81.9(77.9-85.4)	59.9(53.2-66.3)	71.1(66.2-75.6)
High (>0.5)	18.1(14.6-22.1)	40.1(33.7-46.8)	28.9(24.4-33.8)
	P<0.001		
Mean Hip Circumference (cm)	89.3(87.0-91.6)	94.2(92.1-96.3)	91.7(89.7-93.8)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRRN = Central River Region North, CRRS=Central River Region South; URR =Upper River Region

[b] METS =Metabolic equivalents

[c] BMI is categorised into underweight (BMI<18.5kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2).

[d] Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

[e] Based on the WHO definitions (high WHR defined as >0.90 in men and >85 in women)

NB: The p value indicates the statistical significance of the difference in proportions between men and women obtained using Pearson's chi-squared test

Both high WHR and high WHtR were significantly more prevalent among women than men. Unlike the higher BMI categories, the prevalence of both a high WHR and a high

WHtR were significantly higher among rural residents and among those with a lower level of education (Appendix IV, Table S19 and S20

Table 6.2a: Prevalence of BMI categories by selected socio-demographic, behavioural and biological factors in men (The Gambia, 2010)[a, b, c]

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	Obese %(95% CI)	χ^2 P value
Total	56.2(50.8-61.4)	9.7(7.6-12.4)	26.0(21.1-31.6)	8.1(6.0-11.0)	
Age Group					
25 -34	59.0(52.2-65.6)	11.6(8.4-15.9)	22.0(16.3-29.0)	7.3(4.9-10.7)	**0.003**
35-44	54.0(47.3-60.6)	7.3(4.9-10.8)	32.4(25.7-39.8)	6.4(4.1-9.7)	
45-54	48.7(40.5-56.9)	9.3(5.7-14.8)	29.6(23.4-36.7)	12.4(8.8-17.3)	
55-64	61.0(53.4-68.1)	8.0(5.1-12.3)	21.8(16.0-29.0)	9.1(4.6-17.4)	
Marital status					
Never married	55.1(45.1-64.7)	11.9(7.4-18.4)	24.3(16.0-35.2)	8.7(4.8-15.2)	0.222
Married	56.1(50.7-61.4)	7.9(6.0-10.4)	27.7(23.1-32.9)	8.2(5.8-11.6)	
Separated	49.6(34.1-65.2)	14.6(5.7-32.4)	32.1(19.4-48.0)	3.8(0.8-15.6)	
Widowed	63.3(17.6-93.3)	36.8(6.7-82.4)	0.0	0.0	
Cohabiting	60.4(48.7-71.0)	16.3(8.6-29.0)	16.2(9.6-25.8)	7.1(3.5-13.9)	
Ethnicity					
Mandinka	56.8(50.5-62.8)	11.5(8.6-15.1)	25.5(19.1-33.1)	6.3(4.1-9.6)	**0.042**
Wollof	46.8(38.0-55.8)	10.8(6.2-17.9)	32.3(24.4-41.4)	10.2(6.2-16.4)	
Fula	59.1(50.8-66.9)	8.4(5.3-13.1)	25.2(18.3-33.5)	7.3(4.2-12.2)	
Jola	62.6(52.8-71.4)	8.2(4.7-14.1)	22.1(15.3-30.8)	7.1(3.5-13.9)	
Others	55.0(45.2-64.4)	4.8(2.3-9.9)	23.8(16.0-33.7)	16.5(9.8-26.4)	
Residence (LGA) [d]					
Banjul & KM	33.4(25.4-42.8)	3.2(1.7-6.0)	47.2(37.6-57.0)	16.2(11.0- 23.1)	**<0.001**
WCR	68.5(63.5-73.2)	15.3(11.7-19.7)	11.9(9.0-15.4)	4.4(2.9-6.6)	
URR	49.6(38.9-60.3)	4.2(2.0-8.6)	32.4(26.1-39.3)	13.8(8.9-20.9)	
NBR	65.6(54.9-74.9)	13.9(9.1-20.6)	19.1(13.0-27.1)	1.5(1.6-3.4)	
CRR	67.1(54.1-77.9)	15.5(9.6-23.9)	15.6(10.1-23.4)	1.9(0.7-4.4)	
LRR	75.9(62.0-85.9)	5.7(3.0-10.7)	17.9(8.5-34.0)	0.5(0.1-3.1)	
Residence (Rurality)					
Urban	49.1(41.2-57.1)	9.2(6.2-13.5)	30.9(23.2-39.9)	10.7(7.4-15.4)	**0.001**
Semi urban	54.1(40.1-67.5)	8.4(3.3-19.5)	27.7(17.6-40.8)	9.8(4.7-19.1)	
Rural	68.8(62.6-74.3)	10.9(8.1-14.6)	17.1(13.0-22.2)	3.2(1.8-5.6)	
Education level					

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	Obese %(95% CI)	χ^2 P value
No formal education	59.4(54.4-64.1)	9.3(7.1-12.0)	24.9(20.5-29.8)	6.5(4.6-9.3)	**0.007**
Primary/ Middle	61.3(51.9-69.9)	13.4(8.3-21.0)	19.4(13.4-27.4)	5.9(3.0-11.2)	
Secondary/Tertiary	47.7(38.6-56.9)	8.0(4.6-13.7)	32.1(23.6-42.1)	12.1(8.2-17.7)	
Years spent in school					
≤6 Years	60.5(55.7-65.1)	9.4(7.3-12.1)	23.7(19.6-28.3)	6.4(4.6-8.9)	**0.003**
7-12 Years	49.7(41.7-57.8)	13.3(8.6-19.9)	27.9(20.1-37.2)	9.1(5.8-14.1)	
>12 Years	48.5(35.4-61.7)	4.3(2.2-8.5)	34.3(24.8-45.3)	12.9(7.1-22.4)	
Smoking					
Never smokers	53.1(46.8-59.3)	7.0(5.1-9.7)	30.1(24.3-36.7)	9.8(6.8-13.8)	**<0.001**
Current smokers	61.6(54.8-68.1)	13.8(11.0-17.3)	18.8(13.5-25.4)	5.8(3.9-8.7)	
Ex-smokers	55.5(46.8-63.9)	11.8(6.7-20.0)	26.4(18.3-36.6)	6.3(3.2-12.1)	
Servings of fruits and vegs					
≥ 5/day	61.8(54.1-68.8)	9.1(6.5-12.7)	23.3(17.7-29.9)	5.8(3.5-9.6)	0.321
< 5/day	54.1(47.2-60.8)	10.5(7.6-14.3)	27.8(21.5-35.1)	7.8(5.1-10.1)	
Physical Activity [e]					
<600METS/week	46.5(36.3-57.0)	4.7(2.3-9.4)	31.3(22.7-41.4)	17.5(11.5-25.7)	**<0.001**
≥600METS/week	56.8(51.0-62.3)	10.5(8.1-13.5)	25.7(20.2-32.0)	7.1(5.2-9.7)	
Waist circumference [f]					
Normal	57.4(51.3-63.2)	10.9(8.4-14.1)	24.2(18.6-30.7)	7.6(5.3-10.7)	**<0.001**
High	43.2(34.4-52.4)	1.5(0.5-4.7)	41.5(33.2-50.3)	13.8(8.8-21.6)	

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a] BMI is categorised into underweight (BMI<18.5kg/m^2), normal (18.5-24.9 kg/m^2), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2).
[b] Results adjusted for complex survey design and weighted for non-response
[c] Row percentages are presented, i.e the prevalence of being in that BMI category for people with that socio-demographic and behavioural or biological characteristic
N= unweighted sample/observations
[d] KM= Kanifing Municipality; WCR =West Coast Region; URR =Upper River Region.; NBR =North Bank Region ; CRRS=Central River Region South ; CRRN = Central River Region North ; LRR= Lower River Region. Regions ordered from most to least urban
[e] METS =Metabolic equivalents
[f] Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

Table 6.2b: Prevalence of BMI categories by selected socio-demographic, behavioural and biological factors in women (The Gambia, 2010) [a, b, c]

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	Obese %(95% CI)	χ^2 P value
Total	46.6(42.8-50.5)	7.6(6.1-9.5)	28.8(25.8-31.9)	17.0(14.7-19.7)	
Age Group					
25 -34	51.6(46.9-56.2)	8.3(6.3-10.9)	27.4(23.7-31.5)	12.8(10.0-16.2)	**0.001**
35-44	46.1(39.5-52.9)	6.3(4.4-8.9)	28.5(22.9-34.8)	19.1(14.9-24.2)	
45-54	43.3(35.9-51.0)	6.4(3.8-10.5)	32.6(26.5-39.2)	17.7(12.5-24.4)	
55-64	30.3(22.6-39.2)	10.1(5.5-17.9)	29.3(20.3-40.4)	30.3(20.9-41.7)	
Marital status					
Never married	46.8(36.0-57.9)	6.3(3.1-12.7)	36.2(26.4-47.2)	10.7(6.3-17.4)	**0.001**
Married	46.6(42.3-51.0)	6.9(5.2-9.1)	27.9(24.7-31.3)	18.6(15.8-21.8)	
Separated	32.5(22.5-44.4)	9.6(4.5-19.2)	40.8(29.6-53.1)	17.1(9.3-29.5)	
Widowed	37.1(26.6-48.9)	6.0(2.6-13.4)	30.4(21.0-41.8)	26.5(16.1-40.5)	
Cohabiting	57.6(46.8-67.6)	12.5(7.9-19.2)	22.7(16.1-31.1)	7.3(4.8-10.7)	
Ethnicity					
Mandinka	51.1(46.0-56.2)	9.0(6.7-11.9)	26.4(22.6-30.7)	13.5(10.7-16.8)	0.066
Wollof	42.4(33.1-52.4)	4.8(2.7-8.2)	29.3(22.7-36.9)	23.5(17.8-30.4)	
Fula	44.6(37.8-51.6)	7.7(5.2-11.3)	31.7(26.5-37.4)	16.0(12.2-20.6)	
Jola	45.1(37.0-53.4)	8.9(5.1-15.0)	26.4(20.0-33.9)	19.7(13.4-28.0)	
Others	42.5(32.4-53.3)	4.8(2.8-8.1)	34.4(26.8-42.8)	18.3(12.5-26.1)	
Residence (LGA) [d]					
Banjul & KM	32.6(27.2-38.4)	2.3(1.1-4.6)	38.8(33.1-44.8)	26.3(22.1-31.1)	**<0.001**
WCR	49.8(42.8-56.7)	11.4(8.1-15.7)	25.4(20.3-31.2)	13.5(10.0-18.1)	
URR	53.9(45.9-61.6)	9.5(4.7-18.2)	22.7(15.1-32.7)	13.9(8.5-21.8)	
NBR	53.8(46.8-60.6)	13.4(8.2-20.9)	20.9(16.0-26.8)	12.0(9.5-15.2)	
CRR	67.3(51.3-80.1)	7.5(5.0-11.0)	17.7(10.6-27.9)	7.6(3.1-17.1)	
LRR	57.9(44.8-70.0)	7.4(2.9-20.9)	25.6(17.1-36.3)	9.1(4.4-17.9)	
Residence (Rurality)					
Urban	38.0(33.1-43.2)	5.1(3.3-7.7)	34.2(29.7-39.0)	22.7(19.3-26.6)	**<0.001**
Semi urban	43.5(37.5-49.7)	4.2(2.8-6.3)	35.2(30.0-40.8)	17.1(13.8-21.1)	
Rural	60.6(54.9-66.1)	12.1(9.3-15.6)	19.1(15.6-23.2)	8.1(6.1-10.6)	
Education level					

Variable	**Normal (desirable) %(95% CI)**	**Underweight %(95% CI)**	**Overweight %(95% CI)**	**Obese %(95% CI)**	**χ^2 P value**
No formal education	49.5(45.3-53.7)	7.6(5.9-9.9)	27.4(24.1-31.0)	15.6(12.9-18.4)	**0.002**
Primary/ Middle	46.7(39.9-53.6)	8.2(5.4-12.4)	27.2(21.6-33.7)	17.9(13.2-23.9)	
Secondary/Tertiary	32.0(25.0-39.8)	6.3(4.0-9.5)	37.9(30.8-45.5)	23.9(17.7-31.6)	
Years spent in school					
≤6 Years	49.2(45.2-53.2)	8.0(6.3-10.1)	26.9(23.8-30.3)	15.9(13.5-18.6)	**0.012**
7-12 Years	38.5(31.0-46.7)	5.6(3.3-9.3)	35.5(28.8-43.0)	20.4(15.1-26.9)	
>12 Years	31.0(18.9-46.5)	7.5(3.0-17.8)	41.5(26.7-57.9)	20.0(9.1-38.3)	
Servings of fruits and vegs					
≥ 5/day	45.1(39.8-50.6)	9.5(6.0-14.7)	27.9(22.7-33.8)	17.5(12.9-23.2)	0.621
< 5/day	46.2(41.3-51.3)	7.0(5.2-9.4)	29.6(26.1-33.4)	17.2(14.5-20.3)	
Physical activity					
<600METS/week	39.0(32.6-45.8)	5.7(3.2-9.9)	31.6(23.8-40.5)	23.7(18.4-30.1)	**0.022**
≥600METS/week	48.3(43.5-53.0)	8.0(6.3-10.4)	28.0(24.9-31.3)	15.7(13.1-18.6)	
Waist circumference [e]					
Normal	51.8(46.1-57.5)	10.3(7.7-13.8)	24.5(20.1-29.3)	13.4(9.6-18.4)	**<0.001**
High	39.7(34.2-45.4)	4.7(3.1-7.1)	34.3(29.9-39.1)	21.3(17.8-25.2)	

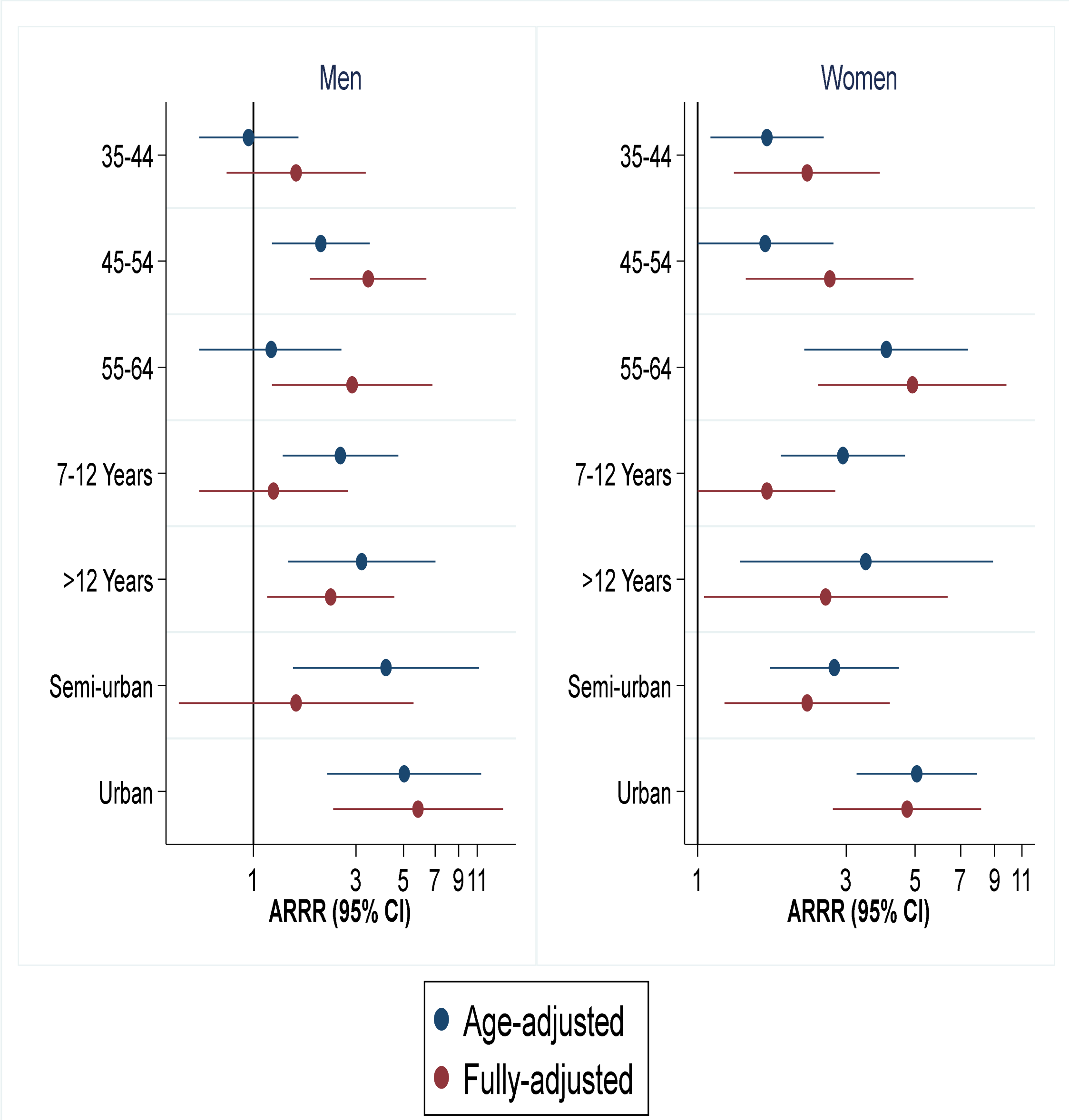
Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a] BMI is categorised into underweight (BMI<18.5Kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9Kg/m^2) and obese (BMI ≥30Kg/m^2).
[b] Results adjusted for complex survey design and weighted for non-response
[c] Row percentages are presented, i.e the prevalence of being in that BMI category for people with that socio-demographic, behavioural or biological characteristic
N= unweighted sample/observations
[d] KM= [a] KM=Kanifing Municipality; WCR =West Coast Region; URR =Upper River Region.; NBR =North Bank Region ; CRRS=Central River Region South ; CRRN = Central River Region North ; LRR= Lower River Region. Regions ordered from most to least urban
[e] METS =Metabolic equivalents
[f] Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

6.3.3 Factors associated with underweight, overweight and obesity

Factors strongly associated with generalised obesity in the multivariable multinomial logistic regressions included older age, ethnicity, higher education and urban residence among both men and women (Tables 6.3a and 6.3b; Figure 6.2). Obesity was also associated with low fruit and vegetable consumption (adjusted relative risk ratio (ARRR) 2.8, 95% CI: 1.1-6.8) in men. All these variables except ethnicity in men were also strongly associated with overweight, while current smoking was inversely associated with overweight (0.5, 0.4-0.7). Compared with rural residents, the associations of overweight and obesity among urban residents were three- and six-fold higher respectively in men (overweight 2.8, 1.5-5.0; obesity 5.8, 2.4-14.5) and three- and five-fold higher in women (overweight 3.1, 1.9-5.0; obesity 4.7, 2.7-8.2). Physical inactivity was strongly associated with obesity among both men and women in the age-adjusted models but not in the fully-adjusted models, although the direction of the association remained unchanged (Tables 6.3a and 6.3b).

Figure 6.2 Factors associated with obesity in multinomial logistic regression (The Gambia, 2010)



Reference categories: 25-34 (age), <7Years (education), Rural (residence). Models adjusted for sociodemographics and behavioural risk factors

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.
Fully adjusted models mutually adjusted for age, ethnicity residence, smoking fruits and vegetable intake, and physical activity

Table 6.3a: Multinomial logistic regression on factors associated with being underweight, overweight or obese in men (The Gambia 2010) [a, b]

	Model I (Age adjusted)			Model II (Fully adjusted)		
	Underweight	**Overweight**	**Obese**	**Underweight**	**Overweight**	**Obese**
Variable	**RRR(95% CI)[c]**	**RRR(95% CI)[c]**	**RRR(95% CI)[c]**	**ARRR (95% CI)[c]**	**ARRR (95% CI)[c]**	**ARRR (95% CI)[c]**
Age Group						
25 -34	Reference	Reference	Reference	Reference	Reference	Reference
35-44	0.69(0.40-1.17)	1.61(1.22-2.12)***	0.95(0.56-1.62)	0.75(0.42-1.36)	2.00(1.38-2.90)***	1.58(0.75-3.33)
45-54	0.97(0.52-1.81)	1.63(1.06-2.52)*	2.06(1.22-3.48)**	1.31(0.66-2.59)	2.21(1.33-3.67)**	3.42(1.83-6.37)***
55-64	0.67(0.37-1.21)	0.96(0.59-1.56)	1.21(0.56-2.57)	0.81(0.43-1.52)	1.13(0.63-2.03)	2.88(1.22-6.80)**
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	1.15(0.65-2.03)	1.48(0.93-2.35)	1.85(1.06-3.23)*	1.17(0.66-2.08)	1.34(0.83-2.18)	1.62(1.04-2.53)*
Fula	0.71(0.41-1.24)	0.93(0.64-1.35)	1.09(0.49-2.39)	0.46(0.24-0.88)*	1.15(0.77-1.72)	0.80(0.34-1.87)
Jola	0.67(0.38-1.18)	0.79(0.45-1.39)	1.05(0.45-2.45)	0.66(0.39-1.13)	1.03(0.56-1.89)	1.29(0.56-2.94)
Others	0.44(0.19-1.04)	0.91(0.51-1.65)	2.56(1.26-5.20)**	0.37(0.14-0.96)*	0.92(0.45-1.88)	1.97(0.71-5.43)
Years spent in school						
≤6 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	1.19(0.76-1.87)	1.56(1.06-2.31)*	2.54(1.37-4.72)**	1.26(0.75-2.11)	1.28(0.81-2.01)	1.24(0.56-2.75)
>12 Years	0.48(0.23-1.00)	1.82(1.12-2.96)**	3.19(1.45-7.02)**	0.50(0.23-1.09)	1.66(1.02-2.71)*	2.29 (1.16-4.53)**
Residence (Rurality)						
Rural	Reference	Reference	Reference	Reference	Reference	Reference
Semi urban	0.97(0.37-2.53)	2.05(0.95-4.43)	4.14(1.53-11.19)**	0.70(0.29-2.11)	1.62(0.70-3.80)	1.58(0.45-5.56)
Urban	1.18(0.71-1.96)	2.52(1.49-4.27)***	5.03(2.20-11.47)***	1.35(0.81-2.23)	2.76(1.52-5.01)***	5.83(2.35-14.50)***
Smoking						
Never smokers	Reference	Reference	Reference	Reference	Reference	Reference
Current smokers	1.71(1.18-2.48)**	0.53(0.38-0.74)***	0.52(0.32-0.84)***	1.48(0.97-2.27)	0.52(0.36-0.74)***	0.61(0.34-1.11)
Ex-smokers	1.71(0.97-3.02)	0.81(0.47-1.40)	0.58(0.26-1.32)	1.86(1.07-3.24)*	0.75(0.38-1.48)	0.58(0.21-1.63)
Servings of fruit and veg						
≥ 5/day	Reference	Reference	Reference	Reference	Reference	Reference
< 5/day	1.31(0.80-2.14)	1.38(0.86-2.22)	1.50(0.74-3.06)	1.38(0.79-2.38)	1.74(1.06-2.87)*	2.75(1.12-6.75)*
Physical Activity [d]						
≥600METS/week	Reference	Reference	Reference	Reference	Reference	Reference
<600METS/week	0.58(0.25-1.36)	1.46(0.86-2.48)	3.02(1.78-5.13)***	0.92(0.31-2.69)	1.20(0.53-2.73)	2.23 (0.87-5.70)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

Fully adjusted models mutually adjusted for the variables shown in the table

[a] BMI is categorised into underweight (BMI<18.5kg/m^2), normal (18.5-24.9 kg/m^2, the reference group), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2).
[b] Those with a desirable weight (normal) used as reference
[c] RRR= Relative Risk Ratio adjusted for age (except for age group as the independent variable), ARRR= Fully Adjusted Relative Risk Ratio
[d] METS =Metabolic equivalents
*p<0.05, **p≤0.01, *** p≤0.001

Table 6.3b: Multinomial logistic regression on factors associated with generalised underweight, overweight and obesity in women (The Gambia, 2010) [a, b]

	Model I (Age adjusted)			**Model II (Fully adjusted)**		
	Underweight	**Overweight**	**Obese**	**Underweight**	**Overweight**	**Obese**
Variable	**RRR(95% CI)[c]**	**RRR(95% CI)[c]**	**RRR(95% CI)[c]**	**ARRR (95% CI)[c]**	**ARRR (95% CI)[c]**	**ARRR (95% CI)[c]**
Age Group						
25 -34	Reference	Reference	Reference	Reference	Reference	Reference
35-44	0.85(0.55-1.31)	1.16(0.83-1.61)	1.67(1.10-2.54)*	0.79(0.52-1.19)	1.37(0.93-2.01)	2.25(1.31-3.85)**
45-54	0.92(0.50-1.71)	1.42(1.01-1.99)*	1.65(1.00-2.73)	0.88(0.48-1.62)	1.98(1.33-2.96)***	2.66(1.43-4.94)**
55-64	2.09(1.04-4.18)*	1.82(1.03-3.24)*	4.04(2.20-7.39	2.30(1.10-4.80)*	2.81(1.58-4.99)***	4.90(2.44-9.82)***
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	0.64(0.32-1.25)	1.31(0.80-2.16)	2.07(1.19-3.61)**	0.69(0.36-1.29)	1.19(0.75-1.87)	1.50(0.90-2.48)
Fula	1.03(0.60-1.78)	1.43(1.01-2.00)*	1.51(0.94-2.41)	0.87(0.47-1.58)	1.69(1.20-2.38)**	1.78(1.09-2.92)*
Jola	1.15(0.64-2.08)	1.14(0.72-1.82)	1.68(0.92-3.07)	1.01(0.57-1.77)	0.98(0.64-1.51)	1.10(0.66-1.84)
Others	0.63(0.31-1.27)	1.54(0.96-2.47)	1.57(0.84-2.92)	0.34(0.14-0.80)**	1.33(0.78-2.28)	1.21(0.62-2.36)
Years spent in school						
≤6 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	0.10(0.58-1.69)	1.93(1.31-2.85)***	2.93(1.85-4.64)***	1.12(0.63-1.99)	1.31(0.87-1.95)	1.67(1.00-2.77)*
>12 Years	1.37(0.46-4.14)	3.09(1.53-6.22)**	3.47(1.37-8.89)**	1.93 (0.52-7.18)	2.40(1.10-5.20)*	2.58(1.05-6.36)*
Residence (Rurality)						
Rural	Reference	Reference	Reference	Reference	Reference	Reference
Semi urban	0.47(0.29-0.75)**	2.52(1.75-3.63)***	2.75(1.71-4.43)**	0.54(0.31-0.95)*	2.31(1.46-3.65)***	2.25(1.22-4.14)**
Urban	0.68(0.41-1.13)	3.03(2.06-4.46)***	5.06(3.24-7.90)***	0.84(0.46-1.55)	3.05(1.86-5.01)***	4.71(2.72-8.15)***
Servings of fruits and vegs						
≥ 5/day	Reference	Reference	Reference	Reference	Reference	Reference
< 5/day	0.71(0.41-1.24)	1.03(0.73-1.46)	0.95(0.62-1.46)	0.65(0.37-1.15)	1.10(0.73-1.66)	1.13(0.74-1.75)
Physical Activity [d]						
≥600METS/week	Reference	Reference	Reference	Reference	Reference	Reference
<600METS/week	0.81(0.42-1.54)	1.32(0.83-2.11)	1.67(1.08-2.58)*	1.1.9(0.58-2.44)	1.07(0.63-1.82)	1.02(0.55-1.91)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.
Fully adjusted models mutually adjusted for the variables shown in the table

[a] BMI is categorised into underweight (BMI<18.5kg/m^2), normal (18.5-24.9 kg/m^2, the reference group), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2).
[b] Those with a desirable weight(normal) used as reference ; [c]RRR= Relative Risk Ratio adjusted for age (except for age group as the independent variable), ARRR= Fully Adjusted Relative Risk Ratio ; [d] METS =Metabolic equivalents . *p<0.05, **p≤0.01, *** p≤0.001

No strong associations were found for underweight (versus normal weight) in men except an increased ARRR among ex-smokers (ARRR 1.9, 1.1-3.2) and an inverse association with being Fula (0.5, 0.2-0.9) or minority ethnicity (0.4, 0.1-1.0) compared with being Mandinka (Table 6.3a). Among women, the risk of being underweight (versus normal weight) was higher aged 55-64 years (2.3, CI: 1.1-4.8) and was inversely related to semi-urban residence compared with rural residence (0.5, 0.3-1.0) and to minority ethnicity compared with Mandinka (0.3, 0.1-0.8) (Table 6.3b).

6.3.4 Factors associated with abdominal obesity

In the fully-adjusted multivariable binary logistic regression model, older age, residence, low fruit and vegetable intake (men only) and being an ex-smoker compared with never smoking (men only) were strongly associated with higher odds of abdominal obesity (Table 6.4). Semi-urban residence (adjusted odds ratio (AOR) 0.4, 95% CI: 0.2-0.9) compared with rural residence, and low fruit and vegetable intake (0.6, 0.4-0.9) compared with the recommended intake of at least five servings a day, were inversely associated with the odds of abdominal obesity among men. However, older age (3.2, 2.1-4.9) compared with younger age, and semi-urban residence (2.1, 1.2-3.7) compared with rural residence, were associated with higher odds of abdominal obesity among women (Table 6.4).

Table 6.4: Multivariate logistic regression on factors associated with high waist circumference (abdominal obesity)(The Gambia, 2010)[a]

	Men			Women		
	Model I [b]	**Model II [b]**	**Model III [b]**	**Model I [b]**	**Model II [b]**	**Model III [b]**
Variable	**OR(95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**	**OR(95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**
Age Group						
25 -34	Reference	Reference	Reference	Reference	Reference	Reference
35-44	1.63(1.08-2.47)*	2.04(1.21-3.43)**	1.62(0.96-2.74)	2.06(1.52-2.80)***	2.17 (1.60-2.92)***	2.04(1.49-2.77)***
45-54	1.89(1.19-3.00)**	2.50(1.41-4.43)**	1.97 (1.14-3.38)**	1.91(1.38-2.65)***	1.91(1.34-2.72)***	1.91(1.33-2.74)***
55-64	2.26(1.36-3.75)**	2.24(1.16-4.34)*	1.90(0.96-3.75)	3.57(2.32-5.49)***	3.39(2.07-5.56)***	3.19(2.09-4.87)***
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	1.12(0.43-2.90)	1.11(0.51-2.43)	1.06(0.40-2.78)	0.92(0.58-1.46)	1.01(0.64-1.58)	0.81(0.51-1.28)
Fula	0.96(0.49-1.91)	1.05(0.51-2.15)	0.90(0.45-1.76)	0.79(0.55-1.13)	0.82(0.55-1.21)	0.69(0.48-0.99)*
Jola	1.22(0.60-2.51)	0.86(0.41-1.80)	1.02(0.49-2.12)	0.94(0.62-1.42)	0.82(0.49-1.36)	0.97(0.62-1.53)
Others	0.81(0.38-1.74)	0.71(0.30-1.67)	0.63(0.27-1.44)	0.58(0.33-1.01)	1.00(0.54-1.84)	0.74(0.43-1.28)
Years spent in school						
≤6 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	0.96(0.58-1.59)	0.97(0.60-1.59)	0.86(0.50-1.46)	0.84(0.59-1.20)	1.10(0.78-1.55)	0.81(0.61-1.09)
>12 Years	1.21(0.65-2.28)	1.25(0.68-2.31)	1.06(0.58-1.97)	0.75(0.32-1.76)	0.92(0.37-2.24)	0.82(0.32-2.06)
Residence (Local government area) [d]						
LRR	Reference	Reference		Reference	Reference	
CRR	1.75(0.32-9.53)	1.92(0.44-8.32)		0.89(0.33-2.41)	1.20(0.45-3.18)	
NBR	1.94(0.66-5.65)	1.63(0.55-4.85)		1.18(0.64-2.20)	1.08(0.57-2.06)	
URR	0.08(0.01-0.65)**	0.14(0.02-0.98)*		0.24(0.11-0.51)***	0.26(0.11-0..65)**	
WCR	2.66(1.02-6.96)	2.43(0.94-6.32)		1.62(0.83-3.15)	1.59(0.79-3.20)	
Banjul & KM	0.71(0.25-2.03	0.71(0.24-2.07)		0.32(0.15-0.71)	0.37(0.14-1.00)	
Residence (Rurality)						
Rural	Reference		Reference	Reference		Reference
Semi urban	0.32(0.12-0.82)**		0.36(0.15-0.90)*	1.53(0.75-3.10)		2.11(1.21-3.68)**
Urban	0.89(0.45-1.75)		0.82(0.41-1.65)	0.82(0.49-1.37)		0.97(0.58-1.62)
Smoking						
Never smokers	Reference	Reference	Reference			
Current smokers	0.72(0.42-1.26)	0.49(0.28-0.86)**	0.60(0.35-1.03)			

	Men			Women		
	Model I [b]	**Model II [b]**	**Model III [b]**	**Model I [b]**	**Model II [b]**	**Model III [b]**
Variable	**OR(95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**	**OR(95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**
Ex-smokers	1.44(0.92-2.27)	1.24(0.81-1.91)	1.56(1.04-2.36)*			
Servings of fruit and vegetables						
≥ 5/day	Reference	Reference	Reference	Reference	Reference	Reference
< 5/day	0.63(0.40-0.99)*	0.61(0.37-1.01)	0.59(0.37-0.93)*	0.95(0.64-1.42)	0.86(0.50-1.49)	0.81(0.48-1.20)
Physical Activity [e]						
<600METS/week	Reference	Reference	Reference	Reference	Reference	Reference
≥600METS/week	0.78(0.37-1.63)	1.81(0.81-4.06)	1.52(0.65-3.57)	0.64(0.32-1.30)	1.46(0.81-2.62)	1.22(0.71-2.10)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a]Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)
[b] Model I adjusted for age only; Model II adjusted for all variables except local government area; Model III adjusted for all variables except rurality
[c] OR= odds ratio adjusted for age (except for age group as the independent variable); AOR= Adjusted odds ratio (fully adjusted)
[d]KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region
[e] METS =Metabolic equivalents
*p<0.05, **p≤0.01, *** p≤0.001

6.4 Discussion

This study has shown that the burden of overweight and obesity is high in The Gambia, especially among women (29% and 17% respectively) and urban residents. No precise quantification of changes since the only previous nationwide study (van der Sande et al., 1997) can be made because of the difference in the age cohorts enrolled. However, I can reasonably assume that the prevalence of obesity has increased substantially in The Gambia within a period of less than 15 years. Almost half of women and more than one-third of men aged 25-64 years were either overweight or obese in 2010 while the prevalence of overweight and obesity in 1996 were 8% and 2% respectively among participants aged 16 and above. The prevalence of underweight, however, halved from 18% in 1996 to 9% in this study. This shows an increasing shift from malnutrition/underweight to overweight and obesity among Gambian adults.

The prevalence of obesity in The Gambia is more than double those reported in similar national WHO STEPwise surveys conducted in Malawi (Msyamboza et al., 2013), Eritrea (Mufunda et al., 2006) and Mozambique (Gomes et al., 2010, Damasceno et al., 2009) but is less than that reported in The Republic of Seychelles (Faeh et al., 2007a). The high prevalence of obesity in The Gambia is a cause for concern, given the increasing burden of NCDs, notably hypertension, as evident in Chapter 5 and my related manuscript based on that analysis (Cham et al., 2018). Although higher in urban areas, generalised obesity is now a problem in both urban and rural areas in The Gambia, unlike in previous studies (van der Sande et al., 1997, van der Sande et al., 2001b). Despite the health risks associated with overweight/obesity, Gambians are culturally obesity tolerant (Siervo et al., 2006a, Siervo et al., 2006b). It has been well documented that perceptions of body weight vary across different parts of the world (Gele and Mbalilaki, 2013, Scott et al., 2012). In some parts of SSA, overweight is not seen as a risk factor for NCDs but rather as a sign of beauty, wealth, success and prestige; such cultural beliefs encourage obesity (Scott et al., 2012, Gele and Mbalilaki, 2013). A study on the perception of body image and attractiveness among adults in urban areas in The Gambia demonstrated high satisfaction with big body image (overweight), especially among women (Siervo et al., 2006a). A cross-cultural comparison using published data on Figure Rating Scales found that Gambians' rating of a 'normal' weight were bigger than those of North Americans, and that Gambians were more tolerant of obesity than white and African-Americans (Siervo et al., 2006a). A related study found that in The Gambia, weight gain was not associated with weight concern, as 68% of those overweight and 37% of those obese did not perceive themselves to be overweight/obese (Siervo et al., 2006b). Associating overweight with beauty and prestige/wealth renders the burden of obesity a silent epidemic, as many people do not consider it a risk or want to address it.

Older age, ethnicity, higher education, and urban residence in both genders, and low fruit and vegetable intake and smoking in men were strongly associated with the risks of overweight and obesity (versus normal weight) in multivariable multinomial logistic regression models. Evidence links urbanisation and the increasing burden of obesity and other NCDs, especially in low income countries (Godfrey and Julien, 2005, Kruger et al., 2001, Ojiambo, 2016, Vorster, 2002). Higher education was also significantly associated with overweight and obesity. People with a higher level of education in The Gambia are more likely to be in office jobs, which are mostly sedentary. Physical inactivity was strongly associated with obesity in the age-adjusted regression models among both men and women. However this relationship became statistically insignificant after full-adjustment for social and demographic factors, suggesting that social and demographic factors may be confounding the relationship between physical inactivity and obesity. Leisure-time physical activity was found to be low, as only 12% reported to engage in any form of leisure time activity in this study and so most of the physical activity reported was work and transport-related. Judging from the data, participants with a higher level of education therefore had lower levels of physical activity and hence were more prone to obesity. There is evidence suggesting that increases in the level of physical activity and/or exercise interventions whether supervised or not has a positive impact on peoples' BMI and their overall health (Ruotsalainen et al., 2015). The Ministry of Health and Social Welfare of The Gambia and its stakeholders should promote physical activity at individual and population level. As the promotion of physical activity especially at population level is multidisciplinary, it should be done in collaboration with other government line ministries, municipalities, community based organisations and non-governmental organisations. The goal of the recent WHO action plan on physical activity 2018-2030 is to reduce the global prevalence of physical inactivity up to 15% by 2030 (WHO, 2018a). The Ministry of Health and Social Welfare of The Gambia should incorporate this in its national health policy and/or the NCDs policy and strategic plan.

Low fruit and vegetable intake (fewer than five combined servings a day) was associated with obesity, especially among men. There is a strong linkage between low fruit and vegetable consumption and increased NCD risk (Boeing et al., 2012). Fruits and vegetables may help prevent unhealthy weight gain especially when consumed as part of a healthy diet (Alinia et al., 2009, Boeing et al., 2012, Ledoux et al., 2011). A systematic analysis for the Global Burden of Diseases study in 2010 attributed more than 6 million deaths globally to inadequate consumption of fruits and vegetables (Lim et al., 2012). The report of a Joint WHO/FAO Expert Consultation review on diet, nutrition and the prevention of chronic diseases and the American Heart Association Nutrition Committee recommended that persons should consume at least 400grams (five combined servings) of fruits and vegetables per day (WHO/ FAO 2003, Lichtenstein et al., 2006). This is the measure of fruit and vegetable intake used in this study. Gambian diets are generally high in carbohydrates and the use of imported cooking oil (with high fat content) is now very common (Prentice and Webb, 2006). Moreover, the use of palm oil, which is mostly locally produced or imported from neighbouring Southern Senegal (Cassamance) or Guinea Bissau, is very common. The consumption of fruits and vegetables as part of a healthy diet should be widely promoted. Future surveys to monitor overweight/obesity in The Gambia should include greater assessment of diet.

Only being an ex-smoker in men and older age in women were positively associated with being underweight (versus normal weight) in the fully-adjusted analyses. Semi-urban residents were less likely to be underweight rather than normal weight compared with rural residents. The association of underweight with being an ex-smoker might be at least partly explained by the associations of both with ill-health. It is possible that ex-smokers were advised to quit smoking because of their illness. Moreover, the association of underweight with older age in women could also be associated with age-related illnesses. Poverty, especially in rural areas, may explain the inverse association of underweight with semi-urban compared with rural residence among women.

6.4.1 Strengths and limitations of this study

This study presents the most recent nationally-representative data on generalised and abdominal obesity among adults in The Gambia. It gives a better picture of the true burden of obesity in the country and hence could serve as baseline study from which future changes can be assessed. There is evidence on the misclassification of BMI using self-reported data which can bias estimates (Connor Gorber et al., 2007, Flegal et al., 2018). The complex sampling strategy and the stringent WHO STEP protocols applied in collecting the data, particularly the use of measurements taken by trained field staff instead of a reliance on self-reported anthropometric data, minimised biases.

My main limitation is the cross-sectional nature of the study, which prevents attribution of causality to the associations. However, it does identify population sub-groups to prioritise with health promotion measures. There is a possibility of misclassifying obesity in people who are physically active and have large muscle mass. For this reason I explored abdominal obesity as an additional outcome variable. 3% of the participants who took part in the physical measurements did not have valid weight and height measurements, which could have led to non-response bias. However, I compared the two groups and there were no systematic differences between those with and without valid anthropometric measurements (data not shown). The survey did not collect self-reported measures on beliefs about body size and weight management, which are important in The Gambian context to assess and monitor trends on beliefs and practices.

6.5 Conclusion

This study reveals a high prevalence of obesity among Gambian adults, while the burden of underweight in this population may be decreasing. There are socio-cultural norms that promote overweight, especially among women. Preventive strategies should be directed at raising awareness of the importance of achieving and maintaining a healthy weight; discouraging harmful socio-cultural practices and beliefs about weight; and the promotion of healthy diet and regular physical activity, particularly in urban areas and among women.

7. Chapter 7: Smoking among men in The Gambia

7.1 Introduction

This chapter summarises the analyses I conducted to address objective four of my thesis: the prevalence of and associated risk factors for smoking among Gambian men. I focus on the prevalence of current smoking in men because of the very low prevalence among women (1%).

7.2 Methods

The study setting and design, sampling, research instruments and data management have been described in Chapter 4 sections 4.1-4.5 and I described the variables in Chapter 5 section 5.2.2. My analyses were restricted to men with valid information on smoking status (n=1766). There were two variables on smoking: one binary variable on current smoking status categorised into not current (ex-smokers and never smokers) and current smokers and a derived categorical variable with three categories (never, ex –smokers and current smokers). The sociodemographic, behavioural and biological risk factors have been described in Chapters 5 and 6.

Of the 3871 non-pregnant participants, 15% (587) were smokers, of whom 93% (546) were daily smokers. The prevalence of current smoking was 32% in men and 1% in women. I therefore limited my analysis to men because of the low prevalence in women. The main analytical sample consisted of 1766 men with valid information on current smoking status. I report the prevalence of smoking in men in the form of proportions with corresponding 95% confidence intervals. The prevalence estimates are weighted and adjusted for complex survey design and non-response but not age-adjusted. I ran age-adjusted and fully-adjusted multivariate logistic regression models to identify factors associated with current smoking, comparing not current (never and ex-smokers) versus current smokers. I also ran multinomial multivariable logistic regression analysis on smoking with three categories: never smoking, ex-smoking and current smoking, using never smoking as the reference group. Age-adjusted (aOR) and fully-adjusted odds ratios (AOR) with corresponding 95% CI are reported for the analysis of smoking using two categories, while age-adjusted (aRRR) and fully adjusted relative risk ratios (ARRR) are reported in the multinomial logistic regression models (smoking using three categories). All my analyses in this chapter were weighted for non-response and adjusted for the complex survey design, using Stata 15.

7.3 Results

7.3.1 Characteristics of the participants.

The unweighted and weighted characteristics of the men in this study has been presented in previous chapters. Briefly the mean age was 41 years, more than 60% were between the ages of 25-44 years and 62% had less than seven years of education.

7.3.2 Prevalence of smoking among men

The prevalence of smoking by age and region (LGA) of residence are presented in Figures 7.1 and 7.2 respectively. The prevalence of current smoking among men was 31% (Table 7.1). More than half of the men were never smokers and 10% were ex-smokers. The median age of starting smoking was 19 years; 25% started before the age of 18 years and 10% between 8-10 years. The average number of cigarettes smoked per day was 10 (CI: 9.1-10.8). The prevalence of current smoking was high in all age groups but it was significantly higher in younger men. However, the prevalence of ex-smoking was higher in the older age group.

Table 7.1: Prevalence of smoking in men by selected socio-demographic, behavioural and biological factors (The Gambia, 2010) (n=1766) [a]

Variable	**Never smoker %(95% CI)**	**Ex-smoker** %(95% CI)	**Current smoker**	χ^2 **P value**
Total	58.7(53.5-63.7)	10.0(7.9-12.5)	31.4(27.2-35.9)	
Age Group				
25-34	59.8(53.6-65.7)	6.9(4.7-10.0)	33.3(27.8-39.3)	**0.001**
35-44	57.1(50.2-63.8)	10.2(7.2-14.2)	32.7(27.2-38.7)	
45-54	58.8(51.0-66.2)	12.5(8.4-18.0)	28.7(22.7-35.6)	
55-64	57.9(49.6-65.8)	19.0(13.4-26.1)	23.1(17.4-30.1)	
Marital status				
Never married	62.6(54.3-70.3)	5.4(2.8-10.0)	32.0(24.4-40.8)	0.072
Married	58.0(52.1-63.7)	11.9(9.3-15.2)	30.1(25.5-35.1)	
Separated	49.0(32.7-65.5)	11.8(5.0-25.3)	39.2(25.0-55.5)	
Widowed				
Cohabiting	54.7(45.6-63.6)	5.6(2.5-12.2)	39.7(31.9-48.0)	
Occupation				
Employed	59.5(51.7-66.8)	8.9(5.7-13.5)	31.7(25.3-38.8)	**<0.001**
Self employed	55.0(49.4-60.5)	11.1(8.5-14.4)	33.9(29.1-39.1)	
Non paid	58.2(41.6-73.0)	13.8(5.0-32.9)	28.0(17.6-41.6)	
Student	74.1(59.0-85.0)	5.2(1.3-18.2)	20.8(10.3-37.5)	
Housemaker	93.8(74.1-98.8)	4.8(0.6-28.1)	1.4(0.2-9.7)	
Retired	71.1(50.9-85.4)	26.3(13.2-45.7)	2.6(0.3-17.6)	
Unemployed	64.1(49.6-76.4)	1.9(0.6-5.4)	34.1(22.3-48.2)	
Ethnicity				
Mandinka	57.8(51.2-64.1)	10.3(7.4-14.2)	31.9(26.4-38.0)	0.052
Wollof	64.1(55.1-72.2)	13.9(8.1-22.6)	22.0(15.6-30.3)	
Fula	53.0(44.6-61.3)	10.1(7.2-14.1)	36.9(29.6-44.9)	
Jola	58.6(49.2-67.4)	5.0(1.9-12.7)	36.4(28.9-44.6)	
Others	66.6(56.0-75.80	7.4(3.9-13.5)	26.0(18.3-35.6)	
Residence (Local government area) [b]				
Banjul & KM	79.1(72.1-84.8)	3.5(2.1-5.7)	17.4(11.7-25.1)	**<0.001**
WCR	45.1(39.0-51.3)	10.6(7.3-15.1)	44.4(38.8-50.1)	
LRR	60.0(50.5-68.9)	6.3(2.5-15.0)	33.7(26.5-41.7)	
NBR	62.5(54.6-69.8)	7.8(3.6-16.4)	29.7(22.1-38.5)	
CRR	62.5(54.6-69.8)	7.8(3.6-16.4)	29.7(22.1-38.5)	
URR	45.1(38.6-51.7)	22.9(16.6-30.8)	32(22.8-42.8)	
Residence (Rurality)				
Urban	63.7(55.9-70.8)	7.3(5.2-10.2)	29.0(22.8-36.2)	**0.004**
Semi urban	52.7(45.8-59.5)	16.4(11.8-22.4)	30.9(23.2-39.8)	
Rural	51.1(45.1-57.1)	13.2(9.1-18.7)	35.7(31.0-40.8)	
Education level				
No formal education	58.1(52.3-63.7)	11.5(8.8-15.1)	30.4(25.4-35.9)	0.230
Primary/ Middle	54.9(45.6-64.0)	8.2(5.1-12.9)	36.9(29.3-45.2)	
Secondary/Tertiary	62.2(55.6-68.4)	8.5(5.5-13.0)	29.3(23.6-35.7)	
Years spent in school				
≤6 Years	56.6(50.8-62.1)	10.8(8.3-13.9)	32.6(27.8-37.9)	0.677

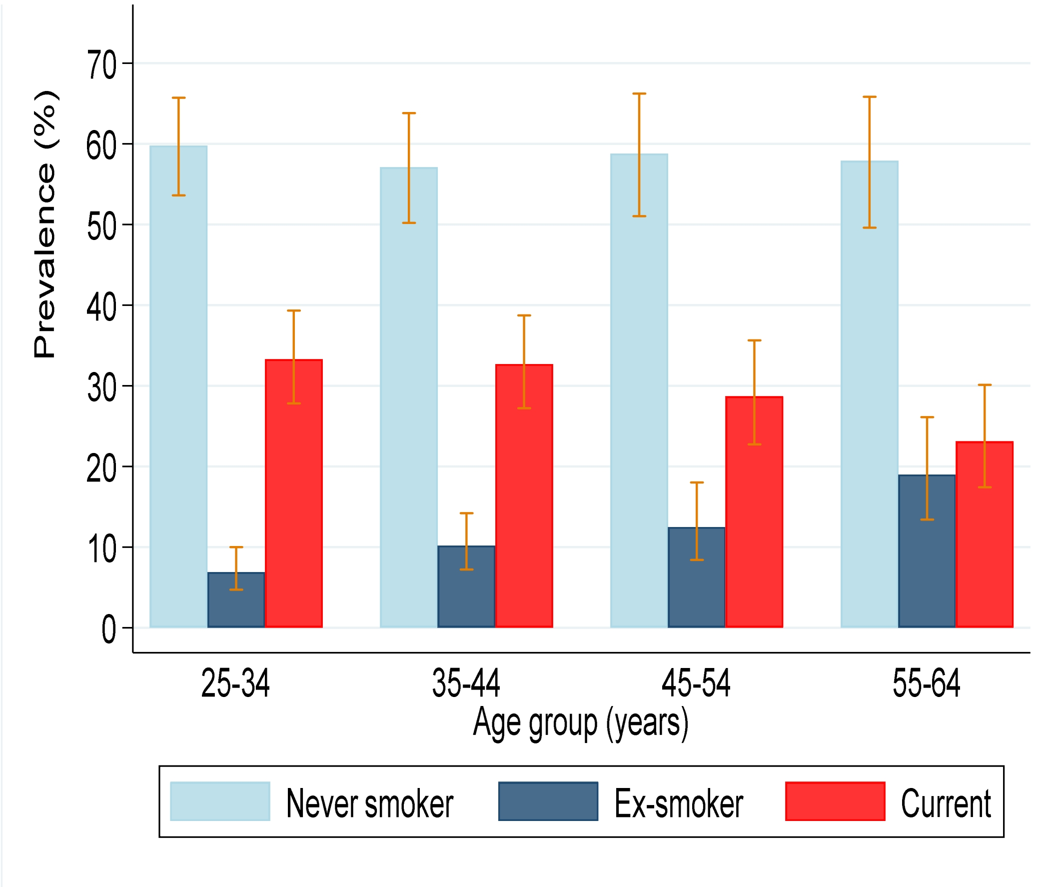
Variable	Never smoker %(95% CI)	Ex-smoker %(95% CI)	Current smoker	χ^2 P value
7-12 Years	60.8(53.6-67.6)	9.5(6.3-14.1)	29.7(23.5-36.7)	
>12 Years	59.9(50.2-68.9)	7.6(3.8-14.9)	32.5(24.8-41.2)	
Servings of fruit and vegetables				
≥ 5/day	60.5(50.6-69.6)	8.2(4.8-13.8)	31.3(23.8-39.8)	0.804
< 5/day	57.6(52.7-62.3)	9.0(6.6-12.3)	33.4(29.3-37.7)	
Physical activity				
≥600METS/week	55.6(51.2-60.0)	10.8(8.4-13.8)	33.6(29.9-37.5)	**<0.001**
<600METS/week	81.9(72.2-88.8)	5.2(2.9-8.9)	12.9(7.0-22.7)	
BMI[c]				
Normal/desirable	54.2(48.8-59.4)	9.7(7.2-12.9)	36.2(31.6-41.1)	**<0.001**
Underweight	41.3(33.2-49.9)	11.9(7.5-18.2)	46.8(39.0-54.8)	
Overweight	66.3(59.9-72.1)	9.9(6.4-15.2)	23.8(18.8-29.6)	
Obese	68.9(57.6-78.3)	7.6(3.6-15.4)	23.5(15.7-33.8)	
Waist circumference [d]				
Normal	56.8(51.9-61.6)	8.9(6.9-11.5)	34.3(30.3-38.5)	0.057
High	59.2(48.7-69.0)	15.0(10.2-21.6)	25.8(16.9-37.3)	
Waist-hip ratio [e]				
Normal	58.6(53.5-63.4)	9.3(7.1-12.1)	32.2(28.1-36.5)	0.068
High	49.0(40.9-57.1)	11.0(7.7-15.6)	40.0(31.5-49.1)	
Waist-height ratio				
Normal (≤0.5)	56.0(50.7-61.1)	8.9(6.8-11.6)	35.1(30.8-39.7)	0.060
High (>0.5)	60.7(52.4-68.5)	12.99.0-18.3)	26.3(19.3-34.9)	
Hypertensive [f]				
No	59.6(54.2-64.8)	7.3(5.3-10.1)	33.1(28.6-37.8)	**<0.001**
Yes	52.0(44.4-59.6)	16.6(12.0-22.6)	31.4(26.0-37.3)	
Hypertension				
No (normotensive)	59.6(54.2-64.8)	7.3(5.3-10.1)	33.1(28.6-37.8)	**<0.001**
Yes (diagnosed)	39.3(28.3-51.5)	31.5(21.3-43.8)	29.2(18.5-42.9)	
Yes (undiagnosed)	55.0(46.4-63.4)	13.1(8.3-20.0)	31.9(25.9-38.6)	

[a] Data shown have been weighted for non-response and the analysis took into account the complex survey design.
N= unweighted sample/observations
[b] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region
[a] BMI is categorised into underweight (BMI<18.5Kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9Kg/m^2) and obese (BMI ≥30Kg/m^2).
[d] Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men)
[e] Based on WHO standards (high waist-hip ratio defined as ≥90cm in men)
[f] Hypertension defined as measured SBP≥140mmHg and/or DBP and/or self-reported hypertension

^ Numbers too small to show results

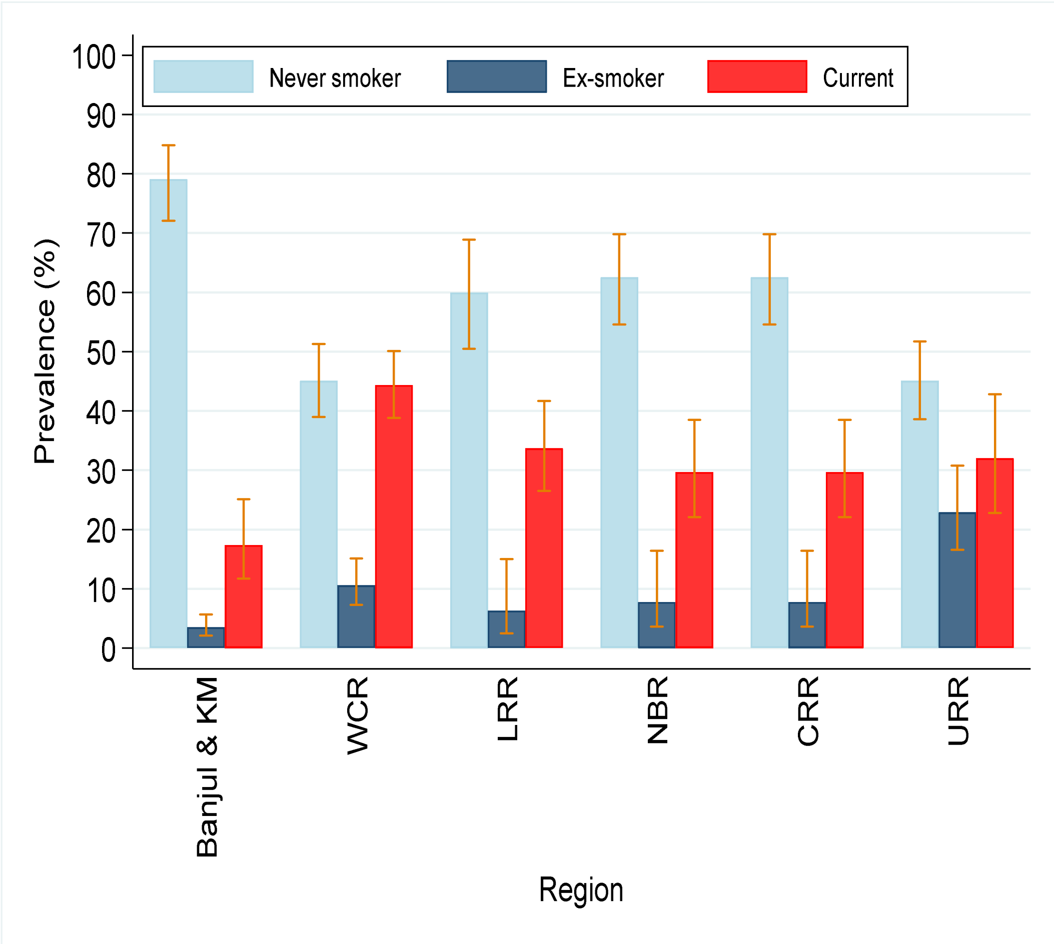
The prevalence of smoking was significantly higher in semi-urban and rural areas compared with urban areas. The prevalence of both current and ex-smoking were lowest in Banjul (the capital city) and Kanifing Municipality when I used region of residence (Figure 7.2). Both current and ex-smoking were significantly higher among the more physically active participants compared with the less active participants (see Table 7.1). However, this could be age-related as younger men were more active. The prevalence of current smoking was significantly higher among the underweight (47%, 95% CI: 39.0-54.8) and those with a normal weight (36%, 31.6-41.1) compared with the overweight (24%, 18.8-29.6) and the obese (24%, 15.7-33.8).

Figure 7.1: Prevalence of smoking in men by age (The Gambia, 2010)



Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design

Figure 7.2 Prevalence of smoking in men by region (The Gambia, 2010)



Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design

There was no statistically significant difference in the prevalence of current smoking between men classed as normotensive and as hypertensive, but the prevalence of ex-smoking was more than twice as high among hypertensives (17%, 12.0-22.6) compared with those normotensive (7%, 5.3-10.1). When I categorised hypertensive status into three categories (normotensive, diagnosed and undiagnosed hypertension), the prevalence of ex-smoking was more than twice as high among those who had their hypertension diagnosed (32%, CI: 21.3-43.8) compared with those who were undiagnosed (13%, CI: 8.3-20.0).

7.3.3 Multivariate regression analysis of factors associated with current and ex-smoking

I ran a multivariable binary logistic regression model on current smoking comparing not current (never and ex-smokers: coded 0) versus current smokers (coded 1). No variable was significantly associated with the odds of current smoking except older age (55-64 years vs 25-34 years (AOR 0.6, 95% CI: 0.4-0.9, P=0.018)) and being overweight vs normal weight (AOR 0.6, 0.4-0.8, P=0.001) which were inversely associated with the odds of current smoking (data not shown). Living in a rural local government area/region was significantly associated with higher odds of current smoking compared with urban residence (Banjul and KM) in the univariate regression analysis but not in the fully adjusted models.

I also ran a multivariable multinomial regression model on smoking using never smokers as my reference. None of the variables was significantly associated with the risk of current smoking versus never smoking except overweight. Compared with those with a normal weight, overweight persons were less likely to be current as opposed to never smokers (ARRR 0.5, 95% CI: 0.4-0.8). However, the odds of being an ex-smoker versus never smoker significantly increased with increasing age. Other factors significantly associated with being an ex-smoker versus never smoker were underweight vs normal weight (ARRR 2.0, 1.2-3.4), high waist circumference vs normal/desirable waist circumference (ARRR 2.0, 1.3-3.0) and diagnosed hypertension vs normal BP (ARRR 2.6,1.1-6.2). The association with former smoking as opposed to never smoking was also higher among those with undiagnosed hypertension compared with a normal blood pressure (ARRR 1.8, 0.9-3.5) but was not statistically significant (Table 7.2).

Table 7.2: Multinomial logistic regression on factors associated with smoking in men (The Gambia, 2010) [a,b]

	Model I(Age adjusted)		**Model II(Fully adjusted)**	
	Ex-smoker	**Current-smoker**	**Ex-smoker**	**Current-smoker**
Variable	**[a]RRR(95% CI)**	**[a]RRR(95% CI)**	**ARRR (95% CI)**	**ARRR (95% CI)**
Age Group				
25 -34	Reference	Reference	Reference	Reference
35-44	1.55(0.94-2.55)	1.03(0.77-1.38)	2.26(1.18-4.35)*	1.11(0.81-1.52)
45-54	1.84(1.11-3.05)*	0.88(0.60-1.28)	2.12(1.15-3.93)*	0.93(0.62-1.39)
55-64	2.84(1.69-4.78)***	0.72(0.46-1.12)	3.76(1.79-7.87)***	0.78(0.50-1.21)
Ethnicity				
Mandinka	Reference	Reference	Reference	Reference
Wollof	1.15(0.55-2.40)	0.62(0.39-1.02)	1.04(0.41-2.63)	0.65(0.38-1.11)
Fula	1.06(0.64-1.76)	1.26(0.84-1.90)	0.80(0.44-1.43)	1.14(0.73-1.76)
Jola	0.45(0.14-1.42)	1.13(0.76-1.70)	0.62(0.24-1.61)	1.07(0.68-1.68)
Others	0.57(0.25-1.29)	0.71(0.45-1.12)		0.63(0.36-1.12)
Education				
≤6 Years	Reference	Reference	Reference	Reference
7-12 Years	0.78(0.47-1.30)	0.74(0.50-1.09)	1.00(0.50-1.90)	0.81(0.53-1.23)
>12 Years	0.51(0.21-1.22)	0.72(0.49-1.07)	0.61(0.25-1.51)	0.97(0.66-1.42)
Residence (Rurality)				
Urban	Reference	Reference	Reference	Reference
Semi urban	2.77(1.57-4.88)***	1.28(0.76-2.15)	1.27(0.63-2.59)	0.91(0.53-1.56)
Rural	2.18(1.18-4.03)**	1.56(1.05-2.33)*	0.84(0.38-1.87)	0.92(0.62-1.37)
Servings of fruits and vegs				
≥ 5/day	Reference	Reference	Reference	Reference
< 5/day	1.11(0.55-2.26)	1.13(0.78-1.67)	0.99(0.47-2.04)	1.14(0.78-1.68)
Physical activity				
≥600METS/week	Reference	Reference	Reference	Reference
<600METS/week	0.26(0.14-0.47)***	0.26(0.13-0.51)***	0.42(0.17-1.07)	0.77(0.42-1.43)
BMI [c]				
Normal weight	Reference	Reference	Reference	Reference
Underweight	1.71(0.97-3.02)	1.71(1.18-2.48)***	2.00(1.17-3.42)**	1.41(0.91-2.17)
Overweight	0.81(0.47-1.40)	0.53(0.38-0.74)**	0.60(0.30-1.17)	0.53(0.36-0.77)***

	Model I(Age adjusted)		Model II(Fully adjusted)	
	Ex-smoker	**Current-smoker**	**Ex-smoker**	**Current-smoker**
Variable	**[a]RRR(95% CI)**	**[a]RRR(95% CI)**	**ARRR (95% CI)**	**ARRR (95% CI)**
Obese	0.58(0.26-1.32)	0.52(0.32-0.84)**	0.41(0.14-1.19)	0.64(0.35-1.17)
Waist circumference [d]				
Normal	Reference	Reference	Reference	Reference
High	1.44(0.92-2.27)	0.74(0.42-1.26)	1.96(1.26-3.04)**	0.73(0.42-1.28)
Hypertension [e]				
No (normotensive)	Reference	Reference	Reference	Reference
Yes (diagnosed)	3.99(1.94-8.20)***	1.02(0.49-2.11)	2.64(1.12-6.23)***	1.14(0.523-2.47)
Yes (undiagnosed)	1.61(0.86-3.02)	1.06(0.76-1.48)	1.76(0.88-3.51)	1.10(0.44-1.50)

[a] Data shown have been weighted for non-response and the analysis took into account the complex survey design

Fully adjusted models mutually adjusted for the variables shown in the table

[b]Never smoking used as reference

[c]BMI is categorised into underweight (BMI<18.5Kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9Kg/m^2) and obese (BMI ≥30Kg/m^2).

[a]RRR= Relative Risk Ratio adjusted for age (except for age group as the independent variable), ARRR= Adjusted Relative Risk Ratio(fully adjusted)

*p<0.05, **p≤0.01, *** p≤0.001 METS =Metabolic equivalents

[d]Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

[e]Hypertension defined as measured SBP≥140mmHg and/or DBP ≥90 mmHg and/or self-reported hypertension

7.4 Discussion

This analysis reveals a high prevalence of current smoking among Gambian men aged 25-64 years (31%). However, the prevalence of smoking among women was low (1%). The median age at which male participants who were current smokers started smoking was 19 years and many started when they were children. I have not found a recent study on smoking among adults in The Gambia in the literature but a study conducted between 1996 and 1997 among adults aged 15 years and above reported a smoking prevalence of 34% in urban areas and 42% in rural areas among men (Walraven et al., 2001), compared with the 31% found in the 2010 STEPS survey data I analysed for men aged 25-64 years. The prevalence of current smoking was 29% in urban and 36% in rural areas among men in my study. The prevalence of smoking among Gambian men has decreased over time but I could not make direct comparisons because of the different age groups enrolled in the two studies. A recent nationwide study among secondary school students aged 12-20 years demonstrated a high prevalence of ever smoking (26% and 9% for boys and girls respectively) among secondary school students in The Gambia (Jallow et al., 2017). An earlier survey using the Global Youth Tobacco Survey conducted among students aged 13-15 years reported a prevalence of ever smoking to be 29% and 20% respectively among boys and girls in The Gambia (Manneh, 2008). The prevalence of current smoking in that study was 13% and 9% among boys and girls respectively. The marked difference observed between the girls in that study and the women in mine could be because women in my study mostly grew up when girls didn't smoke as the prevalence of ex-smoking was less than 1%. These recent findings show that young Gambians including girls initiate smoking at an early age due to being exposed to smoking at a very young age. I was unable to assess levels of exposure to second hand smoke and I was unable to assess whether current smokers have received any advice to stop smoking, as this information was not collected in this survey. In a study on the factors associated with exposure to second hand smoke among students, 97% reported to be exposed to second hand smoke (Jallow et al., 2018). More than half of the participants reported to have purchased cigarettes for their parents or others. The Government should put in place intervention strategies and regulations to reduce the exposure of young people to second hand smoke. Tobacco control policies in The Gambia and the implications of my findings are discussed in chapter 9, section 9.4.3.

Only being overweight (versus normal weight) was inversely associated with current smoking (as opposed to never smoking) in the fully adjusted multinomial regression models. However, being underweight (versus normal weight) and having been diagnosed with hypertension (versus normal blood pressure) were significantly positively associated with being an ex-smoker as opposed to never smoker. Very few studies that used the WHO STEP approach explored factors associated with tobacco use in multivariable regression; three of these were conducted in Zambia (Siziya et al., 2011, Zyaambo et al., 2013, Olusegun Babaniyi et al., 2014), one in Benin (Houehanou et al., 2015), and another in South Africa (Maimela et al., 2016). Tobacco use was higher among males, rural residents, people from lower socio-economic background, and those with lower levels of education in those countries. Generally, use of tobacco, especially smoking, is not acceptable among females in SSA. However, this seems to be changing and require further research as recent findings among students show a shift among younger girls, with 9% reporting being current smokers (Jallow et al., 2017). The stronger association of ex-smoking versus never smoking amongst men with diagnosed hypertension compared with those normotensive and who had undiagnosed hypertension is not a surprising finding. It is likely that ex-smokers with diagnosed hypertension were advised to quit because of their health condition. The survey does not have information on whether current smokers have received any advice to stop smoking.

According to recent estimates from the WHO Comprehensive Information System for Tobacco Control, smoking is projected to increase to over one billion smokers globally by 2025 (Bilano et al., 2015). With current smoking trends, the authors of the study predicted a more rapid increase in the prevalence of smoking in Africa. Tobacco companies are now shifting their target to LMICs to build a broader consumer base, especially among adolescents (Chandora et al., 2016, WHO, 2013b). The countries/regions with the highest levels of smoking is expected to shift from LMICs countries in Europe and the western Pacific to Africa and the eastern Mediterranean region. With the current trends, most of the countries in SSA, including The Gambia, will not meet the WHO global target of a 30% reduction in tobacco use by 2025.

As evident in the literature, smoking is a driver of poverty and is also a consequence of poverty in high, middle and low income countries (Hiscock et al., 2012, Belvin et al., 2015, Xin et al., 2009, Wang et al., 2006, John et al., 2011, John et al., 2012). Tobacco results in the diversion of income meant for important expenditures such as education and good nutrition, to satisfy addictive smoking behaviour. It can lead to increased health care expenditure as a result of tobacco related health conditions (John et al., 2012). It can also cause lower income due to ill health leading to retirement from work due to medical reasons, time off work due to sickness (without sufficient welfare/insurance payments in many countries) or premature mortality, often death of the 'breadwinner' in a household. All these reduce available household income and hence can drive families into poverty. Moreover, people living in more deprived areas in low, middle and high income areas are more likely to smoke. For example, people from more deprived areas in England are twice as likely to smoke compared with those from less deprived areas (Office for National Statistics, 2012). Over one million children in a study in the United Kingdom, nearly half of all children in poverty, were living with at least one parent who smoked (Belvin et al., 2015). If parental expenditure on tobacco were subtracted from the household income, a further 432,000 would be classed as being in poverty, suggesting there are over 1.5 million children living in smoking related poverty in the UK. In Ghana, smoking was more prevalent in those with lower socioeconomic status; smoking was also associated with lower likelihood of purchasing health insurance (John et al., 2012). The costs of smoking takes resources away from households that could otherwise be spent on food, housing, health care and education. It can also be argued that for some people, lack of education, limited resources and ongoing poverty would induce them to engage in risky behaviours including substance abuse and cigarette smoking (Haustein, 2006, Hiscock et al., 2012, WHO, 2004). It is a relatively inexpensive way to obtain immediate satisfaction (if one has become addicted) and in many low income communities, is used as a way to signal adulthood or manhood (Ng et al., 2007, Morrow and Barraclough, 2010). Therefore smoking contributes to poverty but poverty/ lack of opportunity/ lack of hope for a better future may lead some to take up or continue to smoke. Smoking therefore hinders the attainment of the United Nations Sustainable Development Goals, especially goals 1, which aims to end poverty; 3, which aims to ensure healthy lives and promote wellbeing; and 10, which aims to reduce inequality (The United Nations, 2015).

7.5 Strengths and limitations of this study

A main strength of this study is its novelty. Most previous studies in The Gambia were conducted among youths and school children. This is the first nationally representative study on the prevalence and associated risk factors of smoking among Gambian men. It has identified key findings that could be used in policy formulation and intervention strategies in tackling the burden of tobacco use.

As outlined in previous chapters, the main limitation is that my data is cross-sectional, which limits making causal inferences on the findings. Another limitation is the relatively small sample used for the analysis: I focused only on men because of the low prevalence of smoking among women. This might have limited the statistical power to detect any significant differences between groups.

A number of tobacco control policies and initiatives have been implemented in The Gambia recently, including raising of the excise tax on all imported tobacco products, which has contributed to a price increase and reduction of tobacco imports (Nargis et al., 2016). However, these were implemented after the data used for this research was collected. Therefore I could not explore if these policies and initiatives have affected tobacco use or not.

Another possible limitation is that the data on current smoking was self- reported, possibly biasing the prevalence estimates. Previous research has found significant under reporting among participants who had their reported smoking status confirmed by taking measurements of their carbon monoxide level and concentration of serum cotinine (Hald et al., 2003, Brathwaite et al., 2015). Unlike health surveys such as the Health Survey for England, data on serum cotinine was not collected in my data and so I could not confirm the accuracy of participants reported smoking status. Women may also give a biased report of their smoking status for fear of stigmatisation, as smoking is socially undesirable among women in SSA (Addo et al., 2009).

Finally, there is also no nationally representative study conducted among adults prior to this study to enable me determine if the prevalence of smoking has been increasing or decreasing in The Gambia.

7.6 Conclusion

The study reveals a high prevalence of smoking among Gambian men. Most of them started smoking at a young age. Preventive efforts should be focused more on the younger age groups and the exposure of tobacco products to minors should be regulated. This study focused on men because of the low prevalence of current smoking among women but the rise in smoking prevalence among young girls as found in a recent study in The Gambia requires further research and public health intervention. Advice and support to quit smoking should be extended to all smokers regardless of their age and whether they have any underlying health condition.

8. Chapter 8: Clustering of Non-communicable disease risk factors among adults in The Gambia

8.1 Introduction

This chapter describes the analysis I conducted to address my fifth objective, to investigate the clustering of five non-communicable disease (NCD) risk factors among adults (25-64 years) in The Gambia. The risk factors considered were hypertension, overweight/obesity, physical inactivity, low fruit and vegetable intake and current smoking. Clustering is the occurrence of more than one risk factor in an individual simultaneously (e.g. being both hypertensive and obese) (Poortinga, 2007, Scholes, 2018). Clustering of risk factors predisposes an individual to NCDs and the burden increases cumulatively with the number of risk factors (Zaman et al., 2015, Martin-Diener et al., 2014, Wesonga et al., 2016). Research evidence has shown that mortality increases with an accumulation of unfavourable lifestyle factors, including measures of body fatness (Loef and Walach, 2012, Dobson et al., 2012, Behrens et al., 2013).

8.2 Methods

The analysis in this chapter was restricted to non-pregnant participants with valid information on all the five NCD risk factors mentioned in Section 8.1 above (n=3000). Each of the risk factors was assigned a score of one or zero depending on the presence or absence of the risk factor. The risk factors were defined in the same way as used for the specific chapters. Below is a summary of the definitions of the five risk factors.

1. **Hypertension:** defined as measured SBP≥140mmHg and/or DBP ≥90mmHg and/or self-reported hypertension (as diagnosed by a doctor or a health professional).

2. **Overweight/obesity:** defined as body mass index (BMI) greater than or equal to $25.0kg/m^2$.
3. **Low fruit and vegetable intake**: defined as consuming less than five combined servings of fruits and vegetables a day.
4. **Physical inactivity:** defined as not meeting the minimum WHO recommendations in a typical week. The WHO recommendations are 75 minutes/week of vigorous intensity physical activity, or 150 minutes/week of moderate intensity, or a combination of moderate and vigorous PA achieving at least 600 metabolic equivalents (METS)/week.
5. **Smoking:** defined as currently smoking any tobacco products.

8.2.1 Dependent and independent variables

The dependent variable in this chapter is the clustering variable (i.e. the number of risk factors), which I derived from the five variables defined above. The independent variables (covariates) included the sociodemographic variables defined in chapters five and six.

8.2.2 Data Analysis

I coded each of the risk factors by assigning them scores of one or zero depending on the presence or absence of the risk factor in question. I computed the total number of risk factors per participant by adding all the scores together. The number of risk factors per participant ranged from zero (no risk factor) to five risk factors. I presented the prevalence of each individual risk factor in previous chapters. However, because of the smaller sample size available for the clustering analysis presented in this chapter, I described the unweighted socio-demographic characteristics (Table S21) and calculated the distribution of the weighted prevalence of all the five risk factors by selected socio-demographic variables. I calculated the distribution of the number of risk factors with four categories; no risk factor, one risk factor, two risk factors and three or more risk factors. I also conducted gender-stratified analysis to obtain the distribution of the number of risk factors among men and women.

I conducted age-adjusted and fully adjusted gender stratified multivariable multinomial logistic regression analysis to identify factors associated with the number of NCD risk factors. Multinomial logistic regression models were used as a natural choice as I was assessing the correlates associated with the number of NCD risk factors (clustering) groups (1-2, and ≥3 compared to having none) rather than the number of individual risk factors. The dependent variable had three categories: no risk factor; one or two risk factors; and three or more risk factors. I used no risk factors as the reference category. Fully adjusted relative risk ratios (ARRR) with their corresponding 95% confidence intervals (CI) are reported. I further stratified my analysis by gender because of the possibility of different correlates. Apart from the description of the characteristics of study participants (Table S21), all my analyses are weighted non response and adjusted for the complex survey design, using Stata 15.

8.3 Results

8.3.1 Characteristics of the participants included in the clustering of risk factors analyses

Table S21 is a summary of the unweighted characteristics of participants included in the clustering of risk factor analyses. The size of the analytical sample (N=3000) is lower than the samples used in Chapters 5 (hypertension) and 6 (overweight/obesity) because of the fewer number of participants with complete information on all the risk factors considered.

However the distribution of the socio-demographic characteristics are similar to those described in previous chapters.

8.3.2 <u>Prevalence of the five NCD risk factors included in the clustering analysis</u>

The prevalence of each NCD risk factor by selected socio-demographic variables for the complete cases included in the analyses of the number of risk factors (N=3000) is shown in Table 8.1. The prevalence of each risk factor by age-group among men and women are shown in Figure 8.1 and 8.2 respectively. The prevalence of overweight/obesity and physical inactivity were significantly higher in women than in men. Unlike smoking, there was no gender difference in the prevalence of hypertension or in low fruit and vegetable intake. The prevalence of hypertension was significantly higher among semi-urban and rural residents compared with urban residents, while the prevalence of overweight/obesity and physical inactivity were significantly higher in urban compared with semi-urban and rural residents. There was no significant difference in the prevalence of smoking and physical inactivity by rural vs urban residence (rurality). However, there was a significant difference in each of the risk factors when I used local government area to denote residence (Table 8.1).

Table 8.1: Prevalence of NCD risk factors by selected socio-demographic variables (The Gambia, 2010) [a] (n=3000)

Variable	Hypertension %(95% CI)	Overweight/ obesity %(95% CI)	Physical inactivity %(95% CI)	Low fruit and veg. intake %(95% CI)	Smoking %(95% CI)
Total	29.3(26.5-32.3)	40.2(35.0-45.6)	13.7(9.6-19.0)	77.6(71.2-82.9)	17.3(14.9-20.1)
Gender					
Men	27.9(24.4-31.7)	34.4(27.6-41.9)	10.2(6.9-14.7)	77.4(70.7-83.0)	33.3(29.1-37.7)
Women	30.8(27.6-34.2)	46.1(41.5-50.8)	17.2(11.9-24.4)	77.8(70.9-83.4)	1.1(0.6-1.8)
	P=0.167	**P<0.001**	**P=0.001**	P=0.861	**P<0.001**
Age Group					
25 -34	17.6(14.6-20.9)	34.5(28.4-40.9)	10.5(6.9-15.8)	76.9(70.0-82.6)	18.2(14.5-22.6)
35-44	29.1(25.0-33.5)	44.2(38.5-50.2)	13.2(8.3-20.2)	77.7(70.9-83.2)	17.5(14.6-20.9)
45-54	44.8(39.4-50.3)	47.2(39.8-54.8)	15.3(10.3-22.2)	78.5(70.8-84.6)	16.6(13.1-20.8)
55-64	58.7(50.1-66.8)	45.1(36.1-54.0)	26.7(18.0-37.7)	79.2(68.7-86.9)	14.0(10.6-18.2)
	P<0.001	**P<0.001**	**P<0.001**	P=0.845	P=0.462
Marital status					
Never married	18.7(14.1-24.3)	34.9(24.8-46.6)	11.0(6.5-18.1)	72.1(61.0-81.0)	25.2(18.4-33.4)
Married	29.4(26.4-32.6)	42.4(37.1-48.0)	15.5(11.0-21.4)	81.3(74.9-86.4)	16.3(13.8-19.2)
Separated	36.6(27.3-46.9)	52.6(41.5-63.4)	15.9(9.1-26.3)	84.1(74.1-90.8)	14.2(9.0-21.7)
Widowed^					
Cohabiting	34.4(28.8-40.4)	26.6(19.9-34.4)	1.4(0.5-4.0)	63.6(51.9-73.9)	16.3(12.9-20.4)
	P<0.001	**P=0.001**	**P<0.001**	**P=0.001**	**P=0.003**
Ethnicity					
Mandinka	30.4(26.5-34.7)	36.2(30.6-42.3)	11.6(8.2-16.2)	76.0(69.4-81.6)	18.8(15.22.7)
Wollof	30.7(25.4-36.5)	48.2(38.7-57.9)	14.6(9.0-22.7)	89.0(81.6-93.7)	12.8(9.1-17.7)
Fula	27.1(22.7-32.1)	40.6(33.4-48.1)	12.7(7.8-19.9)	79.9(72.2-85.9)	20.2(15.3-26.0)
Jola	25.4(20.5-30.9)	36.6(27.1-47.2)	13.9(7.7-23.6)	67.3(56.4-76.6)	18.6(14.5-23.6)
Others	32.0(25.4-39.4)	47.7(39.8-55.6)	22.0(13.7-33.4)	74.9(65.9-82.2)	11.2(7.3-17.0)
	P=0.357	**P=0.037**	P=0.065	**P<0.001**	**P=0.027**
Residence (Local government area)[b]					
Banjul & KM	21.6(17.2-26.7)	67.2(61.1-72.8)	29.2(18.4-43.0)	77.7(62.9-87.8)	10.5(7.2-15.1)
WCR	31.3(27.6-35.2)	24.9(20.7-29.6)	6.2(3.9-9.8)	69.5(60.8-77.0)	25.1(21.1-29.5)
LRR	40.4(34.6-46.3)	26.9(16.2-41.3)	1.2(0.3-4.2)	91.9(76.2-97.6)	17.1(13.3-21.6)
NBR	36.7(32.2-41.4)	26.7(22.1-31.8)	4.2(1.9-8.9)	81.7(61.2-92.7)	14.1(10.4-18.7)
CRR	36.2(30.3-42.7)	22.5(15.0-32.3)	6.3(3.9-10.1)	97.9(94.5-99.2)	18.8(11.6-29.1)
URR	21.7(15.5-29.6)	36.4(27.6-46.3)	9.1(4.7-17.0)	58.1(48.3-67.4)	17.7(10.1-29.1)
	P<0.001	**P<0.001**	**P<0.001**	**P=0.009**	**P<0.001**
Residence (Rurality)					
Urban	24.8(21.3-28.6)	50.8(42.8-58.8)	20.5(13.7-29.6)	76.4(67.2-83.6)	17.0(13.4-21.4)
Semi urban	40.2(30.9-50.2)	38.7(32.2-45.6)	7.9(3.4-17.3)	79.5(59.5-91.1)	17.2(12.4-23.2)
Rural	34.6(31.7-37.6)	23.2(19.4-27.6)	3.6(2.4-5.3)	79.2(68.5-87.0)	17.9(14.9-21.3)
	P<0.001	**P<0.001**	**P<0.001**	P=0.842	P=0.888
Education					
≤6 Years	33.6(30.8-36.6)	34.3(30.0-38.9)	5.1(3.7-7.0)	80.8(74.2-86.0)	17.2(14.7-20.0)
7-12 Years	23.2(18.2-29.1)	43.4(35.4-51.8)	13.3(8.4-20.4)	78.5(70.2-85.0)	19.3(15.4-23.9)
>12 Years	21.7(15.8-29.0)	54.0(41.2-66.4)	11.4(7.8-16.5)	73.4(60.1-83.5)	27.3(20.3-35.7)
	P<0.001	**P<0.001**	**P<0.001**	P=0.345	**P=0.016**

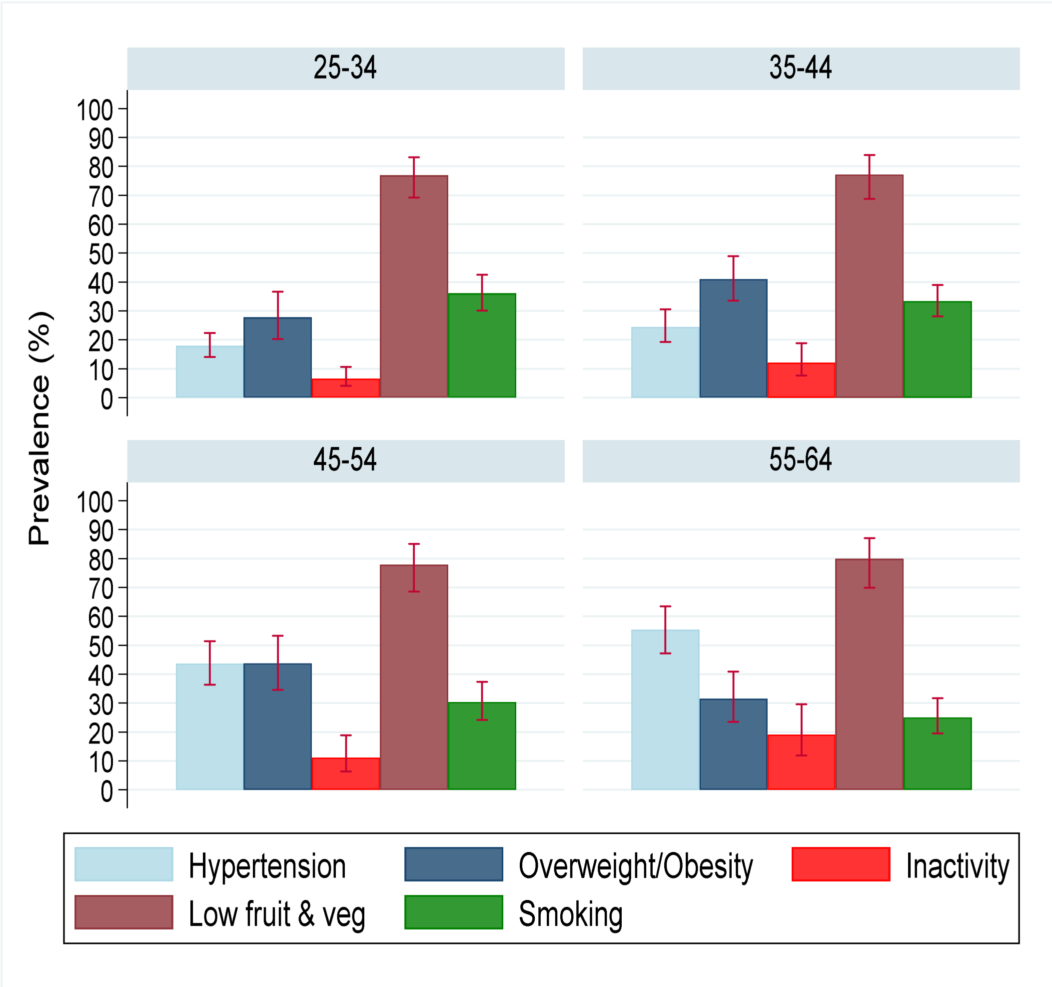
[a] Results adjusted for complex survey design and weighted for non-response

[b] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region

NB: NCD risk factors are as defined in section 8.2

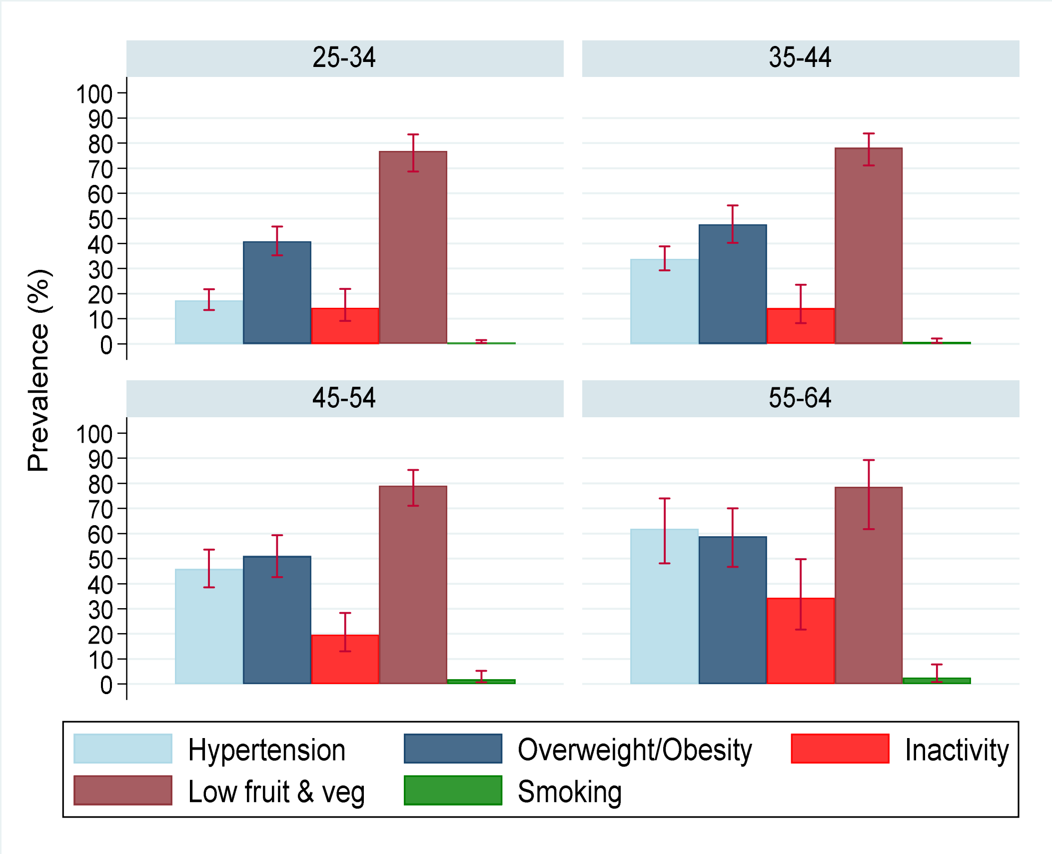
^ N < 10: therefore estimates not shown

Figure 8.1 Prevalence of risk factors by age among men (The Gambia, 2010)



Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

Figure 8.2 Prevalence of risk factors by age among women (The Gambia, 2010)



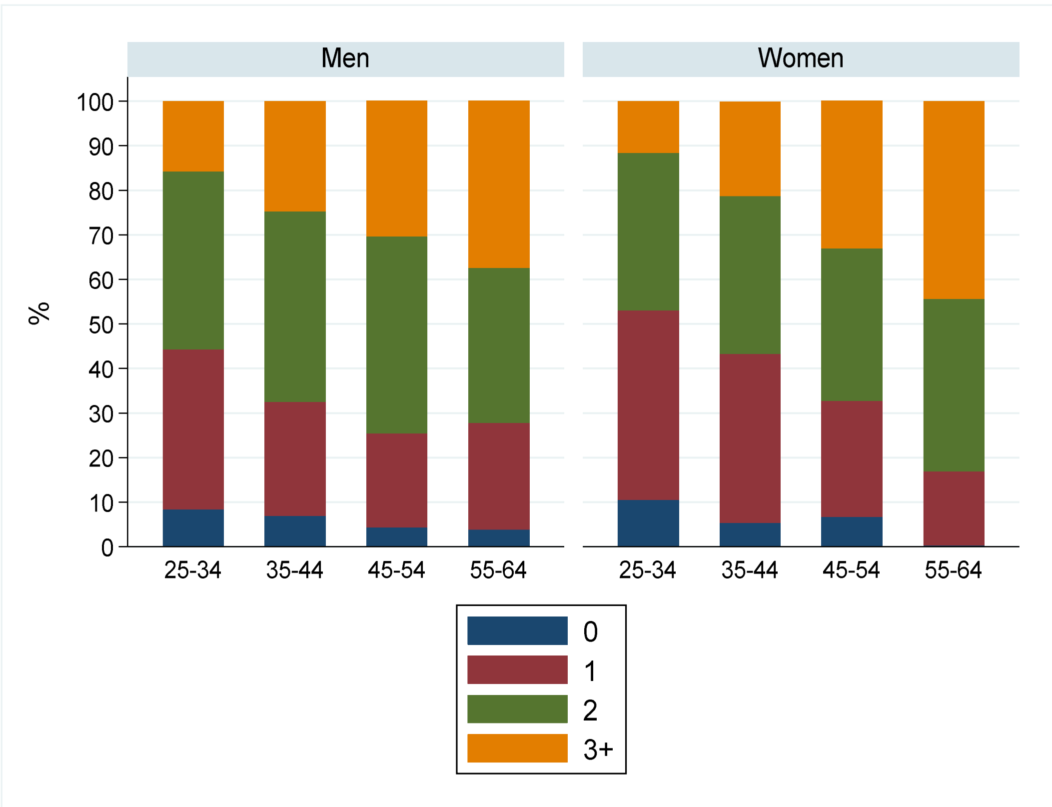
Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

I also explored subgroup differences in the prevalence of having three or more risk factors using the five variables used in creating the clustering variable (Table S22). Co-occurrence of at least three risk factors was most common where physical inactivity or hypertension was one of the risk factors. More than half of the physically inactive (59%, 95% CI: 48.6-68.2) and the hypertensive (52%, 45.8-57.2) had three or more risk factors. Likewise, co-occurrence of at least three risk factors was high among the obese (47%, 40.0-54.9) and smokers (42%, 35.1-49.5). In contrast, the prevalence of three or more risk factors was relatively lower for participants who did not consume at least five servings of fruit and vegetables a day (27%, 24.1-29.9) compared with those who were physically inactive, obese, hypertensive or currently smoke.

8.3.3 Prevalence of clustering by sociodemographic factors

The prevalence of the number of risk factors by selected socio demographic characteristics is shown in Table 8.3. Only 7% (95% CI: 5.2-9.8) had no risk factor; 22% (19.1-24.9) had at least three risk factors. The prevalence of three or more risk factors increased with increasing age among both sexes (Figure 8.3). The prevalence of having three or more risk factors was significantly higher in urban compared with rural areas (26%, 21.7-30.2 vs 15%, 12.0-18.2) (Table 8.3). The findings were similar when I stratified my analysis by gender (Table 8.4).

Figure 8.3: Prevalence of number of NCD risk factors by age and sex (The Gambia, 2010)



Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

Table 8.2: Prevalence of number of NCD risk factors by selected socio-demographic variables (The Gambia 2010) [a]

Variable	No risk factor %(95% CI) n=214	One risk factor %(95% CI) n=1016	Two risk factors %(95% CI) n=1139	Three or more risk factors % (95% CI) n=631
Total	7.2(5.2-9.8)	32.7(29.7-35.8)	38.3(35.2-41.4)	21.9(19.1-24.9)
Gender				
Men	6.8(4.7-9.9)	29.4(25.6-33.5)	40.9(36.9-45.0)	22.9(19.7-26.4)
Women	7.5(5.2-10.7)	36.0(32.6-39.7)	35.6(31.8-39.5)	20.9(17.4-24.9)
	P=0.032			
Age Group				
25 -34	9.4(6.8-12.9)	39.3(35.3-43.4)	37.7(33.8-41.7)	13.7(11.1-16.7)
35-44	6.2(4.2-9.1)	31.6(27.4-36.0)	39.2(34.8-43.8)	23.0(18.8-27.8)
45-54	5.4(3.2-9.1)	23.5(19.3-28.4)	39.3(34.0-44.9)	31.8(26.2-37.9)
55-64	2.1(1.1-4.0)	20.3(14.7-27.3)	36.8(29.6-44.6)	40.9(33.0-49.2)
	P<0.001			
Marital status				
Never married	12.7(8.0-19.7)	34.4(27.8-41.7)	35.7(28.9-43.0)	17.2(11.8-24.4)
Married	5.0(3.4-7.1)	31.5(28.3-34.9)	39.9(36.4-43.5)	23.7(20.8-26.9)
Separated	5.9(2.5-13.1)	27.0(18.6-37.4)	35.2(27.2-44.4)	31.9(23.4-41.8)
Widowed^				
Cohabiting	14.2(8.8-22.3)	41.2(37.5-45.1)	34.2(28.3-40.6)	10.4(7.7-13.8)
	P<0.001			
Ethnicity				
Mandinka	7.9(5.6-11.2)	35.2(31.5-39.1)	36.7(33.0-40.5)	20.2(17.5-23.3)
Wollof	2.5(1.2-5.4)	29.3(23.3-36.0)	41.0(34.9-47.4)	27.2(21.8-33.3)
Fula	5.2(3.1-8.7)	31.5(27.1-36.2)	43.2(37.5-49.1)	20.1(15.6-25.4)
Jola	13.1(7.6-21.6)	32.7(27.3-38.6)	36.3(29.1-44.2)	17.9(13.1-23.9)
Others	7.2(3.9-13.1)	30.1(23.8-37.4)	34.4(27.8-41.7)	28.3(21.4-36.4)
	P=0.001			
Residence (Local government area) [b]				
Banjul & KM	4.4(1.9-9.8)	20.7(16.0-26.3)	44.5(38.6-50.5)	30.5(25.2-36.3)
WCR	11.9(8.4-16.6)	38.0(34.5-41.8)	33.6(29.3-38.3)	16.5(12.9-20.7)
LRR	3.7(1.1-12.3)	38.4(33.9-43.0)	36.2(29.4-43.4)	21.7(14.1-31.9)
NBR	7.8(3.1-18.3)	38.0(32.0-44.4)	38.9(31.3-47.1)	15.2(10.7-21.2)
CRR	0.2(0.02-1.4)	42.9(37.1-48.9)	34.9(29.4-40.9)	22.0(15.9-29.8)
URR	13.0(8.8-18.8)	43.7(36.6-51.2)	33.0(26.1-40.7)	10.3(5.0-19.9)
	P<0.001			
Residence (Rurality)				
Urban	6.5(4.2-9.8)	27.2(23.0-32.0)	40.6(36.2-45.1)	25.7(21.7-30.2)
Semi urban	4.6(1.9-10.7)	37.7(34.1-41.5)	31.0(28.5-33.7)	26.7(19.5-35.4)
Rural	8.8(5.3-14.2)	40.6(37.4-43.8)	35.8(31.8-40.1)	14.8(12.0-18.2)
	P<0.001			
Education				
≤6 Years	7.6(5.2-10.9)	35.3(32.9-37.8)	38.1(34.7-41.6)	19.0(16.3-22.0)
7-12 Years	8.0(4.8-12.9)	32.2(26.5-38.5)	37.4(32.1-43.1)	22.5(18.1-27.5)
>12 Years	7.1(3.3-14.5)	23.4(16.5-32.1)	47.0(38.3-55.8)	22.5(16.3-30.4)
	P=0.210			

[a] Data shown have been weighted for non-response and the analysis took into account the complex survey design.
[b] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region .NB: NCD risk factors ae as defined in 8.2
N < 10: therefore estimates not shown.

Table 8.3: Prevalence of number of NCD risk factors by selected socio-demographic variables by gender (The Gambia, 2010) (n=3000) [a]

	Men n=1372				Women n=1628			
Variable	**No risk factor %(95% CI) n=80**	**One risk factor %(95% CI) n=385**	**Two risk factors %(95% CI) n=576**	**Three to five risk factors %(95% CI) n=331**	**No risk factor %(95% CI) n=135**	**One risk factor %(95% CI) n=635**	**Two risk factors %(95% CI) n=562**	**Three to five risk factors %(95% CI) n=296**
Total	6.8(4.7-9.9)	29.4(25.5-33.5)	40.9(36.9-45.0)	22.9(19.7-26.4	7.5(5.3-10.7)	36.0(32.6-39.7)	35.5(31.8-39.5)	20.9(17.4-24.9)
Age Group								
25-34	8.4(5.2-13.2)	35.9(30.6-41.7)	39.9(34.5-45.3)	15.8(11.8-20.7)	10.5(7.3-14.8)	42.5(37.1-48.2)	35.4(30.3-41.0)	11.6(8.9-15.0)
35-44	7.0(4.2-11.4)	25.5(20.5-31.3)	42.8(36.2-49.7)	24.7(19.4-30.7)	5.4(3.3-8.9)	37.9(32.5-43.7)	35.4(30.0-41.2)	21.2(15.9-27.8)
45-54	4.3(2.1-8.5)	21.2(16.3-27.1)	44.1(37.5-50.9)	30.5(24.6-37.1)	6.7(3.5-12.3)	26.1(20.3-32.8)	34.2(27.8-41.1)	33.1(25.7-41.5)
55-64	3.8(2.0-7.1)	24.0(17.5-31.9)	34.8(28.0-42.4)	37.5(29.8-45.8)	0.3(0.04-2.3)	16.6(9.5-27.2)	38.7(26.2-52.9)	44.4(32.7-56.7)
	P<0.001				**P<0.001**			
Marital status								
Never married	13.6(8.0-22.4)	32.6(24.8-41.5)	35.5(28.2-43.6)	18.3(11.7-27.4)	10.0(4.6-20.3)	40.1(28.2-53.3)	36.1(25.1-48.7)	13.9(7.2-24.9)
Married	4.3(2.7-6.7)	26.9(23.0-31.2)	43.4(38.7-48.3)	25.4(21.9-29.3)	5.6(3.8-8.3)	35.9(31.8-40.3)	36.5(32.2-41.0)	22.0(18.0-25.9)
Separated	1.4(0.2-9.7)	39.2(21.2-60.8)	33.6(18.5-52.9)	25.9(11.9-47.5)	8.0(3.2-18.5)	21.2(13.3-32.2)	36.1(24.7-49.4)	34.7(22.5-49.2)
Widowed	^	^	^	^	2.4(0.5-11.2)	25.1(14.6-39.6)	31.6(16.5-51.9)	41.0(26.5-55.9)
Cohabiting	9.5(5.1-17.2)	37.0(28.5-46.4)	37.1(29.7-45.3)	16.3(11.0-23.6)	17.7(10.8-27.7)	44.4(39.3-49.6)	32.0(25.0-39.9)	5.9(3.5-10.0)
	P=0.004				**P<0.001**			
Ethnicity								
Mandinka	8.4(5.2-13.2)	32.1(26.5-38.2)	38.5(33.0-44.2)	21.1(17.5-25.2)	7.5(5.1-10.8)	38.6(34.6-42.7)	34.7(30.6-39.0)	19.3(15.7-23.4)
Wollof	2.2(0.7-6.5)	28.2(20.7-37.2)	40.7(33.0-48.8)	28.9(22.2-36.8)	2.9(1.2-6.8)	30.3(23.5-38.1)	41.4(34.3-49.0)	25.4(18.7-33.5)
Fula	5.2(2.5-10.5)	24.6(18.9-31.2)	48.4(40.0-56.9)	21.9(16.4-28.6)	5.3(2.9-9.6)	39.3(32.1-47.0)	37.4(31.1-44.0)	18.1(11.5-27.3)
Jola	11.3(5.8-20.9)	25.7(16.9-37.1)	44.4(33.3-56.0)	18.6(13.7-24.8)	14.6(7.7-26.1)	38.6(33.3-44.1)	30.0(22.3-40.2)	17.3(10.7-26.4)
Others	5.5(2.4-11.8)	34.9(26.3-44.5)	33.2(25.0-42.5)	26.5(17.8-37.4)	8.6(3.8-18.4)	26.3(18.2-36.4)	35.4(26.8-44.1)	29.7(20.6-40.8)
	P=0.041				**P=0.007**			
Residence (LGA) [b]								
Banjul & KM	5.1(2.0-12.2)	18.1(12.4-25.8)	43.3(35.7-51.3)	33.5(27.2-40.3	3.7(1.4-9.8)	23.0(17.9-29.2)	45.6(38.6-52.7)	27.7(21.0-35.6)
WCR	9.9(6.1-15.6)	35.9(30.4-41.8)	37.3(30.7-44.5)	16.9(13.6-20.8)	14.3(9.9-20.3)	40.7(35.8-45.8)	29.0(24.1-34.5)	16.0(10.9-22.8)
LRR	4.0(0.8-16.7)	34.4(27.3-42.2)	43.1(30.7-56.3)	18.6(12.3-27.2)	3.5(1.2-9.6)	42.3(33.3-51.8)	29.5(24.8-34.8)	24.7(14.2-39.3)
NBR	5.8(2.0-15.8)	33.1(22.3-46.1)	46.2(37.5-55.1)	14.9(8.7-24.3)	9.4(3.6-22.4)	41.9(37.0-46.9)	33.2(24.9-42.6)	15.5(10.8-21.8)
CRR	0.0	34.3(29.6-39.4)	41.7(33.350.7)	23.9(18.5-30.4)	0.4(0.05-2.8)	51.0(38.4-63.0)	28.4(25.0-32.1)	20.3(10.1-36.6)
URR	0.0	33.3(23.4-45.0)	36.0(26.1-47.1)	15.8(7.2-31.1)	10.7(5.3-20.5)	55.9(48.2-63.3)	29.6(22.6-37.6)	3.8(1.0-13.5)
	P=0.009				**P<0.001**			

	Men n=1372				Women n=1628			
Variable	**No risk factor %(95% CI) n=80**	**One risk factor %(95% CI) n=385**	**Two risk factors %(95% CI) n=576**	**Three to five risk factors %(95% CI) n=331**	**No risk factor %(95% CI) n=135**	**One risk factor %(95% CI) n=635**	**Two risk factors %(95% CI) n=562**	**Three to five risk factors %(95% CI) n=296**
Residence (Rurality)								
Urban	6.9(4.1-11.3)	25.3(20.3-31.1)	41.3(35.8-47.1)	26.6(21.9-31.8)	6.1(3.8-9.7)	29.3(24.3-35.0)	39.9(34.2-45.8)	24.7(19.0-30.6)
Semi urban	5.5(1.7-16.1)	39.2(32.6-46.2)	35.4(31.6-39.4)	20.0(13.3-29.0)	3.5(1.7-7.4)	36.0(28.5-44.2)	25.7(23.0-28.5)	34.8(24.7-46.6)
Rural	7.1(4.0-12.3)	34.6(28.9-40.8)	41.4(35.1-48.1)	16.9(13.1-21.5)	10.3(6.0-17.1)	45.9(42.1-49.7	30.8(27.0-34.9)	13.0(10.1-16.6)
	P=0.045				**P<0.001**			
Education								
≤6 Years	6.6(4.1-10.6)	29.9(26.2-33.9)	42.5(37.4-47.6)	21.0(17.9-24.5)	8.4(5.6-12.3)	39.7(36.5-43.0)	34.6(30.8-38.8)	17.3(13.7-21.6)
7-12 Years	8.3(4.4-15.2)	31.6(24.9-39.2)	39.0(32.4-45.9)	21.1(15.8-27.6)	7.5(4.3-12.8)	32.9(24.9-42.1)	35.3(28.0-43.4)	24.3(18.0-32.0)
>12 Years	7.0(3.0-15.1)	23.5(15.9-33.5)	44.2(35.3-53.5)	25.3(18.1-34.2)	7.8(2.3-22.4)	22.8(12.1-39.0)	59.0(38.3-76.9)	10.5(3.4-28.0)
	P=0.717				P=0.060			

[a] Results adjusted for complex survey design and weighted for non-response

[b] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region

NB: NCD risk factors are as defined in section 8.2

^N <10: therefore estimates not shown.

8.3.4 Factors associated with clustering of NCD risk factors

Age and ethnicity were significantly associated with having three or more risk factors (versus none) among men in the fully adjusted multinomial regression model (Table 8.4). Education, older age, and urban residence were significantly associated with three or more risk factors (versus none) among women (Table 8.5). Although not statistically significant, higher education was inversely associated with the clustering of three or more risk factors among women (ARRR 0.8 95% CI: 0.2-3.8).

In the fully adjusted models for men and women combined, those in the older age group (55-64 years) were more likely than the younger participants (25-34 years) to have three or more risk factors rather than no risk factor. Urban residents were twice (ARRR 2.1, 95% CI: 1.1-4.1) as likely as rural residents to have three or more risk factors rather than no risk factors. Wollofs were more likely (3.7, 1.7-7.9) than Mandinkas to have three or more risk factors rather than no risk factor (data not shown).

Table 8.4: Multivariate multinomial logistic regression on factors associated with clustering of NCD risk factors in men (The Gambia, 2010)

	Model I (Age adjusted)		Model II (Fully adjusted)	
	1-2 risk factors	**3-5 risk factors**	**1-2 risk factors**	**3-5 risk factors**
Variable	**[a]RRR(95% CI)**	**[a]RRR(95% CI)**	**ARRR (95% CI)**	**ARRR (95% CI)**
Age Group				
25-34	Reference	Reference	Reference	Reference
35-44	1.09(0.58-1.99)	1.88(0.92-3.82)	1.03(0.51-2.09)	1.98(0.88-4.46)
45-54	1.69(0.76-3.74)	3.80(1.65-8.77)**	1.41(0.58-3.39)	3.43(1.39-8.43)**
55-64	1.72(0.88-3.40)	5.29(2.38-11.76)***	1.66(0.79-3.49)	6.39(2.69-15.14)**
Ethnicity				
Mandinka	Reference	Reference	Reference	Reference
Wollof	3.65(1.23-10.80)*	4.81(1.64-14.15)**	3.64(1.22-10.88)**	4.85(1.59-14.77)**
Fula	1.65(0.71-3.84)	1.60(0.65-3.91)	1.78(0.67-4.75)	1.77(0.59-5.28)
Jola	0.73(0.31-1.71)	0.62(0.25-1.57)	0.75(0.31-1.79)	0.67(0.27-1.65)
Others	1.43(0.56-3.69)	1.76(0.63-4.94)	1.29(0.49-3.39)	1.79(0.65-4.92)
Education				
≤6 Years	Reference	Reference	Reference	Reference
7-12 Years	0.86(0.36-2.04)	1.26(0.50-3.17)	0.99(0.40-2.41)	1.15(0.45-2.94)
>12 Years	0.91(0.35-2.36)	1.27(0.47-3.41)	0.96(0.34-2.74)	1.00(0.34-2.90)
Residence (Rurality)				
Rural	Reference	Reference	Reference	Reference
Semi urban	1.31(0.36-4.78)	1.70(0.36-7.89)	1.34(0.32-5.66)	1.71(0.30-9.55)
Urban	0.95(0.44-2.06)	1.92(0.79-4.67)	0.88(0.39-1.96)	1.54(0.65-3.64)

NB: Results adjusted for complex survey design and weighted for non-response
Fully adjusted models mutually adjusted for the variables shown in the table
[a]RRR= Relative Risk Ratio adjusted for age (except for age group as the independent variable), ARRR= Adjusted Relative Risk Ratio(fully adjusted)
Reference = No risk factor
*p<0.05, **p≤0.01, *** p≤0.001

Table 8.5: Multinomial logistic regression on factors associated with clustering of NCD risk factors in women (The Gambia, 2010)

	Model I(Age adjusted		Model II(Fully adjusted)	
	1-2 risk factors	**3-4 risk factors**	**1-2 risk factors**	**3-5 risk factors**
Variable	**[a]RRR(95% CI)**	**[a]RRR(95% CI)**	**ARRR (95% CI)**	**ARRR (95% CI)**
Age Group				
25 -34	Reference	Reference	Reference	Reference
35-44	1.81(1.18-2.80)**	3.54(2.20-5.71)***	2.23(1.45-3.48)***	5.55(3.34-9.24)***
45-54	1.21(0.66-2.28)	4.48(2.33-8.62)***	1.31(0.75-2.30)	7.82(4.00-15.41)***
55-64	^	^	^	^
Ethnicity				
Mandinka	Reference	Reference	Reference	Reference
Wollof	2.51(1.00-6.26)*	3.18(1.39-7.29)**	2.28(0.87-5.97)	2.58(1.07-6.21)*
Fula	1.59(0.88-2.89)	1.72(0.79-3.73)	1.58(0.87-2.87)	1.49(0.64-3.47)
Jola	0.46(0.21-0.99)*	0.44(0.14-1.36)	0.42(0.21-0.85)*	0.38(0.14-1.00)
Others	0.73(0.31-1.71)	1.34(0.55-3.26)	0.64(0.27-1.54)	1.00(0.40-2.53)
Education				
≤6 Years	Reference	Reference	Reference	Reference
7-12 Years	1.22 (0.66-2.24)	3.47(1.59-7.55)**	1.08(0.64-1.85)	2.30(1.20-4.40)*
>12 Years	1.40(0.40-)	1.21(0.25-5.93)	1.41(0.44-4.50)	0.80(0.17-3.79)
Residence (Rurality)				
Rural	Reference	Reference	Reference	Reference
Semi urban	2.28 (1.04-5.00)*	7.52(2.75-20.54)***	1.82(0.89-3.74)	5.84(2.36-14.43)***
Urban	1.70(0.79-3.65)	4.48(1.76-11.41)**	1.56(0.78-3.11)	2.77(1.28-5.97)**

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.
Fully adjusted models mutually adjusted for the variables shown in the table
[a]RRR= Relative Risk Ratio adjusted for age (except for age group as the independent variable), ARRR= Adjusted Relative Risk Ratio(fully adjusted)
Reference = No risk factor
*p<0.05, **p≤0.01, *** p≤0.001
^ Number with no risk factor (the reference category) is extremely small (<5) resulting in very wide confidence intervals

8.4 Discussion

The analysis reveals a high prevalence of clustering of NCD risk factors in The Gambian adult population: only 7% had no risk factor, which is a cause for concern. The prevalence of individual risk factors are remarkably high, especially low fruit and vegetable intake (<5 combined servings a day: 78%), overweight/obesity (40%), and hypertension (29%). Physical inactivity (<600 MET/minutes per week), however, was relatively low (14%). Most of the physical activity reported was work- and transport-related. The high prevalence of each individual risk factor as well as the high level of clustering (23% of men and 21% of women had three or more risk factors) is worrying in terms of future NCD burden, given the high prevalence of hypertension in the country, as outlined in chapter 5. Causes of NCDs are multifactorial; the clustering/co-occurrence of risk factors in an individual and/or a population is associated with higher occurrence of chronic NCDs (Zaman et al., 2015, Wesonga et al., 2016). There is evidence suggesting that the multiplicative effects of a combination of risk factors is more detrimental to people's health than the effects of each individual risk alone (Poortinga, 2007, Alageel et al., 2016).

Clustering of risk factors was associated with older age and urban residence, especially in women, in whom lower education was also associated with risk factor clustering. The association of increasing age with clustering is not a surprise as some of the NCD risk factors increase with age, especially age-related biological/metabolic risk factors such as hypertension and obesity. Behavioural risk factors such as physical inactivity are also more common among older people. My findings on the prevalence of clustering of multiple risk factors concur with findings from similar studies in Africa and Asia (Wesonga et al., 2016, Pelzom et al., 2017, Li et al., 2012). However, a study in Spain which focused on behavioural risk factors including smoking, alcohol use, physical inactivity and food habits found higher levels of clustering among the younger age groups compared with the older age groups (Galan et al., 2005). This could be because strongly age-related biological risk factors such as obesity and hypertension were not considered in that study and behavioural risk factors such as alcohol consumption and smoking are more common among younger age cohorts.

Urban residence was significantly associated with clustering of three or more risk factors compared with rural residence (26% and 15% with three or more risk factors respectively). This is in agreement with some studies in the literature (Pelzom et al., 2017, Rawal et al., 2017). However, a study in Uganda found clustering to be associated with rural residence (Wesonga et al., 2016): however, that study compared one-two risk factors vs none rather than the comparison of three or more risk factors versus none in my study. Another study, conducted in China, that focused on behavioural risk factors only, also found clustering to be associated with rural residence (Li et al., 2012). There is evidence on the linkage between urbanisation and the increasing burden of obesity and other NCDs, especially in low-income countries (Godfrey and Julien, 2005, Kruger et al., 2001, Ojiambo, 2016, Vorster, 2002). The Gambia is located in West Africa, the region experiencing the most rapid increase in urbanisation in Africa (Bosu, 2015). As evident in my systematic review (Chapter 3), female gender and urban residence were significantly associated with hypertension, overweight and physical inactivity in SSA (when treating each risk factor on its own). Although the prevalence of having three or more risk factors, as well as modifiable risk factors such as obesity, were higher in urban areas in The Gambia, the prevalence of hypertension was higher in rural areas. Levels of overweight/obesity and physical inactivity were, however, significantly lower in rural areas. I do not have the answers to why these unique findings exist but I have made a comprehensive discussion of reasons that could be associated with this finding in chapter 5 section 5.4.

The prevalence of multiple risk factors was lower among those with higher education in women. Higher education appeared to be inversely associated with three or more risk factors in the fully adjusted models in women but the difference was not statistically significant. There was no significant difference between those with lower and higher education among men (ARRR=1.0). Women with higher education may have greater levels of awareness of risk factors, which can translate to commitment to take preventive measures against the risk factors of NCDs. However this is quite complicated and should be interpreted with caution as women with higher education (compared with those with lower education) had a higher proportion of having two risk factors but a lower proportion of having three to five risk factors. Obesity and physical inactivity were higher among women with higher education. Some previous studies from different countries including China (Li et al., 2012, Hong et al., 2018), Spain (Galan et al., 2005), and Brazil (Ferreira da Costa et al., 2013) that looked at the association of multiple risk factors with education found the clustering of risk factors to be associated with lower education. However, clustering was associated with increasing level of education in a joint study conducted in Bangladesh, India, Indonesia, Thailand, and Vietnam (Ahmed et al., 2009). Other studies in Bangladesh and Nigeria also found clustering to be higher among those with higher levels of education (Zaman et al., 2015, Idowu et al., 2016). Therefore, it is difficult to make direct comparisons because of different risk factors, analytical approaches, age ranges and settings.

I did not find any significant difference between men and women in the clustering of three or more risk factors in the fully adjusted multinomial logistic regression model which combined data from both sexes. Previous studies have found gender differences in the clustering of NCD risk factors. I could not find any study that assessed this in SSA, but in a study in China, clustering was significantly associated with being male (Li et al., 2012). However, in a similar study in Pakistan, clustering was significantly higher among women, however, multivariable regression analyses were not conducted to control for potential confounders (Khuwaja and Kadir, 2010).

8.4.1 Strengths and limitations of the study

Only a few studies have examined the clustering of risk factors for NCDs in sub-Saharan Africa and to my knowledge, this is the only study that has assessed the clustering of NCD risk factors (smoking, hypertension, overweight/obesity, physical inactivity, and low fruit and vegetable intake) at population level in The Gambia.

The main limitation of this analysis is the cross-sectional nature of the data, which limits making causal inferences on the findings. Adding the scores depending on the presence and absence of a risk factor into an overall score gives each factor an equal weight. For example, smoking tobacco may be more detrimental to health compared with low fruit and vegetable intake but the weighting of each risk factor to the overall score is assumed equal. Three of the risk factors (smoking, low fruit and vegetable intake and physical inactivity) were based on self-reported data, which might be subjected to biases. The smaller sample size compared with the sample sizes used in previous chapters to study each risk factor on its own is another limitation. Only 3000 non-pregnant participants had valid information on all the risk factors considered. This weakens the power to detect any significant differences between groups in the propensity for having multiple risk factors.

Another important limitation is the omission of biochemical risk factors such as diabetes and raised cholesterol. As explained in previous chapters, my data only has information on self-reported diabetes and does not have information on blood cholesterol. These were not collected due to costs and technical reasons. However, my analysis is comparable with the other studies reported in academic journals that used the WHO STEPS approach as well as the WHO fact sheets, as all these only used the five risk factors used in my analysis.

Finally, the approach taken in my study involved counting the number of risk factors. However, this approach has been criticised for focusing on the presence of risk factors. An alternative approach is to go beyond just the absence of CVDs and focus on what Lloyd-Jones et al (2010) describe as a "broader, more positive construct" of health (Lloyd-Jones et al., 2010). As an example of this alternative broader approach, the American Heart Association (AHA) recommend a Life's Simple 7 Score as a tool for the primary prevention of CVDs (Lloyd-Jones et al., 2010, Folsom et al., 2015, Mok et al., 2018). The seven metrics are as follows: current smoking, BMI, physical activity, healthy diet, total cholesterol, blood pressure and fasting plasma glucose. Each metric was defined in terms of being poor, intermediate and ideal. Ideal cardiovascular health for adults was defined as having a healthy (normal) blood pressure (< 120/80mmHg), controlled blood cholesterol (<200mg/dL(5.2mmol/L)), normal blood sugar (<100mg/dL(5.5mmol/L)), being physically active (≥ 150 minutes/week moderate intensity or ≥ 75minutes/week of vigorous intensity or a combination), having a healthy diet score, maintain a healthy BMI (<25kg/m^2), and abstaining from/stopping smoking (never or quit more than 12 months ago). (Lloyd-Jones et al., 2010).

8.5 Conclusion

The analysis reveals that more than 90% of Gambian adults have at least one NCD risk factor and that clustering was very high: more than one in five adults had three or more risk factors. The burden of NCDs is expected to increase in The Gambia if preventive and control measures are not taken. Interventions geared towards the prevention and control of NCDs in The Gambia should focus on all the five risk factors and should apply an integrated approach. As all the risk factors considered in this analysis are modifiable, life style changes should be widely promoted throughout the country. There should be an integrated approach targeting all risk factors including wider treatment and control of hypertension.

9. Chapter 9: Discussion and policy implications

9.1 Summary and discussion of key findings

As outlined in Chapter 2, the aim of this research is to examine CVD risk factors in SSA and the general adult population in The Gambia. This research has several key findings. First, from the systematic review (Chapter 3), I found that the burden of hypertension, diabetes and cardiovascular disease risk factors such as obesity, low fruit and vegetable intake and smoking are relatively high in SSA. The proportion of hypertension and diabetes that are undiagnosed is also of great concern. Treatment and control of both hypertension and diabetes were low, providing evidence that the disparities in the prevalence of hypertension between high-income and low- and middle-income countries is magnified by disparities in awareness, treatment and control rates (Bloch, 2016) . The strongest factors associated with hypertension in most of the studies where information on this was available were age, obesity, physical inactivity, and urban residence. Family history of hypertension and diabetes were also associated with higher risk of hypertension and diabetes in studies where these variables were included in the regression models.

Secondly, like many countries in SSA, the prevalence of hypertension was high among adults aged 25-64 years in The Gambia (Chapter 5), as shown by my analyses of the health survey data: 28% and 31% among men and women respectively. I used the standard WHO definition of hypertension as described in section 5.2.1 (SBP/DBP ≥140/90 mmHg and/or self-reported hypertension/treatment). The prevalence of hypertension in The Gambia would be substantially higher if I used the new definition of hypertension, based on the recent American College of Cardiology/American Heart Association (2017 ACC/AHA) *Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in*

Adults, which defines hypertension as SBP/DBP ≥130/80 mmHg and/or self-reported antihypertensive medication (Whelton et al., 2018). Unlike the findings in most of the studies in SSA, the burden of hypertension was higher in rural areas in The Gambia, even after adjusting for potential confounders.

Thirdly, the prevalence of obesity was also high in The Gambia, especially among women (Chapter 6). In contrast to my findings for hypertension, it was urban residence that was significantly associated with overweight/obesity in the fully adjusted models. This suggests that the pattern of hypertension in rural areas observed in Chapter 5 is not due to obesity. Fourthly, the prevalence of current smoking was very low among women but relatively high among men in The Gambia (Chapter 7). The prevalence of smoking was significantly higher among rural and semi-urban residents compared with urban residents. However, in the fully-adjusted multivariable regression models on smoking, there was no significant difference between rural and urban residents. Therefore the high prevalence of hypertension observed in rural areas was not related to variations in smoking by residence, as the association of smoking with rural residence diminished after adjusting for confounders.

Fifthly, there was high level of clustering of NCD risk factors, especially among urban residents (Chapter 8). Overall, 23% of men and 21% of women had three or more risk factors (hypertension, overweight/obesity, low fruit and vegetable intake, smoking, and/or physical inactivity). Among the five NCD risk factors that were used to derive the variable indicating the number of risk factors, low fruit and vegetable intake was the most common (78%). The high prevalence of low fruit and vegetable intake (defined as less than five combined servings of fruit and vegetables per day) in The Gambia, and perhaps most of the countries in SSA, may be associated with the time of data collection. Data collection in The

Gambia was conducted from January to March, which is not the season of locally available fruits such as mangoes and oranges. Almost every household has these fruits in their backyard but imported fruits such as apples and grapes, which are available at the market throughout the year, are relatively expensive.

9.2 Patterns of CVDs in different countries

9.2.1 Patterns of CVDs in sub-Saharan Africa and The Gambia

In this section, I will bring together my aforementioned key findings on the pattern of CVDs and their risk factors in The Gambia and other sub-Saharan African countries under three broad themes: age, gender and residence.

Age

As outlined in chapters 3, 5, 6 and 8, hypertension, obesity and the number of risk factors increased with age in most of the countries in SSA as well as in The Gambia. In contrast, current smoking was more common among the younger age cohorts, and the prevalence decreased with increasing age. Although the prevalence of hypertension was higher in the older age groups, an interesting finding of my research was the high prevalence of hypertension among younger adults in The Gambia (18% and 17% for men and women aged 25-34 respectively) and in many other countries in SSA. As a comparison, the prevalence of hypertension among men and women aged 25-34 in England in 2010 was 6% and 4% respectively (NHS Digital 2018). The prevalence of hypertension among men and women aged 20-34 in the United States in 2007-10 was 9.1% and 6.7% respectively (De Venecia et al., 2016). A recent literature review also found that levels of hypertension at younger ages (< 45 years) were higher in SSA compared with western countries (Twagirumukiza and Van Bortel, 2011). The prevalence of hypertension was unexpectedly high among adults 25-34 years in national STEP surveys conducted in The Gambia (Cham et al., 2018), Malawi (Msyamboza et al., 2012) and Mozambique (Damasceno et al., 2009). A number of sub-national surveys conducted in SSA have also found similar findings, suggesting hypertension is not only a burden among the older people in SSA but is also a burden among younger adults. Therefore in The Gambia levels of hypertension among adults aged 25-64 years are high in each age group. To some extent, I can speculate that the drivers of the high levels of hypertension among young adults in The Gambia are the same as those for the older age groups, including the high levels of salt intake, physical inactivity, poor diet, smoking and obesity. However, this is only speculation: it remains unclear why hypertension levels in The Gambia are high in each age group. I discuss in section 9.5 that future research should explore the factors associated with the high prevalence of hypertension among young adults in The Gambia and by extension SSA.

Gender

As outlined in chapter 3, there was no uniform direction of the association between gender and hypertension in most of the studies in SSA; in my own research (chapter 5), levels of hypertension were similar for men and women. Levels of obesity were significantly higher for women (chapter 6), whereas levels of smoking were higher for men (chapter 7). Clustering of three or more risk factors was more common among men in The Gambia (chapter 8).

My findings were in agreement with those outlined in the systematic review (chapter 3). Obesity and physical inactivity were generally higher among women in all the studies in SSA except one in Mozambique (Padrao et al., 2012a), in which physical inactivity was found to be higher among men. Behavioural risk factors such as smoking and alcohol use were generally higher among men in all the reviewed studies in SSA. A recent study in Kenya also found men had higher levels of clustering of CVD risk factors (Wekesah et al., 2018).

Residence

My systematic review showed that levels of hypertension in SSA were higher in urban than rural areas in some SSA countries; other studies in SSA such as Rwanda, Uganda, Angola and Ethiopia showed similar levels in hypertension by residence (chapter 3). In contrast, my own findings (chapter 5) showed the opposite: levels of hypertension were higher in rural areas compared with urban areas for men (34% rural; 24% urban) and for women (35% rural; 26% urban). My findings therefore suggest that the generally accepted hypothesis suggesting that hypertension is associated with urban residence is not true for all countries and settings in SSA. In regards to the other risk factors, levels of obesity (chapter 6), physical inactivity (chapter 8) and the number of risk factors (chapter 8) were associated with urban residence. Levels of current smoking among men were higher in rural areas (chapter 7). There could be some unknown socio-cultural or genetic factors associated with the linkage between hypertension and rural residence in these communities. The implications of this for further research are discussed in section 9.5 below.

9.2.2 Pattern of CVDs in SSA compared with other regions

Both my systematic review and analyses of the 2010 WHO STEPwise survey clearly show that CVDs are a major burden in SSA and The Gambia. A comprehensive study on the trend of blood pressure from 1975-2015 covering 98% of the world revealed that mean systolic and diastolic blood pressures have decreased in many high income countries but increased in LMICs in South East Asia, Oceania and SSA (NCD Risk Factor Collaboration, 2017).

The study reported that SSA, Central and Eastern Europe and South Asia had the highest BP levels. This has shown that the epidemiological and nutritional transition from infectious diseases to non-communicable diseases has been very much pronounced in SSA. The WHO set up a number of key targets for all countries to achieve by 2025 during the UN high-level meeting on NCDs in September 2011 and the related action plan aimed at reducing the risk of premature mortality from NCDs by 25% by 2025 (25 by 25 strategy) (WHO, 2013a). Given the increasing prevalence of NCDs and their risk factors in SSA, most countries are already off track in achieving these goals. Globally there is a variation in the probability of premature deaths from CVDs, with a greater probability of dying from CVDs in LMICs compared with high income countries (Sacco et al., 2016, Roth et al., 2017). Premature mortality associated with CVDs is projected to increase by 48% by 2025 among women in SSA if current risk factor trends continue (Sacco et al., 2016). NCDs have economic and social consequences, especially in LMICs, and present a barrier to sustainable human development and poverty alleviation (Clark, 2013, Lal et al., 2013, WHO, 2017a). Cumulative economic losses from the four main NCDs (CVDs, diabetes, cancer and chronic respiratory diseases), the target of the UN high level meeting on NCDs, are estimated to be more than 7 trillion dollars in LMICs over the period 2011-2025 (WHO and World Economic Forum, 2011). CVDs accounted for more than 50% of the NCD burden. The problem is compounded by the double burden of communicable and non-communicable diseases in SSA, including The Gambia (Boutayeb, 2006, Nyirenda, 2016).

None of the studies in a recent systematic review on development interventions on NCDs and their behavioural risk factors in LMICs reported on consumption of salt, saturated fat, or alcohol, tobacco use, or physical inactivity (Pullar et al., 2018). The study also revealed that there is a lack of evidence for development interventions on NCD outcomes, as well as the lack of inclusion of NCDs in development interventions' outcome measures.

Despite the high burden of NCDs in The Gambia, only three out of ten essential medicines for NCDs were reported to be available in the country in 2017 (WHO, 2018c). Mean population salt intake among adults 20 years and above was 8g/day in 2010 in The Gambia. This far exceeds the WHO recommendation of less than 5g/day salt or < 2g/day intake sodium (WHO, 2012b) and may contribute to the high burden of hypertension in the country.

9.3 Strengths and limitations of the research

This study is based on analysis of data from the most recent nationally representative health examination survey done in The Gambia using the WHO STEPwise approach. Although the survey was cross-sectional, the WHO STEP methodology on which it was based is of high standard and applied good quality control measures.

Health examination data is more reliable than health interview data and has the ability to capture cases of undiagnosed disease. The survey in The Gambia applied the e-STEPS, which is an electronic version of the STEPS survey questionnaire that allows errors to be detected as data collection is ongoing. It is therefore less error-prone compared with the paper-based questionnaire. Unlike the previous national study (van der Sande et al., 1997), data collection did not take place during the holy month of Ramadan. I made reference to the STROBE checklist for reporting cross sectional surveys throughout the thesis (STROBE statement in Appendix II). I also conducted a comprehensive systematic literature review on the findings of health examination surveys conducted in SSA using the WHO STEP approach. To my knowledge, this is the first systematic review based exclusively on studies that used the WHO STEP approach, which facilitates comparability between and within countries. My study presents the most recent information on CVD risk factors in The Gambia, which can be used to guide policy makers and donor agencies. It has also raised many unanswered questions/hypotheses on the epidemiology of NCDs in The Gambia - and by extension SSA - which can be explored by other researchers.

Despite the many strengths of this study, it has a number of limitations. The cross-sectional nature of the survey limits attributing causality to the associations observed. I could not explore the association of income with the outcomes of interest because of the low response rate to the income component of the questionnaire. I therefore used level of education as a measure of socio-economic status, which may have some limitations in a Gambian setting. This is because there are some wealthy business men and farmers in the country with little or no formal education. I was also not able to use the variable on employment status, as the categories used do not provide any information on the economic (wealth) status of the participants. Behavioural risk factors such as physical inactivity, low fruit and vegetable intake, smoking and alcohol use were self-reported and might be affected by reporting bias/information bias. Participants may also provide a biased report of their smoking and drinking status as these behaviours are socially undesirable in The Gambia because of social and religious factors.

Even though the STEPS questionnaire has been validated in different countries and settings, use of more objective measures of physical activity such as accelerometers could have been more valid and reliable. The STEP questionnaire adopts the Global Physical Activity Questionnaire (GPAQ) for the physical activity section. However, research has shown that lower education and rural residence could be associated with reduced validity and reliability of the GPAQ especially in LMICs (Bull et al., 2009, Barr et al., 2018). The level of education among the participants in The Gambia was low, especially among rural residents. Rural residents reported having higher levels of physical activity but I am not sure if they are active during the farming season only or throughout the year. As outlined in chapter 5, the farming season in The Gambia is very short and hence farmers may be active during this period but sedentary for the greater part of the year. Data collection was conducted between January to March and hence there is some limitation in that the generalisability to the other nine months of the year is not known.

9.4 Policy implications

NCDs are a burden in The Gambia and most of the countries in SSA, as evident in my findings, but little attention is given to them by governments in these countries and donor agencies (van de Vijver et al., 2013a, Nugent and Feigl, 2010). Age is a modifiable risk factor of NCDs and because of the increasing shift towards an ageing population in these countries, the burden of NCDs is expected to increase. The former mayor of New York and founder of Bloomberg Philanthropies, Michael R. Bloomberg, in his annual letter on philanthropy in 2017 stated: "*We must go where the data leads us—and it leads directly to non-communicable diseases and injuri*es" (Bloomberg, 2017). NCDs should therefore be given the attention they deserve and included in the development agenda of all countries as they pose a barrier to poverty alleviation and can hinder the attainment of the United Nations Sustainable Development Goals (Clark, 2013, Lal et al., 2013, WHO, 2017a). There are several policy implications of the key findings in this project. I will discuss them according to the different objectives/outcome variables.

9.4.1 Policy implications of findings from the systematic review

NCDs, including hypertension and diabetes, are becoming a major burden to the health care systems and to families in SSA. Even in the Republic of Seychelles, where health services are free, NCDs remain a major burden to individuals and families (Bovet et al., 2006). NCDs including hypertension pose both a public health burden and an economic burden to individuals, families, governments and society as a whole (Elliott, 2003, Stewart and Sliwa, 2009, Miranda et al., 2008). Average expenditure on healthcare of African governments is 6% of GDP (van de Vijver et al., 2013a). A very small proportion of health budgets is spent on NCDs in SSA; global aid on NCD prevention and control is less than 3% (Nugent and Feigl, 2010). The increasing burden of NCDs will overstretch the public health system, which is not adequately funded in most countries in SSA. Many governments in SSA will not be able to cope with this increasing burden of NCDs coupled with the already existing burden of infectious diseases.

The prevalence of overweight/obesity is high in SSA and is one of the most significant factors associated with hypertension and diabetes in studies in my systematic review that conducted multivariable regression analysis. There are socio-cultural norms that promote overweight, especially among women. Mass media campaigns should be conducted on the risk factors, especially on the importance of maintaining a healthy weight. Harmful social and cultural practices that promote overweight should be discouraged. As overweight is not seen as a burden but rather as a sign of prestige and beauty in some African societies, preventive efforts should not only focus on exercise and diet but also on socio-cultural factors that facilitate the increasing prevalence of obesity and consequent NCDs such as diabetes and hypertension. Governments and donor agencies should increase their attention on NCDs, including capacity building of healthcare providers and all relevant stakeholders.

Doctors and nurses should be encouraged to check the BP and blood glucose of patients as a routine. Periodic community screening programmes should also be instituted for the early detection of cases in communities.

As found in my systematic review, the consumption of fruits and vegetables was generally low in SSA. Approximately 2.7 million deaths annually are attributed to inadequate consumption of fruits and vegetables (Ruel et al., 2005). Several studies including a systematic review and meta-analysis of prospective cohort studies has shown that adequate consumption of fruits and vegetables is protective against CVDs including hypertension and coronary heart disease (Van Duyn and Pivonka, 2000, Wang et al., 2014). Initiatives to increase consumption of fruits and vegetables should be widely promoted in SSA. Farmers should be given incentives to encourage the cultivation of fruits and vegetables. They should also be supported with storage facilities, as fruits and vegetables are highly perishable and can easily get spoilt especially in hot tropical countries.

9.4.2 Policy implications of findings on hypertension and obesity in The Gambia

The high prevalence of hypertension (28% and 31% for men and women respectively) and the proportion that is undiagnosed in The Gambia (86% men; 71% women) is very worrying. The surprisingly high prevalence of hypertension among the younger adults, most of whom had their hypertension undiagnosed, need to be addressed urgently. Even though hypertension is the commonest modifiable risk factor for stroke and other CVDs in Africa, its prevention and control is not prioritised (Kengne and Anderson, 2006, Ataklte et al., 2015). The government of The Gambia and donor agencies should increase their attention to NCDs, including capacity-building of healthcare providers and all relevant stakeholders. From the most recent WHO *"Non communicable Disease Progress Monitor 2017",* there is no NCD policy, salt/sodium policy, saturated fatty acid and transfat policy and no guideline for the management of CVDs and diabetes, among other policy gaps on the prevention and control of NCDs in The Gambia (WHO, 2017b).

Although I did not look at diabetes due primarily to the lack of data on blood glucose (and so I was unable to identify cases of undiagnosed disease), a notable finding of this study was that a high proportion (91%) of the participants reported that they had never had their blood glucose measured, which needs urgent intervention by policy-makers. Just like hypertension, there could be a high number of undiagnosed diabetes cases in the community. As most of the risk factors for and consequences of hypertension and diabetes are similar, interventions to reduce the burden of hypertension should therefore run in parallel with that of diabetes and other NCDs. The Ministry of Health and Social Welfare of The Gambia should also put in place operational NCD policies and action plans. Early detection and treatment is crucial for the effective control of hypertension, diabetes and other NCDs and the prevention of related cardiovascular complications. Doctors and nurses should be encouraged to check the BP of patients as a routine. With new technology of portable, battery-operated BP machines, there should be periodic and systematic screening for the early detection of cases in communities. Assessment of blood glucose should be regularly conducted at least in overweight and obese individuals and those with hypertension to ensure early detection, treatment and control of diabetes. Rural residence was strongly associated with hypertension in this study. Interventions to reduce the burden of hypertension could be further targeted towards those living in rural areas.

There is no information on salt intake in the data used in this study, as highlighted in Chapter 5 (section 5.4.4). Recent findings from the WHO 2018 NCD country profile reveal that the mean salt intake in The Gambian population far exceeds the WHO recommendation of less than 5g/day (WHO, 2018c). Strategies to promote the reduction of sodium consumption should be promoted at population level as evidence shows high sodium intake is a major risk factor of hypertension, especially among people of black African descent (De Wardener and MacGregor, 2002, Ukoh et al., 2004, Forrester, 2004, Stamler et al., 2018). The use of flavour enhancers with monosodium glutamate (MSG) is very common in The Gambia. These flavour enhancers are in abundance in markets and shops in the country and are used by most Gambian households when cooking. There are many advertisements of such flavour enhancers on TV, radio, flyers and bill boards. MSG has a high sodium content and the use of flavour enhancers with MSG might contribute to the high prevalence of hypertension in The Gambia. The Ministry of Health and Social Welfare should ensure the regulation of advertisement and sale of such flavour enhancers. The government should increase its tax on MSG flavour enhancers and institute compulsory labelling of such products with detailed information of the salt/sodium content. As a member of the West African Health Organization (WAHO), The Gambia should implement the statement on salt reduction adopted by all 15 WAHO member countries in 2013 (Sookram et al., 2015). The statement covered a number of strategies on the reduction of salt consumption recommended to member countries to implement. These include raising awareness on the health benefits of dietary salt reduction and developing and implementing policies and plans that help communities reduce salt consumption to levels recommended by the WHO (Sookram et al., 2015). The consumption of fruit and vegetables should also be promoted, considering the small proportion of participants who consumed the WHO recommended servings of fruits and vegetables a day as found in this study.

The prevalence of obesity was also very high (8% and 17% for men and women respectively) and it is one of the most prominent risk factors associated with hypertension in The Gambia. Likewise, physical inactivity (defined as <600 MET/minutes per week) was strongly associated with hypertension in women. Sensitisation campaigns should promote awareness of the NCD risk factors, especially on the importance of physical activity and maintaining a healthy weight. There are socio-cultural norms that promote overweight in SSA (especially among women) as highlighted in section 9.3.1 and The Gambia is not an exception. Preventive efforts should not only focus on physical activity and diet but also on socio-cultural factors that facilitate the increasing prevalence of overweight.

9.4.3 Policy implications of smoking among men in The Gambia

This study was conducted among adults (aged 25-64 years) but the results reveal that many current smokers started smoking as children or teenagers. There are a number of regulations and policies on tobacco control in The Gambia, including the Prohibition of Smoking in Public Places Act (The Ministry of Health and Social Welfare, 1998). The country also ratified the WHO Framework Convention on Tobacco Control (WHO FCTC) (WHO, 2003b) in September 2007. There is also a ban on tobacco advertisements and promotion as well as all tobacco related sponsorship. In April 2016, the Ministry of Health and Social Welfare of The Gambia launched a three year national tobacco cessation clinical guideline with the objective of providing standardised treatment to tobacco users. The country has implemented a specific excise tax on all imported tobacco products, which has contributed to a price increase and reduction of tobacco imports (Nargis et al., 2016). The government gained more revenues as a result of the increment in tax. Total importation of cigarettes decreased from 2012- 2013 but tax collection from cigarettes doubled from GMD88.62 million to GMD166.90 million (US$1=GMD33.34 in 2012) during this period (Nargis et al., 2016). In addition, the Tobacco Control Act 2016, was adopted in December 2016 and it came into force in July 2018 (Campaign for Tobacco-free Kids, 2018). Most of these initiatives were implemented after the data I used for this research was collected. Therefore, I could not explore if the policies have contributed to a reduction in tobacco use.

Article 16 of the WHO FCTC prohibits the sale of tobacco products to minors (WHO, 2003b). However, the implementation of the WHO FCTC is lacking in The Gambia, as evidence shows that tobacco is being sold to minors. There is no information on exposure to second hand smoke in my study but a study among school children revealed a high proportion were exposed to second hand smoke at home and/or in public places (Jallow et al., 2018). Exposure of adolescents to others' smoke increases social acceptability of smoking and smoking initiation among adolescents (Albers et al., 2008, Lee et al., 2016). The risk of nicotine dependence is higher among smokers who started at an early age (DeBry and Tiffany, 2008). There is evidence in the literature suggesting that laws prohibiting illegal sales of cigarettes do not deter illegal sales and have limited influence of reducing prevalence of tobacco use if not enforced (Chandora et al., 2016, Stead and Lancaster, 2005). On the other hand, strict enforcement of regulations prohibiting sales of tobacco products to minors have shown to contribute to a reduction of smoking among youths (Stead and Lancaster, 2005). Support for young smokers who intend to quit smoking is very limited in The Gambia (Jallow et al., 2017). Smoking cessation support should be provided to all smokers, regardless of their age. Government, with support from its partners, should strongly regulate the exposure of minors to tobacco products, both because of the health risks of inhaling others' smoke and the adverse effect of smoking role models on future smoking habits. Although some studies have shown that sensitisation reduces smoking intake among youths (Brinn et al., 2010, Wakefield et al., 2003), other studies have revealed that targeting teenagers with non-smoking messages provided by the tobacco industry, influences - positively - attitudes towards the tobacco industry (Henriksen et al., 2006) and are at best ineffective in deterring smoking uptake (Bates et al., 2000). Youth smoking is most effectively dealt with by preventing exposure to second-hand smoke and by a comprehensive raft of tobacco control policies and smoking cessation interventions aimed at adults (Lee et al., 2016, Albers et al., 2008). Policies and regulations prohibiting smoking in public places should be enforced.

The prevalence of smoking was low among women aged 25-64 years in this study (1%). However, recent findings among students shows a shift among younger girls, with 9% being current smokers (Jallow et al., 2017). With these findings, it can be anticipated that the rates among women will rise and it will be an important group to target for public health intervention efforts. Since tax on tobacco products has proven to be effective in reducing consumption in The Gambia (Nargis et al., 2016), it should be increased further. The proceeds from the increment in tax can be used to fund health promotion activities which could result in consequent health gains.

9.4.4 Policy implications of clustering of NCD risk factors

As evident in Chapters 3 and 8, there is a high degree of clustering of NCD risk factors in SSA and The Gambia respectively. Overall, 23% of men and 21% of women had three or more risk factors (hypertension, overweight/obesity, low fruit and vegetable intake, smoking, and physical inactivity). Addressing multiple risks is important from a public health perspective as evidence suggests that the combination of risks is more detrimental to people's health than would be expected from the added individual risks alone. (Kvaavik et al., 2010)Therefore, addressing the burden of NCDs in The Gambia and by extension other countries in SSA calls for policies that do not only target individual CVD risk factors but also the clustering of risk factors. The policies and strategies recommended in 9.3.1 to 9.3.3 can be applied in the prevention and control of clustering of NCD risk factors.

In the discussion section of chapter 8, I briefly mentioned the AHA's Life's Simple 7 Score which focuses on a broader, more positive construct of health. The AHA have developed a calculator tool based on this score which has been identified as a way of enabling persons to calculate their own risk score for heart disease (Hsu and Wong, 2017). This could be a useful prevention and communication tool for CVDs in The Gambia and other countries in SSA. The Ministry of Health can learn lessons from the implementation of this in the United States of America and try to implement it in The Gambia to communicate issues related to CVDs to the populace and so improve the prevention of NCDs.

The Gambia has implemented successful strategies in the prevention and control of infectious diseases, especially malaria and tuberculosis. The WHO identified The Gambia as one of seven countries in West Africa with accelerated progress towards the elimination of malaria (WHO, 2017c). Malaria parasite prevalence has decreased from 4% in 2011 to 0.2% in 2017, indicating a decrease of more than 90% across the country (WHO, 2017c). Policy-makers and stakeholders should learn from the strategies implemented in the prevention and control of these diseases and use those that are applicable in the prevention and control of NCDs and their risk factors. One example is capacity building of "traditional communicators" and community leaders to lead sensitization campaigns in their communities. This has proven to be effective in the prevention and control of malaria and in promotion of breast feeding in the country. It can therefore be tried in the prevention of the clustering of NCD risk factors. There is a strong political commitment from the government of The Gambia and donor agencies for the control and elimination of malaria. This is another important factor that contributes to the successful control of malaria in the country. For example the former President spearheaded the Environmental management programme, one of the malaria control strategies in the country. He also gave a lot of support to the National Malaria Control Program of the Ministry of Health and Social Welfare.

Some successes have been registered in the prevention and management of NCDs in The Gambia. These include the establishment of the Non Communicable Diseases Prevention and Control Unit under the Directorate of Health Promotion and Education in 2014; the existence of National Health Policy 2012-2020 which has set priorities for NCD programmes; the existence of NCD Policy and Action Plan 2012-2016; the National Tobacco Control Policy and Strategic Plan 2013-2018; as well as the National Cancer Registry. However, the country is still far behind in meeting the WHO national response standards for NCD prevention and control as most of the relevant policies and strategies are either absent or not operational (WHO, 2014b). The philosophy of the current National Health Policy of The Gambia 2012-2020 is "*Health is Wealth*", i.e. a healthy nation is a wealthy nation but the attention given to NCDs is very limited compared with other diseases (The Ministry of Health and Social Welfare, 2012). Like The Gambia, most of the countries in SSA have limited operational strategies to address the increasing burden of NCDs and their risk factors. Inadequate investment in prevention and control are significant contributing factors to the rapid rise of the burden of NCDs and the clustering of risk factors in The Gambia. Healthcare providers should be trained in NCD prevention and management. There should be community outreach programmes to sensitise communities in basic preventive measures. The WHO Package of Essential Non-communicable Disease Interventions (WHO PEN) should be used to ensure the prevention of NCDs and early detection and control of cases. It is crucial to obtain political commitment from government for the control of NCDs. This is important in convincing officials at the Ministry of Finance to increase budget allocation towards NCDs and also convincing donor agencies for support.

9.5 Future research

The findings of this research has raised a number of hypotheses/research questions that should be explored in future research.

First, my findings have raised the research question: Why is the high population prevalence of hypertension apparent even in young adults? Second, with regards to risk factors and residence, what factors underlie the higher levels of obesity, physical inactivity and clustering of risk factors in urban areas compared with rural areas, whilst levels of hypertension are lower? Third, why is the level of hypertension high among the relatively lean (i.e. neither overweight nor obese) in the rural population in The Gambia? Fourth, why are Gambians culturally obesity tolerant as suggested in the literature (Siervo et al., 2006a, Siervo et al., 2006b) and what are the beliefs on diet and fatness in The Gambia? Fifth, with regards to data collection as part of health examination surveys, what culturally sensitive beliefs influence the greater willingness to have blood pressure measured, but be less likely to agree to measurements of weight, waist circumference and hip circumference? Finally, also with regards to data collection, what factors are associated with the high level of missing data for the income variable, and more widely, what other survey items and methods could be used in future surveys to improve the measurement of income?

A combination of qualitative and quantitative research designs could be used to explore these research questions. The surprisingly high prevalence of hypertension among young adults, the higher burden of hypertension in rural areas and most of the research questions above could be explored using qualitative approaches. Face to face interviews as well as focus group discussions among key informants in communities should be conducted. These could explore possible diet and socio cultural factors that may predispose these sub groups to hypertension. For example, the authors of a recent qualitative study in Ghana argued that qualitative work is particularly useful in identifying peoples lay beliefs on hypertension and what factors shape those beliefs (Nyaaba et al., 2018). Importantly, beliefs on diet and body weight and sociocultural perception of fatness can be explored only using qualitative methods. Qualitative studies should be conducted in The Gambia to explore these issues: findings from other areas in SSA have indicated that women tended to frame fatness as a symbol of wealth, as has been found in Senegal (Holdsworth et al., 2004, Macia et al., 2017) and Zambia, (Tateyama et al., 2019) for example. Genetic studies could also be conducted to investigate if the patterns in hypertension and obesity observed in The Gambia is associated with genetics or epigenetics factors. To date there have only been a few small-scale genetic studies of hypertension in Africa as a whole (Yako et al., 2018), reflecting the paucity of genetic data.

The high level of missing data for the income variable may be associated with the sensitive nature of personal and household monetary income which the WHO STEP questionnaire collects. The collection of information on ownership of assets, housing and access to services has been found to be more reliable in low income settings (Falkingham and Namazie, 2002, Howe et al., 2008). These include durable assets (e.g. radio, television, refrigerator, car), housing characteristics (e.g. material of dwelling floor and roof, toilet facilities), and access to basic services (e.g. electricity supply, source of drinking water). Future research should apply such methods as my findings suggests quantifying household income is not a reliable method of assessing socio economic status in The Gambia.

The studies reported in the systematic review and the survey on which the data of my analysis was based were cross-sectional. Because of the paucity of data in SSA, it will be difficult to know the trend of the burden overtime. The survey on which my analysis was based was conducted in 2010 and since then no health examination survey has been conducted in The Gambia. It is therefore important to initiate longitudinal studies and/or repeat cross sectional surveys to monitor and understand trends and/or patterns of NCDs and their risk factors overtime. The WHO Study on global AGEing and adult health (SAGE), which is a longitudinal study collecting data on adults aged 50 years and older, plus a smaller comparison sample of adults aged 18–49 years, currently includes only two countries in SSA: Ghana and South Africa (Kowal et al., 2012). It is crucial to include other countries in SSA to increase knowledge of NCDs and their risk factors.

My systematic review excluded studies conducted in Northern Africa to focus on countries in SSA and therefore the findings are not generalizable to the entire African region. Evidence has shown that the burden of obesity and diabetes in North Africa far exceeds the global average (NCD Risk Factor Collaboration –Africa Working Group, 2017). Therefore the burden of obesity and diabetes is currently under estimated in my systematic review due to the exclusion of North African countries. The different regions in Africa are in different stages of urbanisation and epidemiological transition. Future reviews should include all countries and also compare the five regions in Africa (West, East, South, North and Central).

The survey in The Gambia and most of the surveys based on the WHO STEP method were limited to adults 25-64 years. The possible higher levels of hypertension among older age groups and the emerging burden among the younger age cohort are therefore missed. Future surveys should include younger participants 15 years and above and older participants (above 64 years). Fewer participants agreed to have their waist circumference measured compared with those who agreed to have their weight and height measured. Those who agreed to have had their blood pressure measured was also slightly more than those who agreed to have their weight and height measured. These anthropometric measurements might be culturally sensitive in Gambian settings and hence this also needs further research.

My unique findings of higher prevalence of hypertension in rural areas, even with a higher prevalence of obesity in urban areas in The Gambia, generates new hypotheses on diet and sociocultural practices that should be explored. Dietary, biochemical and genetic research should also be conducted on the lean population in rural areas with a high prevalence of hypertension. As highlighted in sections 5.4.4 and 9.3.2, salt intake is a known risk factor of hypertension but information on salt intake was not collected in The Gambia and most of the STEP surveys conducted in SSA: future studies should explore the level of salt consumption in the population. This should not be limited only to self-report information on salt consumption but 24 hour urine sample analysis should be done for a more reliable estimate of individual and population salt consumption. The high proportion of participants who never had their blood glucose tested has important implications for public health research and policy. Future studies should also include biochemical analysis of blood glucose (or glycated haemoglobin, which is more expensive but is affected less by recent eating and by technical problems) and cholesterol (STEP three) as well as beliefs about body size and weight measurement. Future studies on clustering of CVD risk factors in SSA as well as The Gambia should not only be restricted to the five risk factors but should include all the seven Life Simple scores recommended by the American Heart Association.

Analysis of the economic consequences of NCDs for government, the healthcare system, and families should be conducted.

Most people in LMICs use solid fuels including charcoal, wood , dung and kerosene which causes indoor air pollution (WHO, 2018b). More than 95% of households in The Gambia rely on such polluting fuels for cooking (WHO, 2018c). There is strong evidence on the association between indoor air pollution as a consequence of using solid fuels including biomass for cooking and heating and CVDs (Uzoigwe et al., 2013, Fatmi and Coggon, 2016) . However this has not been adequately explored in SSA. It is crucial to investigate the association between indoor air pollution and hypertension in an African setting given the high burden of hypertension even among the lean and young populations.

9.6 Conclusions

My findings from the systematic review and the analyses from the various chapters of this thesis support my hypothesis that the burden of NCDs are increasing in countries in SSA including The Gambia. This is a contribution to the growing body of evidence demonstrating the epidemiological and nutritional transition in SSA. This transition adds to the already existing burden of infectious diseases, giving such countries the challenge to tackle the double burden of infectious and non-communicable diseases. The prevention and control of NCDs should therefore be included in the development agenda of The Gambia and other countries in SSA. This is crucial as it can contribute to poverty alleviation and to the attainment of the UN Sustainable Development Goals.

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11. Appendices

11.1 Appendix I: Published manuscript on hypertension (based on the second objective of my thesis)

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Blood Pressure Patterns

Burden of hypertension in The Gambia: evidence from a national World Health Organization (WHO) STEP survey

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Abstract

Background: Non-communicable diseases are increasing in sub-Saharan Africa and are estimated to account for 32% of adult deaths in The Gambia. Worldwide, prevalence of hypertension is highest in the African region (46%) and a very high proportion is undiagnosed. This study examined diagnosed and undiagnosed hypertension in The Gambian adult population.

Methods: Data were collected in 2010 from a nationally representative random sample of 4111 adults aged 25–64 years, using the World Health Organization STEPwise cross-sectional survey methods. Analyses were restricted to non-pregnant participants with three valid blood pressure measurements ($n = 3573$). We conducted gender-stratified univariate and multivariate regression analyses to identify the strongest sociodemographic, behavioural and biological risk factors associated with hypertension.

Results: Almost one-third of adults were hypertensive; a high proportion were undiagnosed, particularly among men (86% of men vs 71% of women with hypertension, $P < 0.001$). Rural and semi-urban residents and overweight/obese persons had increased odds of hypertension. Compared with urban residents, participants from one of the most rural regions had higher odds of hypertension among both men [adjusted odds ratio (AOR) 3.2; 95% CI: 1.6–6.4] and women (AOR 2.5; 95% CI: 1.3–4.6). Other factors strongly associated with hypertension in multivariate analyses were age, smoking, physical inactivity and ethnicity.

Conclusions: Rural and semi-urban residence were strongly associated with hypertension, contrary to what has been found in similar studies in sub-Saharan Africa. Intervention to reduce the burden of hypertension in The Gambia could be further targeted towards rural areas.

Key words: Hypertension, Gambia, sub-Saharan Africa, WHO STEP survey, health examination survey

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11.2 Appendix II STROBE Statement

Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	This Thesis
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes
Objectives	3	State specific objectives, including any prespecified hypotheses	Yes
Methods			
Study design	4	Present key elements of study design early in the paper	Yes
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Yes
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	Yes
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes
Bias	9	Describe any efforts to address potential sources of bias	Yes
Study size	10	Explain how the study size was arrived at	Not known; secondary data analysis
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable,	Yes

		describe which groupings were chosen and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Yes
		(*b*) Describe any methods used to examine subgroups and interactions	Yes
		(*c*) Explain how missing data were addressed	Yes
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Yes
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Yes
		(b) Give reasons for non-participation at each stage	Yes
		(c) Consider use of a flow diagram	Yes
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes
		(b) Indicate number of participants with missing data for each variable of interest	Yes
Outcome data	15*	Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Yes
		(*b*) Report category boundaries when continuous variables were categorized	Yes

		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Yes
Discussion			
Key results	18	Summarise key results with reference to study objectives	Yes
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Yes
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Yes

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

11.3 Appendix III: Supplementary tables summarising major findings on cardiovascular disease risk factors (objectives 4 and 5 of the systematic review)

Supplementary Table S1: Search Strategy in PubMed

SEARCH	KEY WORDS
Search 1	"WHO STEP" OR "STEPS" OR "STEPwise" OR "WHO STEPS" OR "STEP SURVEY" OR "world health organisation STEP"
Search 2:	(("non-communicable disease" OR "ncd" OR "NCDS" OR "Non-communicable disease" OR "cvd" OR "CVD" OR "cardiovascular disease"))
Search 3:	(("Hypertension"[Mesh] OR Hypertension OR "CVD" OR "blood pressure" OR OR "high blood pressure" OR "raised blood pressure"))
Search 4:	((("blood glucose" OR "impaired fasting glucose" OR "raised blood glucose" OR "diabetes" OR "pre-diabetes" OR "blood glucose"))
Search 5:	"smoking" OR "tobacco smoking" OR "tobacco use"
Search 6:	"exercise" OR "physical activity" OR "physical inactivity"
Search 6:	"overweight" OR "obesity" OR "abdominal obesity" OR "BMI"OR "raised BMI" OR "waist hip ratio" OR "waist circumference"
Search 8:	"low fruit and vegetable intake" OR "fruit and vegetable intake" OR "fruit intake" OR "vegetable intake"
Search 9:	"Africa" OR "sub-Saharan Africa" OR "Sub Saharan Africa" OR "Africa South of the Sahara" OR "subsaharan Africa"
Search 10:	Angola OR Benin OR Botswana OR "Burkina Faso" OR Burundi OR OR Cameroon OR Cameroons OR "Cape Verde" OR "Central African Republic" OR Chad OR Comoros OR "Comoros Islands" OR Comores OR Congo "Congo Brazaville "OR "Congo Kinshasha" OR Zaire OR "Cote d'Ivoire" OR "Ivory Coast" OR "Democratic Republic of the Congo" OR Djibouti OR Somaliland OR Eritrea OR Ethiopia OR Gabon OR "Gabonese Republic" OR Gambia OR "The Gambia" OR Ghana OR "Gold Coast" OR Guinea OR Kenya OR Lesotho OR Basutoland OR Liberia OR Madagascar OR "Malagasy Republic" OR Malawi OR Mali OR Mauritania OR Mauritius OR Mozambique OR Namibia OR Niger OR Nigeria OR Rwanda OR "Sao Tome" OR Seychelles OR " The Republic of Seychelles" OR Senegal OR "Sierra Leone" OR Somalia OR "South Africa" "Republic of South Africa" OR Sudan OR "South Sudan" OR Swaziland OR Tanzania OR Togo OR "Togolese Republic" OR Uganda OR Zambia OR Zimbabwe OR Rhodesia
Search 11	search ((((((((((("WHO STEP" OR "STEPS" OR "STEPwise" OR "WHO STEPS" OR "STEP SURVEY" OR "world health organisation STEP"))) AND ("non communicable disease" OR "ncd" OR "NCDS" OR "Non-communicable disease" OR "cvd" OR "CVD" OR "cardiovascular disease")) OR ("Hypertension"[Mesh] OR Hypertension OR "CVD" OR "blood pressure" OR "high blood pressure" OR "raised blood pressure")) OR ("blood glucose" OR "impaired fasting glucose" OR "raised blood glucose" OR "diabetes" OR "pre-diabetes" OR "blood glucose")) OR ("smoking" OR "tobacco smoking" OR "tobacco use")) OR ("exercise" OR "physical activity" OR "physical inactivity")) OR ("overweight" OR "obesity" OR "abdominal obesity" OR "BMI" OR "raised BMI" OR "waist hip ratio" OR "waist circumference")) OR ("low fruit and vegetable intake" OR "fruit and vegetable intake" OR "fruit intake" OR "vegetable intake"))) AND ((("Africa" OR "sub-Saharan Africa" OR "Sub Saharan Africa" OR "Africa South of the Sahara" OR "sub-saharan Africa")) OR (Angola OR Benin OR Botswana OR "Burkina Faso" OR Burundi OR Cameroon OR Cameroons OR "Cape Verde" OR "Central African Republic" OR Chad OR Comoros OR "Comoros Islands" OR Comores OR Congo AND "Congo Brazaville "

	OR "Congo Kinshasha" OR Zaire OR "Cote d'Ivoire" OR "Ivory Coast" OR "Democratic Republic of the Congo" OR Djibouti OR Somaliland OR Eritrea OR Ethiopia OR Gabon OR "Gabonese Republic" OR Gambia OR "The Gambia" OR Ghana OR "Gold Coast" OR Guinea OR Kenya OR Lesotho OR Basutoland OR Liberia OR Madagascar OR "Malagasy Republic" OR Malawi OR Mali OR Mauritania OR Mauritius OR Mozambique OR Namibia OR Niger OR Nigeria OR Rwanda OR "Sao Tome" OR Seychelles OR "The Republic of Seychelles" OR Senegal OR "Sierra Leone" OR Somalia OR "South Africa" AND "Republic of South Africa" OR Sudan OR "South Sudan" OR Swaziland OR Tanzania OR Togo OR "Togolese Republic" OR Uganda OR Zambia OR Zimbabwe OR Rhodesia)) AND (("2002/01/01"[PDat] : "2018/08/31"[PDat]))

Supplementary Table 2: Tobacco smoking (reviewed articles)

Author	Country	Survey Year	% Current smoking (past 30 days)			% Current daily smoking		
			M	F	All	M	F	All
Damasceno et al 2013	Mozambique	2005			28.7			
Mondo etal 2013	Uganda	12/2011-2/2012	22.5	15.5	24.0			9.6
Mulenga et al 2013	Zambia(kaoma)*	n/a	39.6	10.8	22.4			
	Kassama		40.4	7.2	21.5			
Babaniyi et al 2014b	Zambia*	n/a	39.6	10.8	22.4			
	Zambia		40.4	7.2	21.5			
Bushara etal 2015	Sudan	2013			20.7			
Gama et al 2013	Mozambique	2005			18.3			
Kengne et al 2007	Cameroon	2004			16.0	10.0	1.5	5.0
Msyamboza et al 2011	Malawi	2009	25.9	2.9	14.1			
Maimela E et al 2016	South Africa	n/a	29.2	4.5	13.7			
Okpechi etal 2013	Nigeria	08/2011-03/2012	26.8	1.0	13.3			
Chukwuonye et al 2015	Nigeria	n/a			13.2(U) 13.5(R)			
Ayah et al 2013	Kenya	2010	22.0	3.8	13.1	89.2	57.9	84.8
Joshi et al 2014	Kenya	2010	22.0	3.8	13.1			
Ezeala-Adikaibe et al 2016	Nigeria	2013	28.5	4.4	13.0			
Msamboza eta al 2014	Malawi	2009			10.9			
Sabir et al 2013	Nigeria	n/a	18.1	0.0	9.7			
Zyaambo et al 2013	Zambia	2011	18.1	1.8	8.7			
Olack et al 2015	Kenya	2013	17.8	1.8	8.5			
Mufunda et al 2007	Eriteria	2004	15.0	0.6	8.1			7.2
Minicuci et al 2014	Ghana	2007/08	13.0	2.8	8.1			
Kufe et al 2015	Cameroon	2007			7.6			
Siziya et al 2011	Zambia	n/a	17.5	1.5	6.8			
Anteneh et al 2015	Ethiopia	2014			6.0			
Mayega et al 2013	Uganda	2012			5.9			
Pessinaba et 2013	Senegal	2010			5.8			
Awoke et al 2012	Ethiopia	2012			2.8			
Padrao et al 2013	Mozambique	2005	40.6**	17.5		33.6	9.1	
van de Vijver et al 2012	Kenya	2008-2009	19.9	0.9				
Tesfaye et al 2009	Ethiopia	n/a	13.5	< 1		11.0		
Tesfaye et al 2008	Ethiopia	2006	13.2	0.3		11.0		
Wu F et al 2015	South Africa	2007- 2010						20.0
	Ghana							7.7
Bovet et al 2006	Seychelles	2004				30.8	3.9	17.4
Bovet et al 2009	Seychelles	2004						17.0
Keetile Mpho et al 2015	Botswana	2007				33.1	8.8	16.6
Pires et al 2012	Angola	2011				18.3	4.3	11.8
Pires etal 2013	Angola	2011				18.3	4.3	11.1
Baragou etal 2012	Togo	10/2009-01/2010				20.2	3.0	9.3
Asiki et 2015	Uganda	2011				16.1	2.0	8.2
Houehanou et al 2015	Benin	2008				13.6	1.2	7.6
Usman et al 2006	Eriteria	2004						7.2
Musinguzi et al 2013	Uganda	2012				15.7	2.4	7.1
Murphy et al 2013	Uganda	2011				13.1	1.3	6.5
Murphy et al 2013	Uganda	2011				13.1	1.3	6.5
Doupa et al 2014	Senegal	2012				9.8	0.6	4.2

Oladapo et al 2010	Nigeria	12/2000-11/2005				3.8	0.0	1.7
Abebe et al 2014	Ethiopia	2012						1.1
Tesfaye et al 2008	Ethiopia	2006	13.2	0.3		11.0		
Nawi et al 2006	Ethiopia	2002				7.7	0.0	

*Data was stratified by district

** Include use of smokeless tobacco

U= urban: R= rural

Supplementary Table 3: Tobacco smoking (fact sheet and reports)

Country	Survey Date	% CS			%CDS			Mean age started smoking			Mean no of CCD		
		M	F	All	M	F	All	M	F	All	M	F	All
Benin	2007	9.7	0.3	3.8	6.5	0.2	2.6	23.7		23.7	5.0		4.9
Benin	2008	15.8	1.7	8.8	14.0	1.2	7.7	23.0		23.4	5.4		5.2
Botswana	2007	32.8	7.8	19.7	27.6	5.9	16.2	21.8	31.8	23.6	7.2	5.2	7.1
Burkina Faso	2013	24.5	0.1	11.3	20.8	0.1	9.6	20.6	20.6		7.7	7.7	
Cameroon	2003	12.7	1.5	6.3	9.7	2.0	4.7	21.3	24.7	21.8	9.0	6.8	8.7
Ivory Coast	2005	23.7	7.3	14.4	18.6	3.7	10.2	20.1	18.4	19.6	6.3	3.4	5.7
Congo(Brazzaville)	2004	20.4	1.7	11.1	15.5	0.9	8.2	20.4		20.8	3.5	3.4	
Cape Verde	2007	15.9	4.0	9.9	13.0	3.2	8.1	19.1	21.0	19.5	10.4	5.6	9.5
Central African Republic	2010	22.8	5.5	14.1	18.3	3.9	11.0	21.3	25.9	22.1	7.0	4.4	6.6
Chad (Njamena)	2008	20.2	1.2	11.2	17.5	0.9	9.7	21.7	25.0	21.8	11.4	10.4	11.4
Comoros	2011	23.8	2.0	12.9	20.6	1.2	10.9	18.6		18.5	9.0	8.4	9.0
Democratic Republic of Congo	2005	14.1	1.4	6.4	10.2	0.6	4.4	21.6	22.7		7.6		7.4
Eritrea	2004	15.3	0.5	7.8	13.5	0.5	6.9	20.2	20.0		9.3		9.5
Ethiopia	2003				8.0	0.0	3.5	25.8			5.1		
Ethiopia	2006	11.0	0.2	4.6				21.9		21.9	7.8		7.7
Gabon	2009	19.7	4.6	12.1	15.0	2.2	8.6	20.1		20.3	9.8		9.5
Gambia	2010	31.3	1.0	15.6	29.4	0.7	14.5	19.7		19.8	9.9		9.9
Ghana(Accra)	2006				5.5	0.3	2.0	21.7	22.5	21.8	9.0	3.6	8.5
Guinea	2009	23.1	2.0	12.8	21.0	1.4	11.3	18.9	18.3	18.9	10.2	6.8	10.0
Kenya	2015	19.7	0.9	10.1	16.6	0.4	8.3	20.6		20.8	7.2		7.1
Lesotho	2012	48.7	0.7	24.5	40.6	0.5	20.4	20.6		20.7	1.8		1.8
Liberia	2011	17.2	2.8	9.9	13.9	1.3	7.5	21.4		21.3	5.9		5.7
Madagascar	2005	33.0	6.3	19.6	29.9	5.6	17.6	19.2	21.6	19.5	9.3	7.4	9.0
Malawi	2009	25.9	2.9	14.1	22.8	2.4	12.4	21.9	24.6	22.1	3.0	1.5	2.8
Mali	2007	30.6	2.8	14.0	28.2	2.4	12.8	19.5		20.5	10.2		10.2
Mauritania (Nouakchott)	2006	34.2	5.7	18.9	32.7	4.8	17.8	17.6		17.6	2.1		2.1
Mauritius	2004	35.9	5.1	18.0									
Mozambique	2005	36.0	6.4	18.7	32.1	5.7	16.7	24.4	30.4	25.6	6.7		6.4
Niger	2007	8.7	0.2	4.6	7.4	0.1	3.9	21.3		21.2	7.7		7.7
Nigeria(Lagos)	2003												

Country	Survey Date	% CS			%CDS			Mean age started smoking			Mean no of CCD		
		M	F	All	M	F	All	M	F	All	M	F	All
Rwanda	11/2012-03/2013				19.1	7.1	12.8	18.4	19.3	18.6	3.3	0.3	2.6
Sao Tome and Principe	2008	9.7	1.7	5.5	6.5	0.8	3.5	19.4		19.5	8.4		8.0
Seychelles	2004	38.5	5.8	22.2	30.8	17.3	3.9	19.2		19.4	10.5		10.2
Seychelles	2013-2014	28.3	5.1								7.3	6.0	
Sierra Leone	2009	43.1	10.5	25.8	39.5	7.5	22.5	21.1	23.0	21.4	7.6	5.6	7.2
Swaziland	2007	12.9	2.2	7.1	11.1	1.5	5.9						
Swaziland	2014	11.7	1.2	6.0	9.5	0.8	4.8	19.3		19.4	5.0		5.0
Sudan	2005				24.7	2.9	12.0	19.9	25.8	20.8	8.6	6.8	8.4
Tanzania	2012	26.0	2.9	14.1	22.2	2.0	11.8	21.8	22.4	21.9	4.9	6.7	5.1
Togo	12/2010-01/2011	12.4	1.8	6.8	9.1	1.0	4.8	23.4		24.5	5.8		5.3
Uganda	2014	16.8	2.9	9.6	14.5	2.6	8.3	22.2	21.5	22.1	3.0	0.9	2.7
Zambia	2008	17.0	1.3	6.5	12.9	1.1	5.0	21.9	20.8	21.7	8.4	6.8	8.2
Zanzibar	2011	14.6	0.7	7.3	12.7	0.5	6.4	22.0		22.1	5.8		5.5
Zimbabwe	2005	33.4	5.0	11.8									

CS=Current smoking

CDS=Current daily smoking

CCD = cigarettes consumed daily

Supplementary Table 4: Alcohol consumption (fact sheet and reports)

Country	Survey year	% Current drinkers (past 30 days)			% drank ≥4days in the past week			%Binge drinkers	
		M	F	All	M	F	All	M	F
Benin(Cotonou)	2007	51.4	28.0	36.9	19.5	5.4	12.9	9.1	4.9
Benin	2008	60.6	36.9	48.8	42.9	25.1	36.2	33.1	12.9
Botswana	2007	30.3	8.8	18.7	19.5	20.0	19.6	54.1	51.8
Burkina Faso	2013	31.0	24.2	27.3	12.1	5.7	8.6		
Cameroon	2003				18.4	6.5	11.8	9.0	4.4
Ivory Coast	2005	46.5	24.4	34.0	23.7	9.7	18.6	31.6	16.5
Congo(Brazzaville)	2004				10.7	3.8	8.3	6.8	7.1
Cape Verde	2007	64.7	16.1	40.3	26.1	10.8	23.1	44.1	12.0
Central African Republic	2010	40.1	22.9	31.5	36.3	20.3			
Chad (Njamena)	2008	22.6	10.6	17.0	34.1	26.3	31.7	69.4*	65.8*
Comoros	2011	1.4	0.1	0.7				1.0	0.04
Democratic Republic of Congo	2005				7.3	3.6	5.6	26.6	15.4
Eritrea	2004	30.2	22.3	26.2	14.4	6.3	11.2	15.6	3.8
Ethiopia(Butajira)	2003								
Ethiopia(Addis Ababa)	2006	56.9	37.9	45.7	12.5	1.3	7.1	18.2	2.6
Gabon	2009	37.1	24.2	30.6	18.2	12.6	16.0	54.2*	39.9*
Gambia	2010	1.5	0.4	1.0	0.8	0.3			
Ghana(Accra)	2006	46.3	23.1	30.9	40.0	19.7	29.8	7.4	4.3
Guinea	2009	3.9	0.6	2.3				2.0	0.5
Kenya	2015	33.8	5.4	19.3				23.1	2.7
Lesotho	2012	47.3	14.4	30.7				34.5	9.4
Liberia	2011	34.3	14.0	24.0				23.0	9.7
Madagascar	2005	46.4	17.4	31.7	3.8	2.9	3.6	37.4	30.1
Malawi	2009	30.1	4.2	16.9				19.0	2.3
Mali	2007	7.0	0.5	3.1					
Mauritania (Nouakchott)	2006								
Mauritius	2004	58.0	28.0						
Mozambique	2005	60.4	34.4	45.2	7.1	3.2	5.4	44.8	35.1
Niger	2007	0.6	0.0	0.3					
Nigeria(Lagos)	2003								
Rwanda	11/2012-03/2013	52.0	31.4	41.2				30.5	17.0
Sao Tome and Principe	2008	89.0	80.5	84.5	55.9	37.7	46.8	29.9	21.0
Seychelles	2004	92.2	82.4	87.3					
Seychelles	2013-2014	73.0	42.0		28.0	6.0		11.0	1.0
Sierra Leone	2009	24.4	10.9	17.2				14.3	5.2
Swaziland	2007	20.1	4.6	11.8	31.0	27.4		50.5*	
Swaziland	2014	22.1	5.3	13.0				14.9	2.7
Sudan	2005	4.1	0.2	1.8	22.2				
Tanzania	2012	38.3	20.9	29.3				27.4	13.4
Togo	12/2010-01/2011	61.3	46.9	53.7				35.7	21.7
Uganda	2014	40.1	17.9	28.5				26.2	7.9
Zambia(Lusaka)	2008	38.3	12.0	20.8	23.7	20.3	22.4	48.5*	45.3
Zanzibar (Tanzania)	2011	3.1	0.4	1.7				1.7	0.3
Zimbabwe	2005	58.0	13.5	24.5					

*proportion of drinkers who binge drink

Supplementary Table 5: Fruit and vegetable intake (WHO fact sheets and reports)

		MNDFC	MNDVC	<5 servings/d FV (%)		
Country	**Survey year**	**All**	**All**	**M**	**F**	**All**
Benin(Cotonou)	2007	2.9	1.2	93.4	95.6	94.7
Benin	2008	2.9	2.1	76.6	80.5	78.5
Botswana	2007	1.0	0.3	96.9	96.2	96.6
Burkinafaso	2013	1.4	0.6	95.3	94.8	95
Cameroon	2003	2.8				
Ivory Coast	2005	2.3	0.9	83.1	83.8	83.5
Congo(Brazzaville)	2004	2.8				
Cape Verde	2007	3.3	1.4	84.1	88.0	86.1
Central African Republic(Bangui)	2010	3.2	1.4	70.8	61.5	66.1
Chad (Njamena)	2008	3.0	1.3	88.5	80.3	84.8
Comoros	2011	3.5	1.8	82.6	88.7	85.7
Democratic Republic of Congo	2005	2.5	1.0	87.1	88.4	87.9
Eritrea	2004	2.4	0.8	97.6	98.5	98.1
Ethiopia(Butajira)	2003	0.8	1.2	96.0	96.8	96.4
Ethiopia(Addis Ababa)	2006	1.0	1.2	99.2	98.7	98.9
Gabon	2009	2.9	1.0	93.8	93.0	93.4
Gambia	2010	3.3	1.0	92.6	93.3	93.0
Ghana(Accra)	2006		1.3	83.4	87.3	86.0
Guinea (Conaky and Basse)	2009	3.3	1.6	81.2	77.3	79.3
Kenya	2015	2.5	0.8	84.2	83.5	83.9
Lesotho	2012	1.6	0.5	93.2	92.2	92.7
Liberia	2011	2.3	0.7	96.7	95.5	96.1
Madagascar (Antanarivo and Toliara)	2005	2.9	2.1	58.1	65.8	62.0
Malawi	2009	2.0	0.5	98.0	97.1	97.5
Mali	2007	3.4	1.6	80.3	81.6	81.1
Mauritania (Nouakchott)	2006	2.3	0.7	94.4	95.2	94.8
Mozambique	2005	2.7	1.1	95.6	94.5	95.0
Niger	2007	1.6	0.5	94.9	98.0	96.4
Sao Tome and Principe	2008	3.9	1.2	83.4	83.2	83.3
Seychelles	2004	4.5	1.4	83.1	74.5	78.8
Sierra Leone	2009	3.4	1.5	90.9	91.0	90.9
Swaziland	2007	3.3	1.1	89.6	85.6	87.4
Swaziland	2014	3.5	1.0	92.5	91.7	92.1
Tanzania	2012	2.5	0.7	97.3	97.1	97.2
Togo	12/2010-01/2011	2.2	0.9	93.5	96.1	94.9
Uganda	2014	2.9	1.4	88.4	87.3	87.8
Zambia(Lusaka)	2008	3.2	0.7	97.9	96.5	97.0
Zanzibar (Tanzania)	2011	3.9	1.1	97.6	98.1	97.9

MNDFC-mean number of days fruit is consumed in a week

MDNVC- mean number of days fruit is consumed in a week

FV- fruit and vegetables

Supplementary Table 6: Physical activity (WHO fact sheets and reports)

		% with LLPA/sedentary behaviour		
Country	**Survey year**	**M**	**F**	**All**
Benin(Cotonou)	2007	14.0	17.5	16.2
Benin	2008	6.2	10.5	8.3
Botswana	2007	26.7	41.7	34.7
Burkinafaso	2013	15.5	19.7	17.7
Cameroon	2003	33.8	50.6	44.3
Ivory Coast	2005	37.8	45.1	41.9
Cape Verde	2007	12.1	26.7	19.4
Central African Republic(Bangui)	2010	20.4	29.0	24.7
Chad (Njamena)	2008	28.8	42.0	34.9
Comoros	2011	10.3	30.0	20.1
Democratic Republic of Congo	2005	36.3	49.1	44.1
Eritrea	2004	25.7	53.4	40.6
Ethiopia(Butajira)	2003	5.6	22.6	15.2
Ethiopia(Addis Ababa)	2006	17.2	32.1	26.0
Gabon	2009	21.9	43.3	32.6
Gambia	2010	18.3	26.5	22.6
Ghana(Accra)	2006	78.1	89.4	85.7
Guinea (Conaky and Basse)	2009	9.2	19.3	14.2
Kenya	2015	6.3	6.8	6.5
Lesotho	2012	10.4	11.8	11.1
Liberia	2011	29.8	36.6	33.2
Madagascar	2005	18.2	25.9	22.2
Malawi	2009	6.3	12.6	9.5
Mali	2007	48.6	66.2	59.0
Mauritania (Nouakchott)	2006	47.6	53.0	50.7
Mozambique	2005	6.7	6.4	6.5
Niger	2007	25.1	31.5	28.2
Rwanda	11/2012-03/2013	98.8	16.5	13.3
Sao Tome and Principe	2008	10.3	24.1	17.6
Seychelles	2004	22.8	20.1	21.4
Sierra Leone	2009	13.8	18.9	16.4
Swaziland	2007	26.2	38.9	33.1
Swaziland	2014	9.2	20.5	15.3
Sudan	2005	1.1	1.2	1.2
Tanzania	2012	7.2	7.8	7.5
Togo	12/2010-01/2011	10.5	15.3	13.0
Uganda	2014	3.7	4.9	4.3
Zambia(Lusaka)	2008	18.9	16.6	17.2
Zanzibar (Tanzania)	2011	7.4	26.8	17.6

Supplementary Table 7: Overweight and obesity (reviewed articles)

			Mean BMI (kg/m^2)			%Overweight BMI ≥25 to <30kg/m^2)			%Obese(BMI≥30)			Mean waist circum.(cm)			Abdominal obesity		
First Author	**Country**	**Survey date**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**
Pires etal 2013	Angola	2011				14.4	24.3	19.1	3.1	10.3	6.6						40.0
Pires et al 2012	Angola	2011				14.4	24.1	19.1	3.1	10.3	6.6				21.5	55.9	40.0
Houehanou et al 2015	Benin	2008	22.8	24.5	23.7				4.6	14.3	9.4	79.8	83.2	79.8	3.1	29.7	16.1
Keetile Mpho et al 2015	Botswana	2007							6.0	24.1	18.4						
Kamadjeu et al 2006 b	Cameroon	2003	23.4	25.7		21.6	28.6		6.5	19.5		80.0	81.7		7.5	28.1	
Kengne et al 2007	Cameroon	2004				23.7	23.8	23.8	7.5	21.2	11.1				14.0	59.5	
Kufe et al 2015	Cameroon	2007						34.6			28.8				37.8	35.7	36.6
Longo- Mbenza et al 2008	DRC	n/a						13.5			4.8						7.5
Mufunda et al 2006	Eritrea	2004									3.3						
Usman et al 2006	Eritrea	2004			21.0			10.4			3.3			76.2			
Tesfaye et al 2009	Ethiopia	n/a	22.3	24.1		20.2	37.7		2.0	10.8					12.9	64.6	
Abebe et al 2014	Ethiopia	2012						8.8			2.5				10.2	49.1	
Tesfaye et al 2007	Ethiopia	2003&2004	19.4	19.2					2.5	2.2							
Anteneh et al 2015	Ethiopia	2014						15.3			3.0						
Awoke et al 2012	Ethiopia	2012			23.4			25.3			5.6						
Tessema et al 2012	Ethiopia	09/2008-01/2009	18.7	19.3								75.2	73.8				
Nawi et al 2006	Ethiopia	2002	19.4	19.1					2.8	2.3							
Wu et al 2015	Ghana	2007-2010									9.7						78.0
Wu et al 2015	South Africa										45.2						≈70
Minicuci et al 2013	Ghana	2007/08							6.3	13.6	12.1				67.0	89.4	77.6
Ayah et al 2013	Kenya	2010				26.1	32.2	29.1	7.1	26.1	16.3				3.2	24.0	13.3
Joshi et al 2014	Kenya	2010	24.2	27.6			32.2			26.1		81.9	86.6		2.6	41.5	
Olack et al 2015	Kenya	2013	22.0	26.0		17.6	32.5	26.2	6.0	25.9	17.3				19.3	80.3	54.6
van de Vijver et al 2012	Kenya	2008/09				14.6	26.9		2.2	15.3					19.4	82.5	

			Mean BMI (kg/m²)			%Overweight BMI ≥25 to <30kg/m²)			%Obese(BMI≥30)			Mean waist circum.(cm)			Abdominal obesity		
First Author	**Country**	**Survey date**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**
Oti et al 2013	Kenya	2008/09							20.0	40.0							
Msyamboza et al 2011	Malawi	2009				16.1	28.1	21.9	2.0	7.3	4.6						
Msamboza et al 2014	Malawi	2009							21.9								
Msyamboza et al 2013	Malawi	2009	22.4	23.5	23.0	14.1	20.7	17.3	2.0	7.4	4.6	77.3	78.6	77.9	5.6	52.8	28.8
Gomes et al 2010	Mozambique	2005				9.4	11.8	n/a	2.3	6.8	n/a	76.1	75.2				
Damasceno et al 2009	Mozambique	2005						11.7			5.2				9.9	1.5	
Silva-Maltos et al 2010	Mozambique	2005			23.6							77.0	77.0				
Gama et al 2013	Mozambique	2005									8.2						
Okpechi etal 2013	Nigeria	08/2011-03/2012							30.1	37.0	33.7						
Oladapo et al 2010	Nigeria	12/2000-11/2005	22.8	25.6		1.9	1.8	1.9	1.5	2.4	2.0	87.1	89.5		2.6	8.9	6.2
Sabir et al 2013	Nigeria	n/a	21.9	22.0	21.9	15.7	10.4	13.0	0.5	3.8	2.0	79.3	77.9	78.6	1.0	10.4	5.4
Ezeala-Adikaibe et al 2016	Nigeria	2013	23.8	26.2	25.3	25.5	29.2	27.9	7.2	23.7	17.8						
Chukwuonye et al 2015	Nigeria	n/a	23.4	25.3	24.8	28.8	27.7	28.2	7.8	16.4	12.3						
Oguoma et al 2015	Nigeria	2014	24.5	23.3								87.2	86.7				52.2
Okafor et al 2014a	Nigeria	n/a	24.7	26.1	25.3	29.3	32.8	31.0	13.4	22.0	17.2	85.6	87.3	86.3	26.7	69.4	46.1
Okafor et al 2014b	Nigeria	06/2006-03/2007	25.4	26.9	26.4	34.4	40.1	38.1	15.8	24.2	21.2	90.1	92.1	91.4			
Sabir et al 2011	Nigeria	n/a	23.7	24.4	24.0	25.1	37.9	31.4	5.5	7.9	6.7	85.5	82.9	84.3	6.1	23.7	14.7
Ulasi et al 2010	Nigeria	n/a						31.6			17.3				14.9	66.0	
Doupa et al2014	Senegal	2012							7.0	36.0	25.0				33.1	34.6	34.8
Pessinaba et 2013	Senegal	2010	22.1	27.0	25.5						23.0	81.2	87.4	84.6			33.2
Bovet et al 2006	Seychelles	2004				52.0	68.3	17.4	15.0	35.2	25.1						
Faeh et al 2007 a	Seychelles	2004	25.2	28.3	26.9	51.9	68.3	60.0	15.0	35.1	25.0						
Bovet et al 2009	Seychelles	2004			26.9												
Maimela et al 2016	South Africa	n/a				24.5	28.7	27.1	10.4	31.8		85.5	87.6		7.8	49.8	34.6
Bushara et al 2015	Sudan	2013						29.8	18.2								

			Mean BMI (kg/m^2)			%Overweight BMI ≥25 to <30kg/m^2)			%Obese(BMI≥30)			Mean waist circum.(cm)			Abdominal obesity		
First Author	**Country**	**Survey date**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**
Dewhurst et al 2013	Tanzania	11/2000-7/2010	20.9	22.2													
Baragou et al 2012	Togo	10/2009-01/2010							16.7	32.2	25.2						
Mondo etal 2013	Uganda	2011				14.7	16.7	15.6	4.9	9.0	6.7						
Murphy et al 2013	Uganda	2011				5.2	16.9	11.8							1.5	30.0	17.7
Asiki et 2015	Uganda	2011				4.7	14.0	9.8	0.5	4.1	2.5				3.6	71.5	40.7
Guwatudde et al 2015	Uganda	2014						16.0			6.4						
Musinguzi et al 2013	Uganda	2012				6.4	17.4	13.5	1.8	8.6	6.2						
Musinguzi et al 2015	Uganda	2012						19.2									
Mayega et al 2013	Uganda	2012						12.6			5.3						
Mayega et al 2012	Uganda	2012			22.0	7.5	16.9	12.3	2.2	8.2	5.3				6.0	47.0	27.0
Mulega et al 2013*	Zambia	n/a				5.1	9.1	7.5	1.4	2.9	2.3				1.1	2.4	1.9
	Zambia	n/a				3.0	11.3	7.7	0.4	4.3	2.6				0.2	0.7	0.4
Babaniyi et al 2014b*	Zambia	n/a				5.1	9.1	7.5	1.4	2.9	2.3						
	Zambia	n/a				3.0	11.3	7.7	0.4	4.3	2.6						
Rudatsikira et al 2012	Zambia	2007							5.1	18.6	14.2						

Supplementary Table 8: Overweight and obesity (WHO fact sheets and reports)

		Mean BMI (kg/m^2)			%Overweight (BMI ≥25 to <30kg/m^2)			%Obese (BMI≥30kg/m^2)			Mean WC (cm)	
Country	**Survey date**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**
Benin(Cotonou)	2007	23.8	27.3	25.9	33.4	58.7	48.9	7.4	30.6	21.6	88.3	84.0
Benin	2008	22.8	24.5	23.6	21.7	38.1	29.8	4.4	14.4	9.4	79.8	83.2
Botswana	2007	22.2	26.3	24.3	22.1	53.4	38.6	5.6	24.6	15.6	82.5	88.4
Burkinafaso	2013	21.8	21.8	21.8	13.7	13.2	13.4	2.9	6.0	4.5	78.4	78.5
Cameroon	2003	23.7	26.0	25.1	31.4	50.5	42.8	7.6	21.4	15.9	81.4	82.7
Ivory Coast	2005	23.1	24.3	23.8	23.7	36.0	30.5	5.1	11.2	8.5	79.7	81.5
Congo (Brazzaville)	2004	22.0	24.6	23.1	18.0	37.1	27.3	2.5	15.0	8.6	81.6	85.3
Cape Verde	2007	23.6	25.0	24.3	31.3	42.6	36.9	6.5	14.6	10.5	83.5	84.6
Central African Republic	2010	21.5	23.1	22.3	13.8	28.0	20.7	3.0	11.6	7.2	77.4	81.4
Chad (Njamena)	2008	23.4	25.6	24.3	29.9	43.7	36.3	8.4	19.9	13.7	90.8	97.7
Comoros	2011	23.5	26.2	24.8	27.6	52.4	39.4	5.5	22.4	13.5	82.3	88.4
Democratic Republic of Congo	2005	20.8	22.8	22.0	11.6	24.1	19.1	2.8	7.9	5.8	76.3	78.3
Eritrea	2004	21.0	21.7	21.3	11.2	17.9	14.5	2.0	4.9	3.4	79.1	75.2
Ethiopia(Butajira)	2003	19.4	18.3	19.3	2.5	2.4	2.4	0.4	0.4	0.4	80.0	80.1
Ethiopia(Addis Ababa)	2006	22.3	24.1	23.3	20.6	37.6	30.6	2.0	10.6	7.1	86.9	87.9
Gabon	2009	23.8	26.3	25.0	32.8	51.0	41.5	7.9	24.5	15.9	71.5	74.3
Gambia	2010	23.6	25.1	24.4	45.3	33.7	39.5	7.9	16.5	12.1	72.1	76.1
Ghana(Accra)	2006	25.1	28.4	27.3	45.4	67.9	60.2	11.6	34.9	26.9	86.4	94.3
Guinea	2009	21.5	23.0	22.2	11.4	25.8	18.2	1.8	8.8	5.1	78.7	81.8
Kenya	2015	22.2	24.4	23.3	13.2	24.9	19	4.3	13.7	8.9	78.6	79.1
Lesotho	2012	23.2	27.7	25.5	24.8	58.2	41.5	7.9	31.9	19.9	79.9	86.5
Liberia	2011	25.4	27.3	26.4	43.0	57.0	49.9	15.4	28.7	22.0	73.3	80.4
Madagascar	2005	9.4	21.6	21.5	9.4	15.4	12.3	1.5	3.1	2.2	76.8	76.5
Malawi	2009	22.4	23.5	23.0	16.1	28.1	21.9	2.0	7.3	4.6	77.3	78.6
Mali	2007	22.6	25.4	24.2	20.7	44.4	34.6	5.2	19.2	13.4	82.1	87.6
Mauritania	2006	23.6	27.2	25.5	31.8	59.4	46.6	8.6	31.5	20.9	81.9	89.6
Mozambique	2005	21.7	23.5	22.7	13.5	27.1	21.2	3.2	10.8	7.5	76.8	76.8
Niger	2007	21.2	22.1	21.6	9.1	16.9	12.7	1.7	4.1	3.2	80.4	82.5
Sao Tome and Principe	2008	23.8	25.3	24.5	28.0	41.6	35	6.6	16.5	11.7	80.7	82.4

Seychelles	2004	25.6	28.3	26.9	52.0	68.3	60.1	15.0	35.2	25.1	89.1	90.3
Sierra Leone	2009	22.4	23.7	23.1	16.2	28.7	22.4	4.8	10.8	7.8	76.6	81.7
Swaziland	2007	24.8	28.4	26.7	38.2	65.4	52.9	13.6	33.5	24.3	81.2	82.4
Swaziland	2014	23.5	27.6	25.7	26.0	59.9	43.8	8.8	30.9	20.5	79.4	86.6
Sudan	2005	24.1	27.4	25.4	41.4	62.5	53.9	11.7	30.7	22.9	90.7	92.6
Tanzania	2012	21.6	24.3	22.9	15.1	37.1	26	2.5	15.0	8.7	80.6	84.9
Togo	12/2010-01/2011	22.0	23.5	22.8	14.3	28.5	21.5	2.3	9.8	6.2	77.7	80.7
Uganda	2014	21.7	23.4	22.6	11.3	27.1	19.1	1.8	7.5	4.6	77.1	80.3
Zambia(Lusaka)	2008	22.4	25.6	24.6	20.9	49.0	39.6	5.2	19.0	14.4	82.4	85.8
Zanzibar (Tanzania)	2011	23.4	25.2	24.3	30.5	42.6	36.6	7.7	20.9	14.3	82.0	87.0
Mauritius	2004				28.0	28.3	28.2	5.9	14.9	11.1		
Rwanda	11/2012-03/2013				9.1	19.0	14.8	0.8	4.7	2.8		
Seychelles	2013-2014	26.3	29.1		56.7	72.0		21.6	39.4			
Zimbabwe	2005	21.7	25.1		14.4	23.9		3.9	19.4			

WC=waist circumference

Supplementary Table 9: Fasting blood glucose and diabetes

Country	Survey date	Mean FBG(mmol/L)			Impaired BG*			% with Raised BG/Diabetes**		
		M	F	All	M	F	All	M	F	All
Benin	2008	3.9	3.7	3.8	2.1	1.7	1.9	3.6	2.5	3.0
Benin(Cotonou)	2007	5.0	4.9	4.9	8.2	8.0	8.0	10.9	8.5	9.4
Burkinafaso	2013	4.0	4.0	4.0	3.5	3.2	3.3	5.2	4.7	4.9
Cameroon	2003	4.8	4.9	4.9	7.9	12.6	10.6	15.2	12.9	13.9
Cape Verde	2007	5.5	5.3	5.4	25.6	25.6	25.6	15.1	10.2	12.7
Central African Republic	2010	5.4	5.5	≈5.5	18.2	21.0	19.6	21.7	20.3	21.0
Chad (Njamena)	2008			5.5						
Comoros	2011	71.0	69.5	70.3	2.6	1.3	1.9	5.4	4.3	4.8
Congo(Brazzaville)	2004	4.6	4.4	4.5	5.0	2.6	3.6	20.0	21.4	20.8
Ghana(Accra)	2006	3.9	3.3	3.5	2.2	1.4	1.7	4.8	4.4	4.5
Guinea	2009	73.5	73.7	73.5	1.9	1.1	1.5	3.4	3.6	3.5
Kenya	2015	4.5	4.7	4.6	3.0	3.2	3.1	1.5	2.3	1.9
Lesotho	2012	4.3	4.6	4.4	2.9	5.0	4.0	6.0	6.6	6.3
Liberia	2011	5.4	5.4	≈5.4	14	15.7	14.9	19.0	19.3	19.2
Malawi	2009	4.3	4.2	≈4.3	5.7	2.7	4.2	6.5	4.7	5.6
Mauritania	2006	5.0	4.9	4.9	4.4	2.8	3.5	5.9	6.4	6.2
Mauritius	2004				7.2	12.3	10.2	20.2	17.7	18.7
Mozambique	2005	3.8	3.6	3.7	3.2	2.8	3.0	4.9	3.1	3.8
Niger	2007	5.4	5.6	5.5	0.6	1.2	0.9	21.8	23.2	22.5
Rwanda	11/2012-03/2013	3.9	3.9	3.9	1.8	1.4	2.2	3.3	2.8	3.1
Sao Tome and Principe	2008	3.6	3.6	3.6				6.2	6.8	6.5
Seychelles	2004	5.8	5.4	5.6	13.4	9.1	11.2	9.7	9.2	9.5
Seychelles	2013-2014	5.9	5.63		43.2	27.7		11.8	10.8	
Sudan	2005	5.5	5.3	5.5				22.2	17.8	19.2
Swaziland	2007	4.2	4.3	3.4	2.2	4.5	3.7	16.2	13.5	14.5
Swaziland	2014	4.9	5.2	5.1	9.5	10.1	9.8	11.3	16.7	14.2
Tanzania	2012	4.8	4.9	4.8	11.3	10.0	9.1	8.0	10.0	9.1
Togo	12/2010-01/2011	4.0	3.9	≈ 3.9	2.4	1.2	1.7	3.5	1.8	2.6
Uganda	2014	3.8	3.9	3.9	2.1	1.9	2.0	1.6	1.1	1.4
Zambia(Lusaka)	2008	4.4	4.4	4.4	3.3	1.7	2.2	4.6	3.8	5.0
Zanzibar (Tanzania)	2011	4.4	4.4	4.4	2.3	2.8	3.3	3.7	3.7	3.8
Zimbabwe	2005	5.3	5.3	5.3	5.3	5.2		9.8	10.2	

≈ approximately equal to (converted from mg/dl to mmol/L)

* plasma venous value ≥6.1mmol/L (110mg/dl) and <7.0 mmol/L (126 mg/dl) or • capillary whole blood value ≥5.6 mmol/L (100mg/dl) and <6.1 mmol/L (110 mg/dl)

** % with raised blood glucose/diabetes defined as plasma venous value ≥7.0 mmol/L or ≥126 mg/dl or capillary whole blood value ≥6.1 mmol/L or ≥110 mg/dl and or currently on medication for raised blood glucose/diabetes

Supplementary Table 10: Cholesterol level

		Mean total cholesterol mmol/L			% with raised total cholesterol*		
Country	**Survey date**	**M**	**F**	**All**	**M**	**F**	**All**
Benin	2008	3.8	3.9	3.8	6.0	9.7	7.9
Burkina Faso	2013	3.1	3.2	3.1	2.4	4.5	3.5
Cape Verde	2007	4.2	4.3	4.2	9.2	16.9	13.0
Comoros	2011	4.5	4.7	≈4.6	20.5	30.2	25.9
Ghana(Accra)	2006				10.7	19.6	16.7
Guinea	2009	4.1	4.3	≈4.2	6.3	13.4	9.8
Kenya	2015	3.4	3.8	3.6	7.3	12.8	10.1
Lesotho	2012	3.2	3.6	3.4	3.0	6.2	4.6
Malawi	2009	4.3	4.4	≈4.4	6.3	11.0	8.7
Mauritania (Nouakchott)	2006	4.3	4.5	4.4	21.7	26.6	24.4
Mauritius	2004				34.6	28.5	
Mozambique	2005	4.4	4.3	4.3	13.7	12.2	12.7
Rwanda	11/2012-03/2013	3.1	3.3	3.2	2.2	3.1	2.6
Sao Tome and Principe	2008	3.9	4.0	4.0	5.5	9.3	7.5
Seychelles	2004	5.4	5.4	5.4	60.1	59.3	59.7
Seychelles	2013-2014	5.0	5.0		35.9	36.6	
Sudan	2005	4.1	4.1	4.1	19.6	19.9	19.8
Swaziland	2007	3.4	3.4	3.4	3.8	7.4	5.8
Swaziland	2014	3.5	3.9	3.7	6.4	14.7	10.9
Tanzania	2012	4.4	4.7	4.6	17.0	33.9	26.0
Togo	12/2010-01/2011	4.3	4.4	≈4.4	11.1	16.3	14.2
Uganda	2014	3.3	3.6	3.4	4.4	8.9	6.7
Zambia(Lusaka)	2008	4.5	4.7	4.6	18.5	26.5	23.8
Zanzibar (Tanzania)	2011	4.6	4.8	4.7	18.2	30.0	24.5
Zimbabwe	2005	4.3	4.3		20.2	21.3	

≈ approximately equal to (converted from mg/dl to mmol/L)

*= Percentage with raised total cholesterol defined as plasma venous value ≥7.0 mmol/L or ≥126 mg/dl capillary whole blood value ≥6.1 mmol/L or ≥110 mg/dl and or currently on medication for high cholesterol

Supplementary Table 11: Combined risk factors

		None of the 5 risk factors			% 25-44 with ≥3 risk factors			% 45-64 with ≥3 risk factors			% 25-64 with ≥3 risk factors		
Country	**Survey date**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**	**M**	**F**	**All**
Benin	2008	11.9	10.1	11.0	9.5	9.5	9.5	16.7	26.4	21.8	12.4	17.5	14.9
Benin	2007	2.1	1.1	1.5	13.9	18.1	16.5	36.3	46.5	42.6	20.9	27.3	24.8
Botswana	2007	1.9	0.5	1.2	18.6	32.0	25.7	35.2	61.8	50.4	24.1	43.2	34.5
Burkina Faso	2013	2.2	3.1	2.7	13.7	8.2	10.7	19.7	15.2	17.6			
Cape Verde	2007	5.6	4.4	5.0	19.3	19.8	19.6	37.5	45.2	41.8	23.1	26.6	24.8
Central African Republic	2010	11.7	12.8	12.2	13.1	11.3	12.3	28.2	30.4	29.4	17.3	18.1	17.7
Chad (Njamena)	2008	0.5	0.0	0.3	22.7	22.9	22.8	29.2	50.0	37.3	25.0	31.7	27.8
Comoros	2011	8.1	3.4	5.9	13.3	24.3	18.5	25.7	39.4	32.3	17.3	29.3	23.0
Democratic Republic of Congo	2005	6.7	4.5	5.3	16.4	21.9	19.9	31.1	36.4	34.0	21.4	25.8	24.1
Eritrea	2004	1.4	0.3	0.8	17.6	10.0	13.5	20.1	31.8	26.1	18.8	19.8	19.4
Ethiopia	2006	0.3	0.3	0.3	14.8	19.2	17.2	32.1	35.4	34.2			
Ethiopia(Butajira)	2003	3.4	2.3	2.8	2.1	2.0	2.1	5.0	5.5	5.3			
Gabon	2009	1.4	1.0	1.2	28.4	31.7	30.0	53.5	46.4	50.0	38.8	34.1	36.4
Gambia	2010	2.7	1.6	2.1	22.8	18.4	20.7	37.6	42.0	39.8	26.8	24.8	25.8
Ghana(Accra)	2006	1.4	0.3	0.7							49.4	59.2	56.0
Guinea	2009	7.3	8.7	7.9	17.8	12.7	15.4	30.1	40.6	35.2	21.6	21.6	21.6
Ivory Coast	2005	5.3	4.6	4.9	23.4	25.4	24.5	45.7	42.9	44.3	30.2	30.0	30.1
Kenya	2015	3.5	2.4	3.0	10.9	9.8	10.4	25.3	26.5	25.9	14.0	13.6	13.8
Lesotho	2012	2.5	2.0	2.2	21.7	22.4	22.1	40.6	42.2	41.6	25.2	28.2	26.7
Liberia	2011	1.0	1.3	1.1	26.7	31.0	28.7	40.7	45.5	43.2	31.0	36.1	33.5
Madagascar	2005	14.2	11.4	12.8	11.7	12.5	12.1	17.8	17.5	17.7	13.6	14.0	13.8
Malawi	2009	0.3	1.6	1.0	15.3	10.7	13.0	22.6	24.7	23.7	17.6	15.5	16.5
Mali	2007	5.0	3.4	4.0	25.6	35.7	31.4	42.3	52.7	48.9	31.0	42.2	37.7
Mozambique	2005	1.5	3.1	2.4	17.0	11.7	14.0	26.7	30.2	28.6	20.5	17.9	19.0
Niger	2007	1.5	0.3	0.9	17.5	17.4	17.5	21.8	34.8	26.8	19.5	24.0	21.4
Rwanda	11/2012-03/2013	0.4	0.3	0.4	11.3	13.9	12.6	24.6	26.6	25.7	15.0	17.7	16.4
Sao Tome and Principe	2008	6.7	6.1	6.4	13.3	17.7	15.6	27.7	43.6	36.1	17.7	26.1	22.1
Seychelles	2004	3.9	4.4	4.2	38.0	21.8	29.9	56.5	47.8	52.1	45.4	32.2	38.8
Sierra Leone	2009	1.1	1.7	1.4	22.7	27.2	18.6	39.9	33.6	37.2	31.5	27.0	22.6
Swaziland	2007	1.8	2.0	1.9	23.7	35.8	30.4	41.1	53.2	47.8	28.8	40.9	35.5
Swaziland	2014	3.6	2.1	2.8	8.2	20.8	14.6	36.7	53.2	45.6	13.2	27.1	20.3
Tanzania	2012	0.6	1.0	0.8	9.9	14.4	12.2	27.4	28.6	28.0	14.9	18.2	16.6
Togo	12/2010-01/2011	2.6	2.2	2.4	11.9	14.1	13.1	21.5	25.6	23.7	14.5	17.6	16.1
Uganda	2014	6.0	7.3	6.6	5.8	7.4	6.6	18.6	23.0	20.9	8.5	11.0	9.8
Zambia (Lusaka)	2008	0.9	1.0	1.0	15.9	16.8	16.6	47.4	46.6	46.8	23.4	23.8	23.7
Zanzibar	2011	0.8	0.5	0.6	15.3	22.1	18.9	30.5	47.5	38.1	20.1	28.4	24.1

M=Male, F= Female

BMI=Body mass index

FBG=fasting blood glucose

WHR= waist to hip ratio

11.4 Appendix IV: Supplementary tables on the other chapters of my thesis

Supplementary Table 12: Characteristics of study participants included in Chapter 5 by selected demographic, behavioural and biological risk factors (unweighted & unadjusted for complex survey design)-The Gambia, 2010

Variables	Men 1633		Women 1940		Total 3573	
	N	%	N	%	N	%
Age Group						
25-34	537	32.9	1030	53.1	1567	43.9
35-44	481	29.2	485	25.0	966	27.0
45-54	346	21.2	278	14.33	624	17.5
55-64	269	16.5	147	7.6	416	11.6
	P<0.001					
Mean age	41.0±11.2		36.1±10.1		38.3±10.9	
Marital status						
Never married	250	15.3	124	6.4	374	10.5
Married	1196	73.2	1430	73.7	2626	73.5
Separated	27	1.7	41	2.1	68	1.9
Divorced	18	1.1	45	2.3	63	1.8
Widowed	4	0.2	94	4.9	98	2.7
Cohabiting	135	8.3	202	10.4	337	9.4
Refused	3	0.2	4	0.2	7	0.2
	P<0.001					
Ethnicity						
Mandinka	692	42.5	811	41.8	1503	42.1
Wollof	251	15.4	293	15.1	544	15.2
Fula	344	21.1	377	19.4	721	20.2
Jola	186	11.4	257	13.3	443	12.4
Sarahule	65	4.0	76	3.9	141	4.0
Serer	51	3.2	56	2.9	107	3.0
Manjago	25	1.5	44	2.3	69	1.9
Aku	16	1.0	25	1.3	41	1.2
Refused	3	0.2	1	0.1	4	0.1
	P=0.380					
Education						
≤6 Years	938	62.3	1320	76.2	2258	69.7
7-12 Years	376	25.0	353	20.4	729	22.5
>12 Years	191	12.7	60	3.5	251	7.8
	P<0.001					
Employment						
Employed[&]	328	20.1	91	4.7	419	11.8
Self employed	1055	64.7	288	14.9	1343	37.65
Homemaker/housewife	37	2.3	1404	72.5	1441	40.4
Others [d]	210	12.9	154	8.0	364	10.2
	P<0.001					
Residence (LGA[)]						
Banjul	84	5.1	95	4.9	179	5.0
KMC	367	22.5	454	23.4	821	23.0

Variables	Men 1633		Women 1940		Total 3573	
WCR	503	30.8	564	29.1	1067	30.0
URR	168	10.3	157	8.1	325	9.1
NBR	254	15.6	356	18.4	610	17.1
CRRN	36	2.2	49	2.5	85	2.4
CRRS	83	5.1	108	5.6	191	5.4
LRR	138	8.5	157	8.1	295	8.3
	P=0.139					
Residence (Rurality)						
Urban	826	50.6	947	48.8	1773	49.6
Semi urban	169	10.4	185	9.5	354	9.9
Rural	638	39.1	808	41.7	1446	40.5
	P=0.271					
Physical activity						
<600METS/week	188	12.0	310	16.7	498	14.6
≥600METS/week	1377	88.0	1546	83.3	2923	85.4
	P<0.001					
Smoking						
Never smokers	922	56.5	1906	98.3	2828	79.2
Current smokers	535	32.8	22	1.1	557	15.6
Ex-smokers	176	10.8	11	0.6	187	5.2
	P<0.001					
Ever consumed alcohol						
Yes	61	3.7	22	1.1	83	2.3
No	1572	96.3	1917	98.9	3489	97.7
	P<0.001					
Servings of fruits and vegetables						
< 5/day	1120	77.9	1336	77.6	2456	77.8
≥5 /day	318	22.1	385	22.4	703	22.2
	P= 0.863					
BP ever measured						
Yes	836	51.2	1322	68.2	2158	60.4
No	797	48.8	616	31.8	1413	39.6
	P<0.001					
History of hypertension						
Yes	118	14.1	196	14.8	314	14.6
No	718	85.9	1126	85.2	1844	85.4
	P=0.648					
Blood glucose ever measured						
Yes	134	8.1	177	9.1	311	8.7
No	1499	1499	1761	90.9	3260	91.3
	P=0.328					
History (reported) diabetes						
Yes	13	9.7	18	10.2	31	10.0
No	121	90.3	159	89.8	280	90.0
	P=0.891					
BMI(Kg/m^2)[b]						
Underweight	162	10.1	160	8.4	322	9.2

Variables	Men 1633		Women 1940		Total 3573	
Normal weight	911	56.9	937	49.3	1848	52.8
Overweight	403	25.2	517	27.2	920	26.3
Obese	124	7.8	286	15.1	410	11.7
	P<0. 001					
Mean BMI (Kg/m^2) ±SD(in cm)	23.5±4.5		24.9±7.6		24.3±6.4	
Mean height (in cm)	167.2±11.7		160.3±9.8		163.5±11.2	
Mean weight (in kg)	65.2±11.4		63.6±17.0		64.3±14.7	
Waist circumference [c]						
Normal	1402	88.6	993	54.1	2395	70.0
High	181	11.4	844	45.9	1025	30.0
	P<0.001					
Mean waist circumference ±SD(in cm)	72.9±15.4		76.2±17.7		74.7±16.8	
Waist-hip ratio						
Normal	1323	83.7	1110	60.4	2433	71.2
High	258	16.3	727	39.6	985	28.8
	P<0.001					
Mean hip circumference ±SD	81.0±13.0		80.4±13.1		80.7±13.1	
Waist-Height Ratio						
Normal (≤0.5)	1273	80.6	1093	59.6	2366	69.3
High (>0.5)	306	19.4	742	40.4	1048	30.7
	P<0.001					

LGA - Local government area; arranged by degree of rurality
[&] Government or non-government employee
[a] KM=Kanifing Municipality; WCR =West Coast Region; URR =Upper River Region ; NBR =North Bank Region; CRRN = Central River Region North, CRRS=Central River Region South; LRR= Lower River Region;
[b]Based on WHO standards
[c]Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men and as ≥80 cm in women)
[d] Others: student/unemployed/retired
NB: The p value indicates the statistical significance of the difference in proportions between men and women, obtained using chi-squared test

Supplementary Table 13: Prevalence of measured hypertension by selected socio- demographic and health factors(The Gambia, 2010) [a, b]

Variable	Men n=1633				Women n=1940				ALL N=3573			
	N	Hypertensive (%)	95% CI	X^2 P value	N	Hypertensive (%)	95% CI	X^2 P value	N	Hypertensive (%)	95% CI	X^2 P value
Gender												
Men									1633	26.0	22.9-29.4	**0.5787**
Women									1940	27.1	24.0-30.5	
25 -34	537	16.9	13.3-21.2	**<0.0001**	1030	14.7	11.4-18.8	**<0.0001**	1567	15.8	13.3-18.7	**<0.0001**
35-44	481	23.8	18.9-29.4		485	30.1	25.7-34.8		966	27.0	23.3-30.9	
45-54	346	40.9	33.8-48.4		278	39.2	32.3-46.6		624	40.1	35.2-45.1	
55-64	269	49.6	41.3-57.9		147	56.6	44.8-67.7		416	53.0	45.6-60.3	
LGA												
Banjul and KM	451	20.7	14.9-28.2	**0.0226**	549	20.4	15.5-26.3	**0.0002**	1000	20.6	15.5-26.3	**<0.0001**
WCR	503	26.6	21.6-32.2		564	27.4	22.4-33.0		1067	26.9	22.4-33.0	
LRR	138	35.5	29.4-42.0		157	41.7	30.0-54.4		295	38.6	30.0-54.4	
NBR	254	32.9	26.9-39.5		356	36.6	33.3-40.1		610	35.0	33.3-40.1	
CRR	119	33.2	26.7-40.3		157	33.9	27.3-41.2		276	33.5	27.3-41.2	
URR	168	21.4	13.8-31.6		157	20.6	13.5-30.2		325	21.1	13.5-30.2	
Marital status												
Never married	250	18.64	13.3-25.5	**0.0062**	124	10.6	5.9-18.2	**<0.0001**	374	16.7	12.4-22.0	**<0.0001**
Married	1196	27.71	24.5-31.2		1430	26.2	22.9-29.8		2626	27.0	24.3-29.7	
Separated/Divorced	45	21.38	12.0-35.1		86	33.3	22.1-46.9		131	29.3	20.8-39.6	
Widowed	4	-	-		94	45.7	33.6-58.4		98	46.7	34.4-59.4	
Cohabiting	135	32.53	24.1-42.3		202	31.8	23.6-41.3		337	32.1	26.6-38.1	
Level of education												
No formal schooling	939	29.5	26.4-32.8	0.0598	1352	30.5	27.5-34.4	**0.0008**	2291	30.3	27.7-33.0	**0.0001**
Lower (primary) and upper basic	253	23.0	17.9-29.0		349	16.6	14.2-26.5		602	21.3	17.4-25.9	
Senior Secondary/ College/ University	440	22.3	16.5-29.5		233	18.8	13.4-24.7		673	21.1	16.7-26.3	
Years spent in school												
≤6 Years	938	29.0	25.7-32.5	0.0629	1320	31.3	27.8-35	**0.0008**	2258	30.3	27.6-33.1	**0.0003**

Variable	Men n=1633				Women n=1940				ALL N=3573			
	N	**Hypertensive (%)**	**95% CI**	**X^2 P value**	**N**	**Hypertensive (%)**	**95% CI**	**X^2 P value**	**N**	**Hypertensive (%)**	**95% CI**	**X^2 P value**
7-12 Years	376	23.3	18.2-29.3		353	17.6	12.1-24.9		729	21.1	16.8-26.0	
>12 Years	191	20.3	13.5-29.5		60	16.7	8.6-29.9		251	19.7	13.8-27.2	
Ethnicity												
Mandinka	692	24.0	24.6-39.5	0.1799	811	29.1	24.8-33.9	0.5966	1503	26.5	22.8-30.5	0.6559
Wollof	251	31.5	19.7-30.7		293	25.3	19.3-32.4		544	28.4	23.6-33.7	
Fula	344	24.8	17.0-31.6		377	27.6	22.3-33.6		721	26.0	22.3-30.3	
Jola	186	23.5	24.1-40.5		257	23.4	18.2-29.6		443	23.4	19.1-28.5	
Others	157	31.7	24.1-40.5		201	27.0	19.1-36.6		358	29.1	22.3-35.4	
Employment/work status												
Employed	328	23.5	17.4-30.9	0.1951	91	14.0	7.5-24.5	0.1196	419	21.8	16.6-28.0	0.1699
Self-employed	1055	28.0	24.6-31.7		288	28.4	22.1-35.6		1343	28.1	24.8-31.6	
Homemaker/ housewife	-				154	28.1	24.7-31.7		364	27.5	24.2-31.0	
Others [d]	247	26.0	22.8-29.3		1404	25.2	17.1-35.4		1441	24.4	19.1-30.6	
Current tobacco use												
Yes	538	24.5	20.0-29.6	0.4402	-	-	-		584	26.9	22.4-32.0	0.8604
No	1095	26.7	23.1-30.8		-	-	-		2988	26.5	23.9-29.3	
Servings of fruits& vegs												
Less than 5 servings	1120	25.2	21.6-29.3	0.5147	1336	28.2	24.4-32.3	0.3510	2456	26.7	23.6-30.0	0.8235
≥ 5 Servings	318	27.5	21.7-34.2		385	24.7	19.2-31.2		703	26.1	22.0-30.7	
BMI*												
Underweight	162	24.1	17.2-32.7	0.7821	160	19.7	14.4-26.3	**0.0007**	322	22.2	17.8-27.3	**0.0104**
Normal	911	25.2	21.8-29.0		937	23.4	19.5-27.7		1848	24.4	21.8-27.2	
Overweight	403	28.3	21.4-36.4		517	29.7	24.3-35.9		920	29.1	23.8-34.9	
Obese	124	26.6	17.7-38.0		286	37.4	30.1-45.3		410	33.8	27.4-40.9	
High Waist circumference**												
Normal	1402	23.7	20.6-27.3	**0.0001**	993	21.4	17.8-25.6	**0.0002**	2395	22.9	20.4-25.7	**<0.0001**
High	231	40.5	32.5-49.1		947	32.9	28.4-37.7		1178	34.6	30.3-39.1	

[a] Measured hypertension defined as measured SBP≥140mmHg and/or DBP ≥90 mmHg

[b]- Results adjusted for complex survey design and weighted for non-response
N= unweighted sample/observations
[c] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRRN = Central River Region North, CRRS=Central River Region South; URR =Upper River Region
[d] Others: student/unemployed/retired

*Based on WHO standards
**Based on the definition of the International Diabetes Federation (≥90 cm men or ≥80 cm women)

Supplementary Table 14: Multivariate linear regression on factors associated with systolic blood pressure (The Gambia, 2010)

Variables		Model I (Men)		Model II (Women)		Model III (All)	
			aβ(95% CI)	aβ(95% CI)	faβ(95% CI)	aβ(95% CI)	faβ(95% CI)
Gender	Men					Reference	Reference
	Women					**-0.16(-1.39-1.63)**	-0.59(-2.48-1.30)
Age	(continuous)	**0.43(0.32-0.55)*** **	**0.43(0.29-0.57)*** **	**0.69(0.56-0.81)*** **	**0.67(0.54-0.80)*** **	**0.56(0.46-0.66)*** **	**0.55(0.44-0.65)*** **
Ethnicity	Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
	Wollof	3.75(-0.27-7.78)	1.33(-2.07-4.73)	-3.11(-6.35-0.13)	-1.77(-5.20-1.64)	0.34(-1.97-2.64)	-0.18(-2.63-2.27)
	Fula	-0.42(-2.68-1.83)	-0.84(-3.48-1.80)	0.65(-2.34-3.64)	-0.01(-3.45-3.42)	-0.14(-2.06-1.79)	-0.69(-290-1.52)
	Jola	**2.63(0.07-5.22)***	0.81(-1.54-3.16)	**-4.07(-7.49- -0.65)***	-2.60(-6.53-1.33)	-0.98(-3.15-1.18)	-0.96(-3.40-1.48)
	Others	**4.29(1.15-7.43)****	**4.47(0.58-8.37)***	-2.61(-7.52-2.30)	-2.25(-7.45-2.94)	0.58(-2.56-3.72)	0.91(-2.36-4.18)
Years in school	>12 Years	Reference	Reference	Reference	Reference	Reference	Reference
	7-12 Years	1.36(-1.28-4.00)	1.35(-0.78-3.48)	0.50(-4.05-5.05)	0.52(-4.82-5.87)	1.32(-1.31-3.94)	1.31(-1.06-3.67)
	≤6 Years	1.93(-1.09-4.96)	-0.15(-2.83-2.52)	2.06(-1.99-6.11)	0.03(-5.51-5.57)	2.05(-0.45-4.55)	0.15(-1.98-2.28)
BMI	(continuous)	0.24(-0.19-0.50)	0.21(-0.05-0.46)	0.10(-0.12-0.31)	0.09(-0.12-0.30)	0.14(-0.05-0.33)	0.10(-1.98-2.28)
Waist circumference	(continuous)	**0.18(0.10-0.26)*** **	**0.22(0.14-0.30)*** **	**0.10(0.02-0.19)****	**0.11(0.03-0.20)****	**0.14(0.08-0.20)*** **	**0.17(0.10-0.23)*** **
Residence	Urban	Reference	Reference	Reference	Reference	Reference	Reference
	Semi urban	**3.64(0.39-6.90)***	**5.70(2.97-8.43)*** **	**5.30(1.36-9.25)****	**5.78(2.21-9.35)****	**4.53(1.19-7.87)****	**5.93(3.20-8.65)*** **
	Rural	**3.77(1.17-6.36)****	**3.66(1.335.99)****	2.67(-0.50-5.84)	**3.18(0.19-6.16)***	**3.21(1.14-5.28)****	**3.61(1.86-5.37)*** **
physical activity	≥600 METS/week	Reference	Reference	Reference	Reference	Reference	Reference
	<600 METS/week	0.11(-3.11-3.32)	-0.30(-4.75-4.14)	-0.34(-5.05-4.36)	-1.37(-6.26-3.53)	-0.15(-3.73-3.43)	-0.99(-4.86-2.87)
Smoking	Non smoker	Reference	Reference	Reference	Reference	Reference	Reference
	Current smoker	0.59(-1.52-2.70)	1.42(-0.91-3.75)	^	^	0.46(-1.41-2.32)	1.27(-0.86-3.40)
	Ex-smoker	**5.36(1.18-9.53)****	**5.23(0.39-10.06)***			**4.63(0.28-8.97)***	4.00(-0.71-8.71)
Servings of fruits and vegs	≥5 servings/day	Reference	Reference	Reference	Reference	Reference	Reference
	<5 Servings/day	-0.96(-4.13-2.21)	-2.11(-5.14-0.93)	0.77(-3.02-4.56)	1.84(-1.66-5.34)	-0.15(-2.74-2.43)	-0.23(-2.28-1.82)

aOR= odds ratio adjusted for age(except for age group as the independent variable), AOR= Adjusted odds ratio(fully adjusted)

*p<0.05, **p≤ 0.01, *** p≤ 0.001 ^Not included in the model because of small numbers

aβ(95% CI)- age adjusted coefficient with its 95% confidence interval, faβ(95% CI) - fully adjusted coefficient with its 95% confidence interval,

METS =Metabolic equivalents

NB: Only residence reported for both systolic and diastolic blood pressure instead of local government area

Supplementary Table 15: Multivariate linear regression on factors associated with diastolic blood pressure (The Gambia, 2010)

Variables		Model I (Men)		Model II (Women)		Model III (All)	
		aOR(95% CI)	AOR(95% CI)	aOR(95% CI)	AOR(95% CI)	aOR(95% CI)	AOR(95% CI)
Gender	Men					Reference	Reference
	Women					0.73(-0.22-1.69)	0.72(-0.26-1.71)
Age	(continuous)	**0.25(0.19-0.310*** **	**0.27(0.19-0.35)*** **	**0.25(0.19-0.32)*** **	**0.23(0.15-0.31)*** **	**0.25(0.20-0.30)*** **	**0.25(0.19-0.31)*** **
Ethnicity	Mandinka		Reference	Reference	Reference	Reference	Reference
	Wollof	2.06(-0.17-4.29)	1.03(-1.22-3.28)	-1.41(-3.34-0.51)	-1.11(-3.31-1.09)	0.37(-1.09-1.83)	-0.04(-1.85-1.76)
	Fula	0.41(-1.01-1.84)	0.45(-1.14-2.04)	0.32(-1.39-2.02)	-0.33(-2.41-1.75)	0.35(-0.82-1.52)	0.05(-1.25-1.35)
	Jola	-0.03(-2.12-2.07)	-0.44(-2.52-1.64)	**-2.71(-5.11- -0.30)***	-1.88(-4.61-0.85)	-1.36(-2.97-0.25)	-1.18(-2.83-0.47)
	Others	0.66(-1.31-2.64)	0.29(-1.80-2.39)	-0.74(-3.38-1.90)	-0.58(-3.15-1.99)	0.04(-1.84-1.91)	-0.13(-1.73-1.47)
Years in school	>12 Years	Reference	Reference	Reference	Reference	Reference	Reference
	7-12 Years	0.16(-1.70-2.02)	0.36(-1.70-2.42)	-0.09(-3.29-3.10)	-0.10(-3.66-3.46)	0.27(-1.42-1.96)	-0.10(-1.94-1.75)
	≤6 Years	-0.15(-1.84-1.54)	-0.48(-2.39-1.43)	-0.06(-2.98-2.86)	-0.43(-3.78-2.91)	0.29(-1.29-1.87)	-0.70(-2.31-0.91)
BMI	(continuous)	**0.39(0.19-0.58)*** **	**0.36(0.13-0.58)** **	**0.16(0.00-0.32)***	0.14(-3.78-2.91)	**0.23(0.07-0.39)** **	**0.20(0.03-0.37)***
Waist circumference	(continuous)	0.02(-0.38-0.07)	0.04(-0.01-0.10)	**0.08(0.04-0.13)*** **	**0.05(0.00-0.11)***	**0.06(0.01-0.10)** **	**0.05(0.01-0.09)***
Residence	Urban	Reference	Reference	Reference	Reference	Reference	Reference
	Semi urban	**3.74(1.79-5.67)*** **	**2.96(0.71-5.21)** **	**4.50(1.98-7.02)*** **	**3.24(0.34-6.15)***	**4.01(2.24-5.78)*** **	**3.10(1.01-5.20)** **
	Rural	0.82(-0.91-2.56)	0.02(-1.94-1.98)	0.48(-1.43-2.39)	0.15(-1.74-2.03)	0.67(-0.82-2.16)	0.06(-1.46-1.58)
physical activity	≥600 METS/week	Reference	Reference	Reference	Reference	Reference	Reference
	<600 METS/week	**2.67(1.31-4.04)*** **	**3.11(0.87-5.36)** **	1.20(-1.26-3.66)	-0.09(-2.57-2.38)	1.66(-0.03-3.36)	1.24(-0.83-3.31)
Smoking	Non smoker	Reference	Reference	Reference	Reference	Reference	Reference
	Current smoker	-0.19(-1.73-1.35)	-0.31(-2.14-1.52)		^	-0.64(-2.07-0.79)	-0.36(-2.08-1.37)
	Ex-smoker	**2.99(0.73-5.24)** **	2.20(-0.36-4.76)			**2.61(0.59-4.64)** **	2.06(-0.36-4.48)
Servings of fruits and vegs	≥5 servings/day	Reference	Reference	Reference	Reference	Reference	Reference
	<5 Servings/day	1.13(-0.71-2.97)	0.29(-1.62-2.19)	1.76(-0.12-3.65)	**2.41(0.51-4.31)** **	**1.45(0.06-2.85)***	**1.36(0.07-2.64)***

aOR= odds ratio adjusted for age(except for age group as the independent variable), AOR= Adjusted odds ratio(fully adjusted)
*p<0.05, **p≤ 0.01, *** p≤ 0.001 ^Not included in the model because of small numbers
aβ(95% CI)- age adjusted coefficient with its 95% confidence interval, faβ(95% CI) - fully adjusted coefficient with its 95% confidence interval,
METS =Metabolic equivalents

Supplementary Table 16: Missing data by gender, Age, residence and education (unweighted)

Variable	Categories	Sample surveyed (n=3878)*	Sample excluded (n=305)**	Analytical sample (n=3573)	X^2 p value [a]
Gender	Men	1,771(45.7)	138(45.3)	1,633(45.7)	0.8780
	Women	2,107(54.3)	167(54.8)	1,940(54.3)	
Age Group	25 -34	1681(43.3)	114(37.4)	1,567(43.9)	**0.0300**
	35-44	1072(27.6)	106(34.8)	966(27.0)	
	45-54	675(17.4)	51(16.7)	624(17.5)	
	55-64	443(11.4)	27(8.9)	416(11.6)	
	Missing	7(0.2)	7(2.3)	-	
	Mean age ±SD	38.4±10.9	38.4±10.0	38.3±10.9	
Local government area [b]	Banjul	181(4.7)	2(0.7)	179(5.0)	**<0.0001**
	KM	984(25.4)	163(53.4)	821(23.0)	
	WCR	1109(28.6)	42(13.8)	1,067(29.9)	
	LRR	297(7.7)	2(0.7)	295(8.3)	
	NBR	615(15.9)	5(1.6)	610(17.1)	
	CRRN	92(2.4)	7(2.3)	85(2.4)	
	CRRS	203(5.2)	12(3.9)	191(5.4)	
	URR	397(10.2)	72(23.6)	325(9.1)	
Education (years excluding preschool)	≤6 Years	2399(61.9)	141(46.2)	2,258(63.2)	**<0.0001**
	7-12 Years	778(20.1)	49(16.1)	729(20.4)	
	>12 Years	260(6.7)	9(3.0)	251(7.02)	
	Don't know/Refused	441(11.4)	106(34.8)	335(9.4)	

*This does not include pregnant women
**Sample excluded because of missing blood pressure readings
[a] difference between excluded and analytical samples
[b]KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRRN = Central River Region North, CRRS=Central River Region South; URR =Upper River Region

Supplementary Table 17: Characteristics of study participants included in Chapter 6 by selected demographic, behavioural and biological risk factors (unweighted & unadjusted for complex survey design)

Categories	Men 1611		Women 1922		Total 3533	
	N	%	N	%	N	%
Gender						
Men	1611					45.6
Women			1922			54.6
Age Group						
25-34	530	32.9	1020	53.1	1550	43.9
35-44	476	29.6	479	24.9	955	27.0
45-54	339	21.0	277	14.4	616	17.4
55-64	266	16.5	146	7.6	412	11.7
	P<0.001					
Mean age (±S.D.)	41.0(±11.2)		36.1(±10.2)		38.3(±10.9)	
Marital Status						
Never married	244	15.2	121	6.3	365	10.4
Married	1182	73.5	1416	73.8	2598	73.7
Separated/divorce	44	2.7	86	4.5	130	3.7
Widowed	4	0.3	92	4.8	96	2.7
Cohabiting	134	8.3	203	10.6	337	9.6
	P<0.001					
Ethnicity						
Mandinka	676	42.0	805	41.9	1481	42.0
Wollof	251	15.6	287	14.9	538	15.3
Fula	342	21.3	379	19.7	721	20.4
Jola	184	11.4	254	13.2	438	12.4
Other	155	9.6	196	10.2	351	10.0
	P=0.435					
Years spent in school						
≤6 Years	931	62.4	1318	76.5	2249	70.0
7-12 Years	372	25.0	347	20.1	719	22.4
>12 Years	188	12.6	59	3.4	247	7.7
	P<0.001					
Residence (Local government area) [a]						
Banjul	84	5.2	97	5.1	181	5.1
KMC	358	22.2	443	23.1	801	22.7
WCR	494	30.7	559	29.1	1053	29.8
URR	166	10.3	154	8.0	320	9.0
NBR	254	15.8	355	18.5	609	17.2
CRRS	82	5.1	107	5.6	189	5.4
CRRN	36	2.2	49	2.6	85	2.4
LRR	137	8.5	158	8.2	295	8.4
	P=0.154					
Residence (Rurality)						
Urban	810	50.3	933	48.5	1743	49.3
Semi urban	168	10.4	186	9.7	354	10.0
Rural	633	39.3	803	41.8	1436	40.7
	P=0.307					
Smoking						
Never smokers	910	56.5	1888	98.3	2798	79.2
Current smokers	530	32.9	22	1.2	552	15.6
Ex-smokers	171	10.6	11	0.6	182	5.2
	P<0.001					

Categories	Men 1611		Women 1922		Total 3533	
	N	%	N	%	N	%
Servings of fruits and vegetables						
≥5 /day	319	22.4	386	22.6	705	22.5
< 5/day	1104	77.6	1325	77.4	2429	77.5
	P= 0.924					
Physical activity [b]						
≥600METS/week	1363	88.6	1539	84.1	2902	86.1
< 600METS/week	176	11.4	292	16.0	468	13.9
	P<0.001					
BMI[c]						
Underweight	163	10.1	160	8.3	323	9.1
Normal	919	57.1	948	49.3	1867	52.8
Overweight	404	25.1	524	27.3	928	26.3
Obese	125	7.8	290	15.1	415	11.8
	P<0. 001					
Mean BMI (kg/m^2) ±SD	23.5±4.5		25.0±8.1		24.3±6.8	
Mean height (cm) ±SD	167.1±11.4		160.3±9.7		163.4±11.1	
Mean weight (kg) ±SD	65.2±11.5		63.9±19.3		64.5±16.2	
High Waist circumference [d]						
Normal	1399	88.7	996	54.1	2395	70.1
High	178	11.3	845	45.9	1023	29.9
	P<0.001					
Mean waist circumference (cm) ±SD	72.8±15.4		76.2±17.8		74.7±16.8	
Waist-to-Hip Ratio						
Normal	1317	83.6	1110	60.3	2427	71.1
High	258	16.4	731	39.7	989	29.0
	P<0.001					
Waist-Height Ratio						
Normal (≤0.5)	1274	80.8	1096	59.5	2370	69.3
High (>0.5)	303	19.2	745	40.5	1048	30.7
	P<0.001					
Mean Hip Circumference	90.2±13.7		94.5±15.2		92.5±14.6	

[a] KM=Kanifing Municipality; WCR =West Coast Region; URR =Upper River Region.; NBR =North Bank Region ; CRRS=Central River Region South ; CRRN = Central River Region North ; LRR= Lower River Region. Regions ordered from most to least urban

[b] METS =Metabolic equivalents

[c] BMI is categorised into underweight (BMI<18.5Kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9Kg/m^2) and obese (BMI ≥30Kg/m^2).

[d]Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

NB: The p value indicates the statistical significance of the difference in proportions between men and women obtained using Pearson's chi-squared test

Supplementary Table 18: Prevalence of waist circumference categories by selected socio-demographic and health factors (n=3418) [a, b c]

	Men					Women		
Categories	**N**	**Normal %(95% CI)**	**High %(95% CI)**	**χ^2 P value**	**N**	**Normal %(95% CI)**	**High %(95% CI)**	**χ^2 P value**
Total	1577	89.7(86.7-92.2)	10.3(7.8-13.4)		1841	54.2(47.4-60.7)	45.9(39.3-52.6)	**<0.001***
Age Group								
25 -34	523	92.6(89.2-95.0)	7.4(5.0-10.8)	**0.003**	1020	64.6(57.9-70.9)	35.4(29.2-42.2)	**0.001**
35-44	467	88.3(83.7-91.7)	11.7(8.3-16.3)		479	46.9(38.4-55.7)	53.1(44.3-61.6)	
45-54	339	86.8(80.6-91.3)	11.7(8.3-16.3)		277	48.6(38.8-58.4)	51.5(41.6-61.2)	
55-64	266	84.6(78.9-88.9)	15.4(11.1-21.1)		146	33.7(23.8-45.1)	66.4(54.9-76.2)	
Marital status								
Never married	240	95.0(90.3-97.5)	5.1(2.6-9.8)	**0.001**	115	72.8(58.0-83.8)	27.2(16.2-42.0)	0.078
Married	1155	89.4(85.7-92.2)	10.6(7.8-14.4)		1356	53.4(45.8-60.8)	46.6(39.2-54.2)	
Separated	42	93.6(79.9-98.2)	6.4(1.8-20.1)		82	56.6(42.5-69.7)	43.4(30.3-57.5)	
Widowed	4	100.0	0.0		82	50.6(34.9-66.2)	49.4(33.8-65.1)	
Cohabiting	134	77.3(66.9-85.2)	22.7(14.8-33.2)		203	48.1(35.9-60.5)	51.9(39.5-64.1)	
Occupation								
Employed**	317	87.5(81.7-91.6)	12.5(8.4-18.3)	0.384	91	56.7(41.4-70.8)	43.3(29.2-58.6)	**0.010**
Self employed	1022	89.4(85.2-92.5)	10.6(7.5-14.8)		278	44.7(36.0-53.8)	55.3(46.2-64.0)	
Non paid***	43	92.2(78.9-97.4)	7.8(2.6-21.1)		15	69.4(38.9-89.0)	30.6(11.0-61.2)	
Student	42	94.8(82.6-98.6)	5.2(1.4-17.4)		43	71.4(49.8-86.3)	28.6(13.7-50.2)	
Housemaker	37	93.6(82.6-97.8)	6.4(2.2-17.4)		1326	55.2(48.5-61.8)	44.8(38.2-51.5)	
Retired	33	89.9(75.7-96.2)	10.2(3.8-24.3)		21	25.8(9.7-52.9)	74.2(47.1-90.3)	
Unemployed	80	94.6(87.4-97.8)	5.4(2.2-12.6)		64	66.4(47.2-81.4)	33.6(18.6-52.8)	
Ethnicity								
Mandinka	667	90.2(85.7-93.4)	9.8(6.6-14.3)	0.905	773	51.1(43.9-58.3)	48.9(41.7-56.1)	0.279
Wollof	244	88.4(76.7-94.7)	11.6(5.3-23.3)		279	52.3(40.6-63.8)	47.7(36.2-59.4)	
Fula	334	90.2(84.7-93.9)	9.8(6.1-15.3)		363	58.7(51.1-65.9)	41.3(34.1-48.9)	
Jola	180	87.8(79.4-93.0)	12.2(7.0-20.6)		242	52.7(42.1-63.1)	47.3(36.9-57.9)	
Others	149	91.1(84.4-95.1)	8.9(4.9-15.7)		183	62.4(48.2-74.7)	37.6(25.3-51.8)	
Residence (Local government area) [c]								
Banjul & KM	425	94.3(90.8-96.5)	5.7(3.5-9.2)	**0.014**	507	73.5(62.0-82.5)	26.5(17.5-38.0)	**<0.001**

	Men				Women			
Categories	N	Normal %(95% CI)	High %(95% CI)	χ^2 P value	N	Normal %(95% CI)	High %(95% CI)	χ^2 P value
WCR	484	84.1(79.2-88.0)	15.9(12.0-20.9)		540	36.3(29.1-44.3)	63.7(55.7-70.9)	
LRR	136	92.5(83.0-96.9)	7.5(3.1-17.0)		147	44.1(31.3-57.7)	55.9(42.3-68.7)	
NBR	252	86.2(78.1-91.7)	13.8(8.3-21.9)		353	41.3(35.1-47.8)	58.7(52.2-64.9)	
CRR	117	88.1(63.3-96.9)	11.9(3.1-36.8)		156	50.3(30.4-70.2)	49.7(29.8-69.6)	
URR	163	99.4(96.2-99.9)	0.6(0.1-3.8)		138	78.4(69.9-85.0)	21.6(15.0-30.1)	
Residence (Rurality)								
Urban	783	89.7(86.5-92.2)	10.4(7.8-13.5)	0.190	884	57.8(47.9-67.1)	42.2(32.9-52.1)	0.162
Semi urban	166	96.0(91.7-98.1)	4.0(1.9-8.3)		171	39.3(24.2-56.6)	60.7(43.4-75.8)	
Rural	628	88.1(80.7-92.9)	11.9(7.1-19.3)		786	51.3(43.6-58.9)	48.7(41.1-56.4)	
Education level								
No formal education	908	88.9(84.6-92.1)	11.2(7.9-15.4)	0.325	1281	53.7(46.8-60.4)	46.3(39.6-53.2)	0.822
Primary /Middle	250	92.4(88.3-95.2)	7.6(4.8-11.7)		326	54.9(45.5-63.9)	45.1(36.1-54.5)	
Secondary/Tertiary	418	89.5(84.8-92.8)	10.5(7.2-15.2)		229	56.1(45.7-66.1)	43.9(34.0-54.3)	
Years spent in school								
≤6 Years	1067	89.5(85.8-92.4)	10.5(7.6-14.2)	0.397	1478	52.8(45.8-59.7)	47.2(40.3-54.2)	0.127
7-12 Years	318	91.3(86.4-94.5)	8.7(5.5-13.6)		300	60.5(51.0-69.2)	39.5(30.8-49.1)	
>12 Years	181	86.9(80.0-91.7)	13.1(8.3-20.1)		56	61.4(43.1-76.9)	38.6(23.1-56.9)	
Smoking								
Never smokers	884	89.3(85.4-92.3)	10.7(7.7-14.6)	0.064				
Current smokers	528	92.1(87.7-95.0)	92.1(87.7-95.0)					
Ex-smokers	165	84.0(76.2-89.5)	84.0(76.2-89.5)					
Servings of fruits and vegs								
≥ 5/day	310	84.9(79.5-89.0)	15.2(11.0-20.5)	**0.032**	362	50.6(40.4-60.7)	49.4(39.3-59.6)	0.816
< 5/day	1091	90.2(86.6-92.9)	9.8(7.1-13.4)		1290	51.8(45.1-57.9)	48.2(41.6-54.9)	
<600METS/week	162	90.7(82.5-95.3)	9.3(4.7-17.5)	0.761	265	60.0(43.5-74.6)	40.0(25.4-56.5)	0.401
≥600METS/week	1346	89.7(86.2-92.3)	10.3(7.7-13.8)		1496	53.0(46.4-59.6)	47.0(40.4-53.6)	
BMI[d]								
Normal	897	92.1(88.8-94.5)	7.9(5.6-11.2)	**<0.001**	904	60.7(53.7-67.2)	39.3(32.8-46.3)	**<0.001**
Underweight	163	98.4(95.3-99.5)	1.6(0.5-4.7)		158	72.2(61.8-80.6)	27.8(19.4-38.2)	

	Men					Women		
Categories	**N**	**Normal %(95% CI)**	**High %(95% CI)**	**χ^2 P value**	**N**	**Normal %(95% CI)**	**High %(95% CI)**	**χ^2 P value**
Overweight	394	83.6(75.6-89.3)	16.4(10.7-24.4)		501	45.7(35.7-56.1)	54.3(43.9-64.4)	
Obese	123	82.7(72.1-89.8)	17.3(10.2-27.9)		278	42.6(30.0-56.3)	57.4(43.7-70.0)	
Waist –hip-ratio [e]								
Normal	1317	93.6(91.7-95.1)	6.4(4.9-8.3)	**<0.001**	1110	73.3(67.5-78.4)	26.7(21.6-32.5)	**<0.001**
High	258	70.4(59.1-79.6)	29.6(20.4-40.9)		731	24.7(18.8-31.8)	75.4(68.3-81.2)	
Normal (≤0.5)	1274	98.9(97.9-99.5)	1.1(0.5-2.1)	**<0.001**	1096	87.8(94.2-90.7)	12.2(9.3-15.8)	**<0.001**
High (>0.5)	303	48.1(39.6-56.6)	52.0(34.4-60.4)		745	3.9(2.7-5.6)	96.1(94.4-97.3)	
Hypertensive[f]								
No	1066	92.3(89.5-94.3)	7.7(5.7-10.5)	**<0.001**	1287	59.8(53.1-66.2)	40.2(33.8-46.9)	**<0.001**
Yes	504	82.8(76.8-87.5)	17.2(12.5-23.2)		537	41.5(33.4-50.1)	58.5(49.9-66.6)	

Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

[b] Results adjusted for complex survey design and weighted for non-response

[c] Row percentages are presented, i.e the prevalence of being in that waist circumference category for people with that socio-demographic, behavioural or biological characteristic

N= unweighted sample/observations

*This p value indicates the difference between men and women

[d] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region

[e] BMI is categorised into underweight (BMI<18.5Kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9Kg/m^2) and obese (BMI ≥30Kg/m^2).

[f] Based on WHO standards (high waist-hip ratio defined as ≥90cm in men or ≥85 cm in women)

[g] Hypertension defined as measured SBP≥140mmHg and/or DBP ≥90 mmHg and/or self-reported hypertension

Supplementary Table 19: Prevalence of waist-to-hip ratio categories by selected socio-demographic and health factors (n=3416) [a, b]

	Men				Women			
Categories	**N**	**Normal %(95% CI)**	**High %(95% CI)**	**χ^2 P value**	**N**	**Normal %(95% CI)**	**High %(95% CI)**	**χ^2 P value**
Total	1575	83.2(79.4-86.4)	16.8(13.6-20.6)		1841	60.6(54.8-66.1)	39.4(33.9-45.2)	**<0.001***
Age Group								
25 -34	522	83.4(78.2-87.5)	16.6(12.5-21.8)	0.286	985	67.9(61.4-73.8)	32.1(26.2-38.6)	**<0.001**
35-44	466	84.6(80.4-88.1)	15.4(11.9-19.7)		456	56.7(49.5-63.7)	43.3(36.3-50.5)	
45-54	332	83.6(77.3-88.4)	16.4(11.6-22.7)		263	54.1(45.5-62.5)	45.9(37.5-54.5)	
55-64	255	77.7(70.6-83.5)	22.3(16.5-29.4)		137	48.0(38.0-58.2)	52.0(41.9-62.0)	
Marital status								
Never married	240	82.5(81.5-92.7)	11.8(7.3-18.5)	**0.046**	115	73.0(61.6-82.0)	27.0(18.1-38.4)	0.311
Married	1153	88.2(77.5-86.6)	17.5(13.4-22.5)		1356	58.7(52.3-64.7)	41.4(35.3-47.7)	
Separated	42	87.7(72.9-95.0)	12.3(5.0-27.1)		82	67.9(54.2-79.1)	32.1(20.9-45.8)	
Widowed	4	62.4(16.9-93.1)	37.6(6.9-83.1)		82	63.2(48.7-75.7)	36.8(24.3-51.3)	
Cohabiting	134	74.8(67.9-80.6)	25.2(19.4-32.1)		203	60.8(44.2-75.2)	39.2(24.8-55.8)	
Occupation								
Employed	317	87.6(81.9-91.6)	12.5(8.4-18.11)	0.107	91	61.0(48.0-72.6)	39.0(27.4-52.0)	0.564
Self employed	1020	81.2(76.3-85.3)	18.8(14.7-23.7)		278	55.0(47.7-62.2)	45.0(37.8-52.3)	
Non pai	43	97.7(85.4-99.7)	2.3(0.3-14.6)		15	78.1(42.0-94.6)	21.9(5.4-58.0)	
Student	42	84.8(71.7-92.4)	15.2(7.6-28.3)		43	67.9(49.6-82.0)	32.1(18.0-50.4)	
Housemaker	37	79.8(58.9-91.5)	20.2(8.5-41.1)		1326	61.3(55.3-66.9)	38.7(33.1-44.7)	
Retired	33	80.1(61.0-91.2)	19.9(8.8-39.1)		21	55.2(23.6-80.9)	44.8(16.9-76.4)	
Unemployed	80	82.5(71.2-90.0)	17.5(10.0-28.9		64	65.7(46.5-80.9)	34.3(19.1-53.5)	
Ethnicity								
Mandinka	666	84.8(80.1-88.5)	15.2(11.5-19.9)	0.855	773	55.1(49.1-61.0)	44.9(39.0-50.9)	0.129
Wollof	244	81.6(71.1-88.9)	18.4(11.1-29.0)		279	64.9(55.7-73.0)	35.1(27.0-44.3)	
Fula	334	82.5(73.3-89.1)	17.5(10.9-26.8)		363	63.0(55.5-70.0)	37.0(30.1-44.5)	
Jola	179	81.0(73.9-86.6)	19.0(13.4-26.1)		242	64.3(50.8-75.9)	35.7(24.1-49.2)	
Others	149	82.7(74.0-89.0)	17.3(11.0-26.1)		183	62.4(48.2-74.7)	37.6(25.3-51.8)	
Residence (Local government area) [c]								
Banjul & KM	423	91.0(84.6-94.9)	9.0(5.1-15.4)	**<0.001**	507	81.1(71.5-88.0)	18.9(12.0-28.5)	**<0.001**
WCR	484	78.4(73.6-82.5)	21.6(17.5-26.4)		540	47.6(39.7-55.6)	52.4(44.4-60.3)	

	Men				Women			
Categories	**N**	**Normal %(95% CI)**	**High %(95% CI)**	**χ^2 P value**	**N**	**Normal %(95% CI)**	**High %(95% CI)**	**χ^2 P value**
LRR	136	92.4(90.9-93.6)	7.6(6.4-9.1)		147	51.3(46.8-55.8)	48.8(44.2-53.3)	
NBR	252	83.2(76.0-88.5)	16.8(11.5-24.0)		353	50.7(44.4-56.9)	48.8(44.2-53.3)	
CRR	117	54.8(33.5-74.4)	45.2(25.6-66.5)		156	37.9(30.2-46.2)	49.3(43.1-55.7)	
URR	163	95.8(91.8-97.9)	4.3(2.2-8.2)		138	37.9(30.2-46.2)	62.1(53.8-69.8)	
Residence (Rurality)								
Urban	781	86.6(82.7-89.6)	13.5(10.4-17.3)	**<0.001**	884	67.1(58.5-74.8)	32.9(25.2-41.5)	**0.005**
Semi urban	166	95.9(92.2-97.9)	4.1(2.1-7.8)		171	58.2(47.2-68.4)	41.8(31.6-52.8)	
Rural	628	74.3(65.8-81.3)	25.7(18.7-34.2)		786	51.3(44.3-58.2)	48.7(41.8-55.7)	
Education level								
No formal education	907	80.0(74.4-84.7)	20.0(15.4-25.6)	**0.008**	1281	57.4(51.5-63.2)	42.6(36.8-48.5)	**0.006**
Primary & middle	250	88.9(84.4-92.2)	11.1(7.8-15.6)		326	64.5(55.1-72.9)	35.5(27.1-44.9)	
Secondary/Tertiary	418	85.1(80.1-89.0)	14.9(11.0-19.9)		229	71.3(61.8-79.2)	28.8(20.9-38.2)	
Years spent in school								
≤6 Years	1066	81.1(76.3-85.2)	18.9(14.8-23.8)	0.067	1478	58.1(51.9-63.9)	42.0(36.1-48.1)	**0.004**
7-12 Years	317	88.4(82.4-92.6)	11.6(7.4-17.6)		300	69.4(60.1-77.4)	30.6(22.7-39.9)	
>12 Years	181	83.9(75.8-89.6)	16.1(10.4-24.2)		56	75.7(63.4-84.9)	24.3(15.1-36.7)	
Smoking								
Never smokers	882	85.5(81.5-88.8)	14.5(11.2-18.5)	0.070				
Current smokers	528	80.0(74.0-85.0)	20.0(15.3-26.0)					
Ex-smokers	165	80.5(72.6-86.5)	19.5(13.5-27.4)					
Servings of fruits and vegs								
≥ 5/day	310	85.2(80.4-88.9)	14.8(11.1-19.6)	0.287	362	62.4(51.9-71.4)	37.7(28.3-48.1)	0.481
< 5/day	1090	82.3(77.8-86.0)	17.7(14.0-22.2)		1290	58.6(52.5-64.5)	41.4(35.5-47.5)	
Physical activity								
<600METS/week	160	88.3(80.2-93.3)	11.7(6.7-19.8)	0.158	265	70.7(56.6-81.7)	29.3(18.3-43.4)	0.086
≥600METS/week	1346	82.6(78.4-86.1)	17.4(13.9-21.6)		1496	58.6(52.9-64.0)	41.4(36.0-47.1)	
BMI [d]								
Normal	895	81.7(76.8-85.7)	18.3(14.3-23.2)	0.626	904	58.6(51.8-65.2)	41.4(34.8-48.3)	0.433
Underweight	163	85.7(76.3-91.8)	14.3(8.2-23.8)		158	57.1(46.4-67.1)	42.9(32.9-53.6)	

	Men				Women			
Categories	**N**	**Normal %(95% CI)**	**High %(95% CI)**	**χ^2 P value**	**N**	**Normal %(95% CI)**	**High %(95% CI)**	**χ^2 P value**
Overweight	394	85.2(77.9-90.3)	14.8(9.7-22.1)		501	62.2(55.5-68.4)	37.9(31.6-44.5)	
Obese	123	84.1(74.3-90.6)	15.9(9.4-25.7)		278	65.1(53.9-74.9)	34.9(25.1-46.1)	
Waist circumference [e]								
Normal	1397	86.8(82.9-89.9)	13.2(10.1-17.1)	**<0.001**	996	82.1(76.3-86.7)	17.9(13.3-23.7)	**<0.001**
High	178	51.6(42.1-61.0)	48.4(39.0-57.9)		845	35.3(31.2-39.7)	64.7(60.4-68.9)	
Waist height ratio								
Normal (≤0.5)	1272	88.7(85.0-91.6)	11.3(8.4-15.0)	**<0.001**	1096	78.5(72.9-83.2)	21.5(16.8-27.1)	**<0.001**
High (>0.5)	303	58.3(50.4-65.8)	41.7(34.2-49.6)		745	33.9(29.9-38.2)	66.1(61.8-70.2)	
Hypertensive [f]								
No	1064	84.4(80.2-87.9)	15.6(12.1-19.8)	0.161	1287	65.4(59.2-71.0)	34.6(29.0-40.8)	**<0.001**
Yes	504	80.3(73.9-85.4)	19.7(14.6-26.1)		537	51.1(44.6-57.6)	48.9(42.4-55.4)	

[a] Based on WHO standards (high waist-hip ratio defined as ≥90cm in men or ≥85 cm in women)

[b] Results adjusted for complex survey design and weighted for non-response

[c] Row percentages are presented, i.e the prevalence of being in that waist hip ratio category category for people with that that socio-demographic , behavioural or biological characteristic

*This p value indicates the difference between men and women

N= unweighted sample/observations

[d]KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region

[f] BMI is categorised into underweight (BMI<18.5Kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9Kg/m^2) and obese (BMI ≥30Kg/m^2).

[e]Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

[g]Hypertension defined as measured SBP≥140mmHg and/or DBP ≥90 mmHg and/or self-reported hypertension

Supplementary Table 20: Prevalence of waist height ratio categories by selected socio-demographic and health factors (n=3418)[a, b, c]

Variable	N	Normal %(95% CI)	High %(95% CI)	χ^2 P value	N	Normal %(95% CI)	High %(95% CI)	χ^2 P value
Total	1577	81.9(77.9-85.4)	18.1(14.6-22.1)		1841	59.9(53.2-66.3)	40.1(33.7-46.8)	**<0.001***
Age Group								
25 -34	523	85.8(81.2-89.4)	14.2(10.6-18.8)	**<0.001**	985	69.1(62.4-75.1)	30.9(24.9-37.6)	**<0.001**
35-44	467	81.1(75.8-85.5)	18.9(14.5-24.2)		456	54.0(45.4-62.5)	46.0(37.5-54.6)	
45-54	332	83.6(77.3-88.4)	16.4(11.6-22.7)		263	55.3(45.5-64.7)	44.7(35.3-54.5)	
55-64	255	79.1(72.5-84.4)	20.9(15.6-27.5)		137	40.0(29.5-51.6)	60.0(48.4-70.5)	
Marital status								
Never married	240	92.6(87.4-95.8)	7.4(4.2-12.7)	**<0.001**	115	77.7(66.2-86.2)	22.3(13.8-33.8)	0.116
Married	1155	79.8(74.9-84.0)	20.2(16.0-25.1)		1356	58.4(50.8-65.6)	41.6(34.4-49.2)	
Separated	42	88.7(64.0-97.2)	11.3(2.8-36.0)		82	61.7(46.3-75.1)	38.3(24.9-53.7)	
Widowed	4	100.0	0.0		82	56.1(39.6-71.3)	43.9(28.7-60.4)	
Cohabiting	134	67.2(56.1-76.6)	32.8(23.4-43.9)		203	59.1(45.7-71.2)	40.9(28.8-54.3)	
Occupation								
Employed	317	82.6(76.7-87.2)	17.4(12.8-23.4)	**0.017**	91	61.1(47.9-72.9)	38.9(27.1-52.1)	**0.004**
Self employed	1022	82.1(77.4-86.0)	17.9(14.0-22.6)		278	49.8(39.9-59.9)	50.2(40.2-60.2)	
Non paid	43	79.3(61.5-90.1)	20.8(9.9-38.5)		15	69.4(38.9-89.0)	30.6(11.0-61.2)	
Student	42	88.4(75.9-94.9)	11.6(5.1-24.1)		43	76.3(58.5-88.0)	23.7(12.0-41.5)	
Housemaker	37	57.3(41.0-72.1)	42.7(27.9-59.0)		1326	61.5(54.6-68.0)	38.5(32.0-45.4)	
Retired	33	80.2(49.2-94.2)	19.8(5.6-50.8)		21	27.6(10.6-55.1)	72.4(45.0-89.4)	
Unemployed	80	87.8(77.0-94.0)	12.2(6.0-23.0)		64	68.5(51.2-81.8)	31.5(18.2-48.8)	
Ethnicity								
Mandinka	667	85.5(81.5-88.7)	14.6(11.3-18.5)	**0.023**	773	56.7(50.0-63.1)	43.3(36.9-50.0)	0.187
Wollof	244	76.3(66.1-84.1)	23.7(15.9-33.9)		279	56.7(43.7-68.9)	43.3(31.1-56.3)	
Fula	334	82.5(74.2-88.6)	17.5(11.4-25.8)		363	63.6(54.5-71.7)	36.5(28.3-45.5)	
Jola	180	73.6(63.4-81.7)	26.5(18.3-36.6)		242	60.1(48.7-70.5)	39.9(29.5-51.3)	
Others	149	85.2(77.0-90.8)	14.8(9.2-23.0)		183	70.3(58.0-80.3)	29.7(19.7-42.0)	
Residence (Local government area) [d]								
Banjul & KM	425	86.1(78.2-91.5)	13.9(8.5-21.7)	**0.003**	507	76.3(64.6-85.0)	23.7(15.0-35.4)	**<0.001**
WCR	484	76.0(71.0-80.4)	24.0(19.6-29.0)		540	44.1(35.5-53.0)	55.9(47.0-64.5)	
LRR	136	89.3(78.9-94.9)	10.7(5.1-21.1)		147	56.3(47.3-64.9)	43.7(35.2-52.7)	
NBR	252	76.2(68.5-82.6)	23.8(17.4-31.5)		353	47.5(40.5-54.5)	52.5(45.5-59.5)	

Variable	N	Normal %(95% CI)	High %(95% CI)	χ^2 P value	N	Normal %(95% CI)	High %(95% CI)	χ^2 P value
CRR	117	73.5(51.9-87.7)	26.5(12.3-48.1)		156	51.3(30.6-71.6)	48.7(28.4-69.4)	
URR	163	98.3(91.8-99.7)	1.7(0.3-8.2)		138	89.9(79.9-95.3)	10.1(4.8-20.1)	
Residence (Rurality)								
Urban	783	82.6(78.0-86.4)	17.4(13.6-22.1)	0.062	884	62.3(52.5-71.2)	37.7(28.8-47.5)	0.337
Semi urban	166	92.0(85.5-95.8)	8.0(4.2-14.5)		171	48.2(34.7-61.9)	51.8(38.1-65.3)	
Rural	628	78.2(69.8-84.7)	21.8(15.3-30.2)		786	58.3(49.5-66.7)	41.7(33.3-50.5)	
Education level								
No formal education	908	78.2(72.4-83.1)	21.8(16.9-27.6)	**0.011**	1281	59.4(52.4-66.1)	40.6(34.0-47.6)	0.707
Primary/Middle	250	84.5(78.6-89.0)	15.5(11.0-21.4)		326	62.8(53.0-71.7)	37.2(28.3-47.0)	
Secondary/Tertiary	418	86.4(81.2-90.3)	13.6(9.7-18.8)		229	59.4(48.2-69.7)	40.6(30.3-51.8)	
Years spent in school								
≤6 Years	1067	79.4(74.3-83.7)	20.6(16.3-25.7)	**0.049**	1478	59.2(52.1-66.0)	40.8(34.0-47.9)	0.459
7-12 Years	318	86.2(80.4-90.4)	13.8(9.6-19.6)		300	64.2(54.5-72.9)	35.8(27.1-45.5)	
>12 Years	181	84.6(77.2-89.9)	15.4(10.1-22.8)		56	63.0(44.1-78.6)	37.0(21.4-55.9)	
Smoking								
Never smokers	884	80.7(75.2-85.2)	19.3(14.8-24.8)	0.063				
Current smokers	528	85.8(80.6-89.7)	14.2(10.3-19.4)					
Ex-smokers	165	75.7(66.5-83.0)	24.4(17.1-33.5)					
Servings of fruits and vegs								
≥ 5/day	310	77.2(70.8-82.6)	22.8(17.5-29.2)	0.110	362	57.2(46.6-67.1)	42.8(32.9-53.4)	0.924
< 5/day	1091	82.2(77.6-86.0)	17.8(14.0-22.4)		1290	57.6(51.1-63.9)	42.4(36.1-48.9)	
Physical activity								
<600METS/week	162	82.2(71.5-89.4)	17.8(10.6-28.5)	0.932	265	65.4(49.2-78.7)	34.6(21.3-50.8)	0.424
≥600METS/week	1346	81.8(77.4-85.5)	18.2(14.5-22.6)		1496	59.0(52.1-65.5)	41.0(34.5-47.9)	
BMI[e]								
Normal	897	85.1(80.7-88.6)	15.0(11.4-19.3)	**<0.001**	904	69.3(62.1-75.6)	30.7(24.4-37.9)	**<0.001**
Underweight	163	97.3(92.8-99.1)	2.7(1.0-7.2)		158	86.9(77.5-92.7)	13.1(7.3-22.5)	
Overweight	394	73.5(62.3-82.3)	26.5(17.7-37.7)		501	48.7(39.0-58.4)	51.3(41.6-61.0)	
Obese	123	68.4(55.7-78.9)	31.6(21.2-44.3)		278	41.3(28.4-55.5)	58.7(44.5-71.6)	
Waist circumference [f]								
Normal	1399	90.3(87.4-92.6)	9.7(7.4-12.6)	**<0.001**	996	97.1(95.9-98.0)	2.9(2.0-4.1)	**<0.001**
High	178	8.5(4.4-15.8)	91.5(84.2-95.6)		845	16.0(12.2-20.6)	84.0(79.4-87.8)	

Variable	N	Normal %(95% CI)	High %(95% CI)	χ^2 P value	N	Normal %(95% CI)	High %(95% CI)	χ^2 P value
Waist-hip ratio [g]								
Normal	1317	87.3(84.2-89.8)	12.7(10.2-15.8)	**<0.001**	1110	77.6(72.0-82.3)	22.4(17.7-28.0)	**<0.001**
High	258	55.0(43.9-65.7)	45.0(34.3-56.1)		731	32.7(26.5-39.6)	67.3(60.4-73.6)	
Hypertensive [h]								
No	1066	85.1(81.0-88.4)	15.0(11.6-19.0)	**<0.001**	1287	65.7(59.1-71.7)	34.3(28.2-40.9)	**<0.001**
Yes	504	73.3(66.6-79.1)	26.7(21.0-33.5)		537	47.3(38.8-56.0)	52.7(44.0-61.3)	

[a] Waist-height ratio (Normal ≤0.5, High>0.5)
[b] Results adjusted for complex survey design and weighted for non-response
[c] Row percentages are presented, i.e the prevalence of being in that waist hip ratio category for people with that that socio-demographic , behavioural or biological characteristic
N= unweighted sample/observations
*This p value indicates the difference between men and women
[d]KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region
[e]BMI is categorised into underweight (BMI<18.5Kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9Kg/m^2) and obese (BMI ≥30Kg/m^2).
[f]Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)
[g] Based on WHO standards (high waist-hip ratio defined as ≥90cm in men or ≥85 cm in women)
[h] Hypertension defined as measured SBP≥140mmHg and/or DBP ≥90 mmHg and/or self-reported hypertension

Supplementary Table 21 Characteristics of study participants included in Chapter 8 by selected sociodemographic characteristics (unweighted & unadjusted for complex survey design)

Variable	Men		Women		Total 3000	
Variable	N	%	N	%	N	%
Gender						
Men	1372	45.7				
Women			1628	54.3		
Age Group						
25-34	439	32.0	883	54.2	1322	44.1
35-44	402	29.3	390	24.0	792	26.4
45-54	301	21.9	225	13.8	526	17.5
55-64	230	16.8	130	8.0	360	12.0
	P<0.001					
Mean age ± SD		41.3±11.2		36.0±10.3		38.4±11.0
Marital status						
Never married	208	15.2	105	6.5	313	10.5
Married	990	72.2	1177	72.4	2167	72.4
Separated/Divorced	36	2.6	75	4.6	111	3.7
Widowed	4	0.3	71	4.4	75	2.5
Cohabiting	132	9.6	197	12.1	329	11.0
	P<0.001					
Ethnicity						
Mandinka	601	43.9	704	43.3	1305	43.6
Wollof	221	16.1	253	15.6	474	15.8
Fula	257	18.8	291	17.9	548	18.3
Jola	165	12.1	219	13.5	384	12.8
Others	125	9.1	160	9.8	285	9.5
	P=0.719					
Residence (Local government area) [b]						
Banjul & KM	398	29.0	479	29.4	877	29.2
WCR	436	31.8	463	28.4	899	30.0
LRR	135	9.8	153	9.4	288	9.6
NBR	234	17.1	334	20.5	568	18.9
CRR	94	6.9	127	7.8	221	7.4
URR	75	5.5	72	4.4	147	4.9
	P= 0.069					
Residence (Rurality)						
Urban	712	51.9	783	48.1	1495	49.8
Semi urban	126	9.2	142	8.7	268	8.9
Rural	534	38.9	703	43.2	1237	41.2
	P= 0.060					
Education						
≤6 Years	790	61.8	1110	74.9	1900	68.8
7-12 Years	317	24.8	319	21.5	636	23.0
>12 Years	172	13.5	54	3.6	226	8.2
	P<0.001					

NB: The p value indicates the difference between men and women using chi-squared test of association for two-way tables

Supplementary Table 22: Prevalence of clustering by sub groups using the five CVD risk factors(The Gambia 2010)

Variable	No risk factor %(95% CI)	One risk factor %(95% CI)	Two risk factors %(95% CI) n=576	Three to five risk factors %(95% CI)
Hypertension				
Normal	10.2(7.3-13.9)	42.9(38.1-47.8)	37.3(32.9-42.0)	9.6(7.1-12.9)
Hypertensive	0.0	8.0(5.4-11.7)	40.5(35.7-45.5)	51.5(45.8-57.2)
Hypertension				
Normal	9.8(7.1-13.4)	41.7(37.1-46.4)	37.5(33.3-41.9)	11.0(8.5-14.3)
Hypertensive (undiagnosed)	0.0	9.2(6.1-13.5)	43.8(38.6-49.3)	47.0(40.9-53.2)
Hypertensive (diagnosed)	0.0	4.6(1.9-10.9)	26.9(19.1-36.4)	68.5(59.0-76.6)
Obesity				
Normal/desirable weight	11.7(8.7-15.5)	49.0(45.9-52.1)	32.7(29.5-36.0)	6.67(5.15-8.59)
Underweight	13.8(8.5-21.6)	48.3(42.2-54.5)	27.9(21.9-34.8)	10.6.8-14.4)
Overweight	0.0	9.0(5.9-13.5)	48.8(43.1-54.5)	42.2(36.6-48.1)
Obese	0.0	7.6(4.5-12.6)	45.0(37.3-52.9)	47.4(40.0-54.9)
Smoking				
Non-smokers (never)	8.7(6.3-11.9)	36.9(33.4-40.6)	36.7(32.8-40.9)	17.7(14.6-21.3)
Ex-smokers	8.4(3.2-20.3)	40.6(29.1-53.3)	33.9(22.3-47.9)	17.0(9.6-28.5)
Current smokers	0.0	11.6(7.3-17.8)	46.3(39.53.0)	42.1(35.1-49.5)
Servings of fruit and vegetables				
≥5 servings	32.0(27.4-37.0)	41.0(36.6-45.5)	22.5(18.1-27.6)	4.5(7.3-30.0)
< 5 servings	0.0	30.3(26.9-33.8)	42.8(39.6-46.1)	26.9(24.1-29.9)
Physical activity				
≥600METS/week	8.3(6.0-11.4)	36.2(33.2-39.4)	39.4(35.8-43.1)	16.1(13.7-18.8)
<600METS/week	0	10.2(6.2-16.4)	31.0(24.9-37.9)	58.8(48.6-68.2)