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RISK FACTORS ASSOCIATED WITH HYPERTENSION AMONG OLDER ADULTS: EVIDENCE FROM GHANA

BY

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DECLARATION

I, **Ahmed Duker**, the author of this thesis do hereby declare that, except for references to other author 's work and data used for the study, which have been duly cited, this thesis is the result of my original work submitted towards the award of a Master of Philosophy (MPhil) degree at the Institute of Statistical Social and Economic Research (ISSER), University of Ghana.

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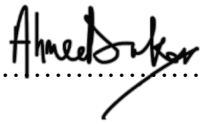
Signature……  …… Date…1st August, 2025……

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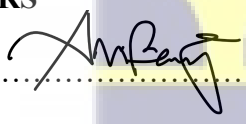
Signature……  …… Date…1st August, 2025……

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ABSTRACT

The growing burden of hypertension and other non-communicable diseases poses a critical public health challenge globally, with pronounced impacts on the health of older people particularly in low and middle-income countries. Hypertension tends to increase with age, and in Ghana, the increasing prevalence of hypertension coupled with a growing aged population has worrying implications for the health and well-being of older people. Existing literature explains that biological factors such as age and gender, social factors like marital status and education level, and lifestyle factors such as smoking and alcohol intake, all impact hypertension risk. The study sought to investigate the risk factors associated with hypertension among older adults as well as assess whether engaging in multiple lifestyle choices increased their hypertension risk. To achieve this, the study used the Biopsychosocial model of health as a guiding theoretical framework. The study also used datasets from the 2014/2015 World Health Organization's Study on Global Ageing and Adults Health (SAGE) Wave 2 and analysed both self-reported and field-measured hypertension to achieve a broad-based examination of hypertension prevalence and risk factors. The study employed the logistic regression estimation technique, and the findings revealed a 13.68 percent and 33.93 percent prevalence of self-reported and field-measured hypertension among older adults aged 50 years and above in Ghana. The study also found that demographic, socioeconomic and lifestyle factors increased the likelihood of hypertension among older adults and further discovered that engaging in multiple lifestyle factors increases the risk of hypertension for older adults. The implications of the results reaffirm the significant burden of hypertension and suggest the need for enhancing health interventions, including but not limited to promoting health screenings, weight management programmes, improving health systems, and widespread public education initiatives, led by the Ministry of Health.

DEDICATION

This work is dedicated to my family and friends; thank you for supporting and encouraging me to complete this thesis successfully. It is also dedicated to all who are interested in research for development.

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LIST OF ACRONYMS / ABBREVIATIONS

AU	African Union
BMI	Body Mass Index
CHPS	Community Health Planning and Services
DBP	Diastolic Blood Pressure
DHS	Demographic and Health Survey
FMH	Field-Measured Hypertension
FnV	Fruit and Vegetable
GDHS	Ghana Demographic and Health Survey
HBP	High Blood Pressure
HICs	High-Income Countries
LEAP	Livelihood Empowerment Against Poverty
LEKMA	Ledzokuku-Krowor Municipal Assembly
LMICs	Low-and-Middle-Income Countries
MMDAs	Metropolitan, Municipal, and District Assemblies
NCDCP	Non-Communicable Disease Control and Prevention
NCDs	Non-Communicable Diseases
NHIS	National Health Insurance Scheme
PASCAR	Pan-African Society of Cardiology
SAGE	Study on Global Ageing and Adult Health
SBP	Systolic Blood Pressure
SDGs	Sustainable Development Goals
SRH	Self-reported Hypertension
SSA	Sub-Saharan Africa
SSNIT	Social Security and National Insurance Trust
UN	United Nations
UNDP	United Nations Development Programme
VIF	Variance Inflation Factor
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The aged population is increasing rapidly around the world. The United Nations (UN) projects that the number of people aged 65 years and above will rise from 703 million in 2019 to 1.5 billion in 2050 (United Nations, 2019). The demographic shift has significant implications for both healthcare systems and the health of the ageing population, who are more likely to experience various health issues and challenges, including chronic ailments. Thus, various countries are putting measures to ensure that their health and social systems can address such challenges (Ibeneme et al., 2020).

There is a higher prevalence of chronic diseases, also known as Non-Communicable Diseases (NCDs), among older people, with many experiencing comorbidities and multiple morbidities (Taylor, 2018; Quiñones, 2016). Some common chronic (NCD) health conditions associated with older people include diabetes and hypertension, psychological (Alzheimer's, depression) disorders, sensory alterations (hearing loss, visual acuity), osteoarthritis, back pain, geriatric syndromes (falls, frailty, urinary incontinence, etc.) (Jaul & Barron, 2017; WHO, 2021).

Chronic conditions in older adults are influenced by several factors, including gender, geographical location, age, and others (Cagney, 2018; Jaul & Barron, 2017; Smith, 1997; WHO, 2001). Research suggests that women tend to experience high rates of disability and morbidity burden as they age, while men tend to have a high mortality rate and lower life expectancy (Bowling, 2009; WHO, 2001). Moreover, older individuals living in developing countries, particularly those in sub-Saharan Africa, are more likely to experience declining health conditions due to inadequate and poor health systems (National Research Council,

2006). A study by Jaul and Barron (2017) found that cardiovascular diseases, as well as physical and psychological health issues, are prevalent among older adults 85 years and above.

Chronic conditions are a growing concern, especially among the ageing population, and pose a significant threat to the population. Aside from the challenge of mortality, chronic diseases substantially increase the socio-economic burdens of societies as well (Mair, 2020; Mascie-Taylor, 2003; Mielck, 2014). Their quality-of-life declines, which affects the physical mobility and functional status of adults (Somrongthong, 2016) and vice versa. In January 2023, the political declaration of the third high-level meeting of the General Assembly on the prevention and control of NCDs and mental health discussed four key chronic diseases (Mielck, 2014). These were diabetes, cancer, chronic respiratory diseases and cardiovascular diseases, which included hypertension. These diseases have common risk factors and contribute significantly to the disease burden, especially hypertension, which is a pressing concern among older people living with chronic diseases (Buford, 2016; Mielck, 2014; Oliveros et al., 2020)

Hypertension, also known as High Blood Pressure (HBP), is described by the World Health Organisation (WHO) as a condition when the pressure in your blood vessels is too high (140/90 mmHg or higher) (WHO, 2023). As a leading cause of cardiovascular disease and premature death globally (Mills et al., 2020; Vijver, 2014), hypertension has become a significant threat to public health owing to the increasing aged population, exacerbated by the increase in the prevalence of obesity, alcohol consumption, physical inactivity, unhealthy diet, high sodium intake and low potassium intake (Oliveros et al., 2020; Sarki et al., 2015; WHO, 2023). What is alarming is that almost half of the people with hypertension are unaware they have the condition (WHO, 2023), putting their health at risk.

The incidence of hypertension among adults increased from 650 million cases to 1.3 billion cases globally in 1990 and 2019, respectively (WHO, 2023). Further, the prevalence of hypertension is location-specific, and according to Mills et al. (2020), the disparity in incidence depends on risk factors including obesity, low physical activity, high salt intake, and alcohol consumption. It affects about 31.5 percent of adults in Low-and-Middle-Income Countries (LMICs) compared to about 28.5 percent in Higher Income Countries (HICs) (Mills et al., 2020). In a cross-sectional study, Geldsetzer et al. (2019) found a hypertension prevalence rate of 17 percent among LMICs. Despite this pronounced prevalence of hypertension, there is still low awareness compared to just about a third of people in LMICs knowing their hypertension status (Schutte et al., 2021).

The prevalence varies widely among countries. In sub-Saharan Africa, an estimated 55% of older adults in the region have systemic hypertension (Bosu et al., 2019), and several African countries have reported a rise in the prevalence (Belue et al., 2009; Mohamed et al et al., 2018; Peltzer, 2013). For instance, Mohamed et al. (2018) reported that there was a 24.5% prevalence of hypertension in Kenya. Ware et al. (2019) also found a 43% prevalence rate in South Africa with high rates of undiagnosed and uncontrolled hypertension, while Drame et al. (2018) reported a 27.9% prevalence in Benin. The high prevalence can be strongly associated with changes in the individual and societal lifestyle, such as an increase in the use of tobacco, excessive alcohol intake, physical inactivity, unhealthy fats and oils, and adoption of western diets high in salt content and refined sugar (Vijver et al., 2013).

In Ghana, national estimates mirror regional patterns, with hypertension prevalence ranging from 13% to 30% with a disproportionately high burden among older people (Aheto & Dagne, 2021; Minicuci et al., 2014; Tannor et al., 2022; Tetteh et al., 2020). For instance, Tetteh et al.

(2020) reported a 15.8% prevalence, while Tannor et al. (2020) reported a 27.3% prevalence, signalling that there is undiagnosed hypertension among the population. The growing burden of undiagnosed and uncontrolled hypertension threatens health and well-being, especially for older people.

The United Nation's 2030 Agenda for Sustainable Development emphasises the importance of 'leaving no one behind' which includes prioritizing healthcare, poverty reduction, social protection, disability support, and addressing ageism and vulnerabilities in national agendas, particularly for older individuals who are considered high risk (Adeniji et al., 2023; Schröder-Butterfill & Marianti, 2006; United Nations, 2015). Given the significant burden of hypertension, it is essential to investigate its prevalence and risk factors to develop targeted interventions and evidence-based strategies that can effectively mitigate the health issue and ensure that all individuals, including older people, have quality healthcare.

Age is a significant risk factor for hypertension (CDC & NACDD, 2020; Jaul & Barron, 2017; Maresova et al., 2019; Prasad et al., 2012; United Nations, 2019), meaning older people stand a high risk of developing the disease. Thus, it is essential to prioritise this condition, especially in LMICs like Ghana, where NCDs and the aged population are both rising (Gyasi, 2018). Indeed, the principle of "leaving no one behind" also underscores the importance of prioritising the health of older people. This study aims to investigate the factors that contribute to hypertension among older people in Ghana. By achieving this objective, the data can assist the government of Ghana and its health agencies in developing national policies on hypertension, particularly among older people. It is important to focus on high-burden LMIC countries like Ghana, where NCDs are on the rise, particularly hypertension.

The study intends to gather a deeper understanding of the complex interplay between demographic, socioeconomic, and health-related variables that contribute to hypertension among older people, which ultimately informs the development of targeted interventions and evidence-based strategies to improve hypertension management and reduce its burden on the vulnerable old population.

1.2 Problem Statement

The Sustainable Development Goals (SDGs) Goal 3 aims to ensure healthy lives and promote well-being for all ages (United Nations, 2015). Specifically, target 3.4 seeks to "reduce by one-third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being" by 2030. In pursuit of this target, Ghana has implemented various measures to improve diagnosis and treatment, advancing research and education initiatives, and enhancing public awareness about NCDs, particularly, hypertension among older people. For instance, the Non-Communicable Disease Control and Prevention (NCDCP) Programme has the objective to reduce the incidence of NCDs, and their morbidity, and prevent NCD-related disability to ensure quality of life (Bosu, 2012).

Ghana has not been spared from the global challenge of hypertension. Some studies conducted in Ghana indicate that the prevalence of hypertension in Ghana ranges from 13% to 30% (Aheto & Dagne, 2021; Konlan et al., 2022; Minicuci et al., 2014; Sanuade et al., 2018; Tannor et al., 2022; Tetteh et al., 2020). It affects 1 in every 4 persons and accounts for about 4.7% of overall hospital admissions and about 15% of associated deaths (Atibila et al., 2021; Ghana Health Service, 2018). This alarming prevalence emphasises the importance of understanding the risk factors associated with the disease. There is a need for better prevention and control measures,

which include improved health screening and health education (Bosu & Bosu, 2021; Tannor et al., 2022).

Additionally, Ghana's elderly population is rapidly growing (Gyasi, 2018). The proportion of people aged 60 years and above increased from 200,000 in 1960 and 1.6 million in 2010 to about 2 million in 2021 (Ghana Statistical Service, 2013, 2021). As Ghana experiences these demographic shifts in the aged population, there are significant implications for public health and a pressing need to address the health concerns that older people face. Notably, WHO statistics confirm that older people are disproportionately affected by NCDs, such as hypertension (WHO, 2021). In a few years, NCDs will surpass communicable diseases and become the leading cause of mortality and morbidity for the age group in Ghana (de-Graft Aikins et al., 2012; Ministry of Health, 2021; WHO, 2018).

Hypertension is caused by risk factors grouped into two types: non-modifiable factors that cannot be changed, such as age, ethnicity, and family history, and modifiable factors that can be altered or changed, such as lifestyle factors including physical activity, body mass index, dietary needs, and smoking and alcohol consumption (Aheto & Dagne, 2021; Dai et al., 2022; Konlan et al., 2022; WHO, 2023). There is also an increasing obesity and weight in Ghana's ageing population, which contributes to increasing hypertension burdens (Ofori-Asenso et al., 2016). In Ghana, urbanisation has contributed to a surge in hypertension prevalence through high blood pressure, as urban areas are often characterised by a sedentary lifestyle, high consumption of westernised diets and processed foods high in salt and cholesterol, and declined physical activity and higher stress levels (Bosu, 2021; Ofori-Asenso et al., 2016). Yet, Appiah et al. (2021) assert that hypertension now expands beyond being associated with urban areas to becoming a worry for people living in Ghana's rural areas.

Comorbidities are also important in determining health outcomes. They are diseases that occur either simultaneously or sequentially with hypertension, thereby further increasing the disease burden on older people. It was found that older people who had arthritis, diabetes, asthma, and angina were significantly more likely to be hypertensive (Boateng et al., 2015). Also, the Ghana Statistical Service warns that diabetes adds up to hypertension as the top two diseases that affect people aged 50 years and above in Ghana. These comorbidities not only complicate the treatment of hypertension but can also contribute to morbidity and mortality rates. Also, while existing studies, such as those of Nguyen et al. (2019) and Lelong et al. (2019), suggest a link between engaging in multiple lifestyle risk factors and developing hypertension, there remains a need to further explore the interplay of these factors within specific populations, particularly among older adults in LMICs like Ghana. This study builds on this understanding by examining how these lifestyle risk factors collectively contribute to hypertension prevalence among older adults in Ghana, where some socio-cultural or economic contexts may influence the dynamics of these risks.

Addressing hypertension requires a collective and holistic approach to develop strategies that enhance diagnosis, provide accessible treatment mechanisms and promote education and awareness. Although treatment and management measures are key, awareness of hypertension remains alarmingly low, especially among older adults who are unaware of their condition. This lack of awareness is worrying as it hinders early detection and intervention, thereby increasing health risks among older adults (WHO, 2023). Apart from playing a critical role in improving health outcomes, awareness additionally addresses the root causes of hypertension.

Self-reported or hospital diagnosis has traditionally been used to diagnose or identify hypertension prevalence. However, research also indicates that these methods have often

underestimated the true burden of the disease (Gorber, 2008). In contrast, field measurement or community screening of blood pressure has proven to be effective in identifying undiagnosed or unrecognised cases of hypertension (Anker et al., 2018). Such proactive methods improve awareness and diagnoses of hypertension among a population, eventually enhancing hypertension management and improving health outcomes. According to Mills et al. (2016), raising awareness about the risk factors of hypertension is essential to managing blood pressure and reducing the general disease burden.

The increasing prevalence of hypertension in Ghana, coupled with a growth in the ageing population, poses a significant public health threat. To mitigate this threat, it is important to adopt a comprehensive strategy that prioritises understanding the risk factors that contribute to the development of hypertension among the ageing population. This study, therefore, adopts a twin approach. That is, it utilises both field-measured and self-reported hypertension data to assess prevalence and examine associated risk factors among older adults in Ghana.

Gaining insight into the risk factors among older adults is crucial for formulating policies aimed at improving the health and well-being of older adults and improving their quality of life to reduce hypertension prevalence. These reasons underscore the need for targeted research and interventions to address the unique challenges faced by older people. In this study, the terms "older people" and "older adults" are used interchangeably to refer to individuals aged 50 years and above, which is consistent with other health studies that confirm that it allows for a more nuanced understanding (Ayernor, 2012; Gyasi, 2018; Kowal & Dowd, 2001). By exploring these issues, the research contributes to the development of evidence-based solutions that address the increasing hypertension burden among the ageing population.

1.3 Research Questions

Based on the problem statement, the study considers the following questions.

1) What is the prevalence of hypertension among older people in Ghana?
2) What are the risk factors associated with hypertension among older people in Ghana for
    a. Self-reported hypertension among older people in Ghana?
    b. Field-measured blood pressure (hypertension) among older people in Ghana?
3) Does engaging in multiple lifestyle risk factors increase the risk of hypertension among older people in Ghana?

1.4 Research Objectives

1) To determine the prevalence of hypertension among older people in Ghana.
2) To identify and analyse the risk factors of hypertension among older people in Ghana
3) To determine whether engaging in multiple lifestyle risk factors increases the risk of hypertension among older people in Ghana.

1.5 Hypothesis

1) Diabetic older adults in Ghana are more likely to have hypertension than non-diabetic older adults.
2) Older adults with higher BMI are more likely to have hypertension than older adults with lower BMI.

1.6 Rationale

Hypertension is one of the leading causes of cardiovascular disease, mortality and morbidity in Ghana with high prevalence rates (Vijver et al., 2014; Bosu et al., 2019). At the same time, there is a growing ageing population in Ghana (Ghana Statistical Service, 2021). This study is relevant given the increasing prevalence of hypertension and the demographic shift towards an aged population. Also, due to the growing shift in health priorities in LMICs from infectious diseases to NCDs, there is an urgent need to fill critical information gaps on hypertension and its associated risk factors. Understanding these factors is essential for effective health planning and resource allocation. For instance, if hypertension is found to be more prevalent in urban areas, targeted allocation of health resources to urban areas can be prioritised.

This research explores key modifiable lifestyle risk factors for hypertension, such as smoking, alcohol intake, fruit and vegetable consumption, and salt intake. By identifying and analysing these factors, the study aims to provide actionable insights to inform government policies and public health interventions. The findings can shape strategies that promote healthy lifestyle choices, particularly for the ageing population who are at high risk of hypertension. This will contribute to the effort to reduce the disease burden and improve health outcomes.

Moreover, SDG Goal 3 Target 3.4 aims to "by 2030, reduce premature deaths from NCD by one-third through prevention and treatment and promote mental health and well-being" (United Nations, 2015). As significant contributors to communities, good health for older people is important to achieving this goal, as hypertension can affect their quality of life and hinder their contribution to development. Thus, findings from this study can also inform and orient health institutions and social work agencies with interventions to reduce the burden of hypertension among older people in Ghana, contributing to national and global health goals.

Lastly, the study examines both self-reported and field-measured hypertension, which addresses the limitations in other studies that rely on a single measurement method. By examining both approaches, this research contributes to a more comprehensive discussion of hypertension in Ghana, offering valuable insights to inform global health strategies and interventions.

1.7 Arrangement of Chapters

The chapters of the study are organised as follows: Chapter One presents the introduction of the study, with the background of the study, problem statement and research objectives. It is followed by Chapter Two, which contains a review of relevant literature and the theoretical model and theoretical framework. Chapter Three presents the methodology and sources of data for the study, while in Chapter Four, there is the presentation and discussion of the results. In chapter five, the summary of findings, conclusions and recommendations is centred on the findings of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a comprehensive review of existing literature on health and ageing concepts and how ageing impacts health and vice versa. The chapter discusses the prevalence of Non-Communicable Diseases (NCDs) and delves into hypertension and its prevalence. It explores associated factors that are relevant to hypertension. Furthermore, the chapter discusses the theoretical model and framework that underpins the study, aligning with the major themes and research objectives of this study.

2.2 Ageing Concept, Health and Population Dynamics

2.2.1 The Concept of Ageing

It is admissible that ageing, in principle, begins at birth. Yet, the concept is commonly used to typically refer to the later stages of life compared to the infancy and youthful stages of a person's life. There is a clear transition from being a child to becoming an adult, and this marks a significant shift in roles, responsibilities and experiences. Thus, the definition of ageing can vary depending on this transitional phase. However, Barrow and Smith (1979) outline six key factors that affect the concept and definition of ageing. They postulate that, firstly, societies often use specific age markers, such as pension schemes, to distinguish between youth and old age. Secondly, physical factors such as worsening muscle strength, poor blood circulation, weak sensory activity and skin elasticity naturally occur with ageing, differentiating it from a young person, although the functioning of these factors can be improved with lifestyle choices like exercise and healthy living. Thirdly, mental functions like memory, learning capacity and cognitive abilities play a role in defining ageing. Fourthly, individuals' self-concepts – how

they perceive their age – strongly affect their behaviour, attitudes and approach to life circumstances. Barrow and Smith (1979) further argue that the fifth factor, occupational factors, whereby people engage in physical hard work, can accelerate the ageing process due to injury or strain on health, although some individuals in these fields remain healthy into older age. While this is true, it is also important to note that a sedentary lifestyle can affect health and the ageing process. Lastly, stress may increase with age, as proposed by Barrow and Smith (1979), possibly due to factors to accumulated life experiences. However, it is important to note that this is not universal, as factors such as the availability of strong family ties and support, and the presence of wealth may reduce stress during older age.

Notably, people can exhibit characteristics commonly associated with older adults while they are still relatively young. Younger people may also possess attributes typical of older people. This underscores the importance of considering these individuals' differences when identifying the target population for research. Thus, to overcome these challenges, this study adopts a chronological definition of age, which focuses strictly on the amount of time an individual has lived. The ageing concept by Barrow and Smith (1979) provides insight into understanding how physical, societal and mental factors affect the health and well-being of older adults. That notwithstanding, the chronological definition in their concept definition allows a methodological level ground for the participant to be selected as a sample for the study.

2.2.2 Demographic Trends and Dynamics of Ageing

One of the primary reasons for ensuring an optimal health and social system is due to the impact of population demographic changes. Many countries need to adjust to address the consequences of population ageing, and its effect on health, availability of labour, economic

productivity and other social issues. According to WHO (2022), the rate of population ageing is accelerating at a pace that is faster than in previous decades, and the proportion of older person aged 60 years and above will nearly double to 2.1 billion (22%) by 2050 from 1.1 billion (12%) in 2015, with about two-thirds expected to live in LMICs. In recent times, LMICs, including Ghana, have experienced a significant increase in population ageing, although this used to be a usual characteristic associated with HICs such as Japan (WHO, 2022).

Some projections have been made as far as the population is concerned. The aged population in Nigeria, Ethiopia and South Africa is projected to be 12 million, 6 million and 5 million in 2030 (Velkoff & Kowal, 2006). Ghana has one of the highest proportions of elderly in sub-Saharan Africa (WHO, 2014), although it is considered a youthful population (Ghana Statistical Service, 2021). The elderly population (60 years and above) has increased nearly 10 times in the last six decades, from about 200,000 to almost 2 million in 2021 (Ghana Statistical Service, 2021). Similar to the WHO's high projection of the aged population in the coming decades for LMICs, the Ghana Statistical Service (GSS) projects that the population aged 60 years and above will continue to increase. From its recent population census, this age group grew from about 320,000 in 1960 to nearly 2 million in 2020. It is predicted that this number will more than double to nearly 5.6 million in 2050 (Ghana Statistical Service, 2020). They also find that about 25.7% of the elderly population is multidimensionally poor, with about a third (37.5%) of the elderly population employed. Kpessa-Whyte (2018) argues that this ageing population has significant social and economic implications for public policy and development, requiring the government to adapt and respond to these demographic changes.

As Ghana's population ages, population demographics can significantly affect disease prevalence among the aged due to their susceptibility, frailty and other vulnerabilities

(Brocklehurst & Laurenson, 2008; Lekamwasam & Lekamwasam, 2020; Kpessa-Whyte, 2018). These limitations affect their independence and ability to engage in livelihood activities.

Older adults are the main subject of interest in this study. They are a vital segment of society, deserving equal attention and consideration as any other group, and form an integral part of our community and development. They are disposed to high probabilities of weakening physiological, cognitive and physical functioning as well as contracting several acute and chronic diseases due to their increased susceptibility to diseases like diabetes, neuromuscular disorders, chronic renal failure and environmental factors such as poor living, ventilation and nutrition conditions (Bozzaro et al., 2018; Lekamwasam & Lekamwasam, 2020).

2.2.3 Ageing, Health Issues and Policy

This section discusses the health issues associated with ageing and the interventions that address them. As the population grows, there are implications for healthcare, health systems and policy. Jaul and Barron (2017) explain that the changes associated with older people's health can be divided into normal ageing (sensory change, immunosenescence, urologic changes), diseases and chronic conditions (cardiovascular disease, hypertension, cancer, osteoarthritis, diabetes, osteoporosis, physical function (walking speed, mobility disability, falls, frailty, incontinence), psychological and cognitive changes (cognitive ageing, dementia, depression) and social or environmental (loneliness or isolation). These changes demand attention, and there should be policies and health systems in place to ensure that health issues faced by older people have solutions. Policies can be an instrumental factor in addressing some of these issues, but it is important to understand what factors affect their health.

Many High-Income Countries (HICs) have good ageing policies in place for older people (Shetty, 2012), while in Africa, many countries are yet to develop and implement a comprehensive national policy on ageing (Shetty, 2012; WHO, 2020). As Africa's population is expected to experience a significant surge in aged people by 2050, according to the WHO (2022), countries in this region must accelerate the implementation of national policies that address ageing concerns and promote healthy ageing. According to Michel and Sadana's (2017) definition, healthy ageing involves the development and maintenance of functional abilities that contribute to the well-being of older people. In line with this perspective and referencing Jaul and Barron's (2017) categorisation of age-related changes, it is clear that health indeed plays an essential role in enabling older adults to maintain their functional abilities. Without good health, older people may struggle to perform everyday tasks, maintain social connections, move around independently, and contribute to their communities.

WHO collaborated with member states to develop and implement several national policies that support ageing and health. Key among these initiatives was the Global Strategy and Action Plan for Ageing and Health (2016-2020), which aimed to promote member action, create an age-friendly environment, align healthcare systems, create reliable and appropriate health systems for long-term care, and improve strategy for monitoring and studying the health of older people (WHO, 2016). Based on this effort, the WHO launched the Decade of Healthy Ageing (2020-2030), strongly linked to the SDGs to improve the lives of older people, their families and communities. The policy focuses on promoting research and data on older people, supporting member states' plans and actions, and implementing ageing policy (WHO, 2020). In contrast to Shetty's (2012) findings, which suggested that sub-Saharan African (SSA) countries were behind in enacting national ageing policies, Saka et al. (2019) revealed that several sub-Saharan African (SSA) countries have developed policies aimed at promoting

healthy ageing and access to healthcare services for the aged. Also, several of them had integrated NCD management into their policies. They realised that it was a health issue that caused devastating effects on older people in the region. The challenge discovered, however, was the need for proper implementation of the policies.

To achieve the objectives of the African Union Policy Framework and Plan of Action on Ageing (AU-Plan), the African Union (AU) proposed action plans to integrate preventive and curative care services for major NCDs into primary healthcare, and also enhance healthcare access for older people by eliminating financial barriers and establishing social protection programmes for older people (African Union, 2007). Ethiopia, Ghana, Kenya, Malawi, Mozambique, South Africa, Tanzania, Uganda, Zimbabwe, and recently, Nigeria and Rwanda are some SSA countries with national policies on ageing (Federal Ministry of Humanitarian Affairs, Disaster Management and Social Development of Nigeria, 2020; Rwandan Ministry of Local Government, 2021; Saka et al., 2019).

Ghana is one of the few countries in SSA that have policies that are directed at enhancing welfare and support for older people (Alidu et al., 2016; Saka et al., 2019). The Ghana National Ageing Policy, developed by the Ministry of Employment and Social Welfare (now Ministry of Gender, Children and Social Protection), was ratified to recognise the rights of older people, respond to their challenges, including health and security and include them in national development (Ministry of Employment and Social Welfare, 2010). One of the key tenets of the policy was to consider the factors that affect people during their older age and what guidelines the policy could offer. Implementation has, however, come with some challenges, ranging from finance, inadequate data about older people, and the formation of the National Council on Ageing that will coordinate the proper implementation (Ashirifi et al., 2022; Dovie, 2018;

Employment and Social Welfare, 2010). Other national ageing programmes include the National Health Insurance Scheme (NHIS), the Social Security and National Insurance Trust (SSNIT) and the Livelihood Empowerment Against Poverty (LEAP).

NHIS is a crucial aspect of healthcare systems, particularly for older adults. Fenny (2017) recommends that to enhance accessibility, the NHIS's target population should be expanded to include individuals who are aged 60 to 69, in addition to those who are 70 years and above, who are currently exempt from premium payment. Duku et al. (2015) reported that 45.3% of people aged 60 to 69 years indicated that the NHIS insurance premium was expensive and they could not afford it. The LEAP program, though it has its setbacks, is a cash transfer payment that contributes to alleviating poverty among older people 65 years and above, while SSNIT also makes benefits available to pensioners (Alidu et al., 2016; SSNIT, 2015).

The Non-Communicable Disease Control and Prevention (NCDCP) Programme was set up by the Ministry of Health in 1992 with the objective of reducing the incidence of NCDs, and their morbidity and preventing NCD-related disability to ensure quality of life (Bosu, 2012). Also, the Pan-African Society of Cardiology (PASCAR) established an action plan towards hypertension control in Ghana. Unfortunately, the initiative did not achieve significant progress due to poor adherence to established hypertension control and reduction measures, as well as low research support to produce evidence to guide the interventions (Sambah et al., 2023). These policies have largely been hindered by implementation and lack of support in terms of resources and finance (Bosu, 2012; Nyaaba et al., 2020; Sambah et al., 2023).

In conclusion, health issues have policy implications, and it has been indicated above how countries in Africa have even integrated NCDs as a core concentration in their ageing policy

frameworks (African Union, 2007; Saka et al., 2019). NCDs are indeed a crucial health concern for older people and governments (Jaul & Barron, 2017; Gyasi & Phillips, 2020; Minicuci et al., 2014; WHO, 2014; Yiengprugsawan et al., 2016).

2.3 Defining Older Adults in Ghana

There is no universally accepted numerical standard that defines who is an old or aged person. In Ghana, the elderly are noted for their wisdom during decision-making and problem-solving, and they have contributed immensely to the development of the country (Braimah & Rosenberg, 2021; Dosu, 2014). They should be paid attention to in matters relating to their health and well-being. They are regarded as essential contributors to the 2030 agenda for sustainable development across "poverty eradication, good health, gender equality, economic growth and decent work, reduced inequalities and sustainable cities" (UNDP, 2017).

The UN recommends defining 60 years and above as the recommended definition for old age (UNHCR, 2023). Some studies have defined who qualifies as an older person; likewise, in every country, which has an association with Barrow and Smith's (1979) ageing definition. While others have defined older people as 60 years and above (Mba, 2010; Newton et al., 2021; Tawiah, 2011; Waweru et al., 2003), the Ghana National Ageing Policy (Ministry of Employment and Social Welfare, 2010) adopts a similar definition. However, this study takes a much broader approach, considering individuals aged 50 years and above as older people. The definition has been used in various health and gerontological studies in Ghana, sub-Saharan Africa, LMICs and HICs (Awoke et al., 2017; Ayernor, 2012; Gyasi, 2018; Kowal & Dowd, 2001; Marshall et al., 2016; Phaswana-Mafuya et al., 2013). A particular consideration is the WHO Study on Global Ageing and Adult Health (SAGE) Wave studies in Ghana (Ayernor, 2012; Capistrant et al., 2019; Dai et al., 2022; Minicuci et al., 2014).

Ayernor (2012) posits that defining older adults to include 50-59-year-olds allows for a better comparison group for health research. Similarly, Keiron (2017), in exploring the health status of older people in sub-Saharan Africa, adopted the definition to include people aged 50 years and above, acknowledging that this range allows for a more nuanced understanding of the health profiles of the aged population. Moreover, a study on hypertension among older adults conducted by Marshall et al. (2016) in the United States and England, and Phaswana-Mafuya et al. (2013) in South Africa, supports the use of the 50 years and above age categorisation.

Moreover, the life expectancy rate - the average number of years individuals can expect to live in each country - has a significant indication of a population's health status. A high life expectancy is often indicative of a country's success in mitigating the prevalence (Martinez, 2021). Conversely, countries with low life expectancy are likely to experience a disease burden and have fewer individuals reaching old age, which means they are unable to live longer, all things being equal. According to the United Nations Development Programme (UNDP), Ghana's current life expectancy stands at 63.9 years, which is an improvement over the years, although lower than the global average of 72.6 (United Nations, 2024; UNDP, 2024). Given this relatively low life expectancy, it can be expected that people may experience early age-related health issues earlier than in other countries where life expectancy is higher. Hence, defining older adults in Ghana to include ages 50-59 years can capture more people who may experience health challenges at an earlier age than the life expectancy rate of 63.9 years. The inclusion of the age range of 50-59 years further provides another important perspective on the demographic characteristics of this age group.

2.4 Non-Communicable Diseases in Older People

NCDs significantly impact older populations, especially in developing countries. The increasing rate of NCDs in developing countries has been linked to significant demographic and epidemiological shifts, where people are increasingly faced with both infectious diseases and NCDs. Its burden has been increasing due to demographic ageing, behavioural changes, and developmental factors (Gyasi & Phillips, 2020). In the Asia-Pacific region, NCDs such as ischaemic heart diseases, chronic obstructive pulmonary disease, stroke and diabetes represent the major cause of mortality among older people aged 50 to 69 years (Yiengprugsawan et al., 2016). In Samsun, Turkey, elderly people were recorded to be living with at least one NCD (Canbaz, 2003). Similarly, in Africa, the disease burden of communicable diseases is shifting towards NCDs as was declared during the consultative review for the 6th session of the African Union Conference of Ministers of Health on NCDs (Van de Vijver et al., 2014). In SSA, the rapid increase in the population of older people is associated with a double disease burden of NCDs and contagious diseases (Gyasi & Phillips, 2020). For instance, Phaswana-Mafuya et al. (2013) reported that the incidence of chronic NCDs among older adults in South Africa was 51.8% with multimorbidity conditions.

Ghana's incidence of NCDs is on the rise and increasing with age, which threatens the quality of life of older people (Minicuci et al., 2014). Between 2008 and 2015, the burden of NCD morbidity increased by 8.2% while mortality increased by 7.7% (He et al., 2018). There has been significant progress made in managing NCDs. The NHIS, Non-communicable Diseases Control and Prevention (NCDCP) Programme, and other programmes have been ratified. Inadequate funding, lack of political will, low community awareness, and the cost of drugs, among others, continue to derail the proper implementation of the policies (Bosu, 2012).

For the elderly, the main health problems are chronic diseases and degenerative diseases, which increase with age (Yiengprugsawan et al., 2016). Among the NCDs, cardiovascular diseases, including hypertension, are very common in LMICs and are major contributors to mortality (Yiengprugsawan et al., 2016). Various literature notes that hypertension is the most dominant chronic disease or NCD among older people (Canbaz, 2003; Ibrahim et al., 2002; Mozaffarian, 2015; Phaswana-Mafuya, 2013; Vokonas et al., 1988). We focus on hypertension in this study to find out the determinants of the disease among older people.

2.5 Prevalence and Patterns of Hypertension

Hypertension, also known as High Blood Pressure (HBP), is a chronic disease characterised by persistent blood pressure levels in the arteries at or above Systolic Blood Pressure (SBP) / Diastolic Blood Pressure (DBP) 140/90 mmHg (Messerli, 2007; Oliveros et al., 2020; WHO, 2023). Hypertension has gradually become a common disease globally. An estimated 1.28 billion adults worldwide have hypertension, where two-thirds of this number live in LMICs and 46% also are unaware of their hypertension status (WHO, 2023). The disease, thought to be almost non-existent in Africa during the early twentieth century, is now said to be prevalent in Africa, where in some countries, about 40% of adults are hypertensive (Addo et al., 2007).

The condition has risk factors or determinants such as age, body mass index, diabetes, smoking, cholesterol, gender, diet, physical activity, alcohol consumption and health insurance, and when uncontrolled for some time can lead to events such as heart failure, stroke, dementia, and renal failure (Lloyd-Sherlock et al., 2014; Messerli, 2007; Minicuci et al., 2014; Van de Vijver et al, 2014; WHO, 2013). The risk factors are grouped into modifiable and non-modifiable risk factors. Modifiable risk factors include unhealthy diets such as excessive salt, high-fat foods, fruit and vegetable intake, physical activity, smoking and drinking, obesity, and pollution. The

non-modifiable risk factors include family history, age, and existing diseases like diabetes and kidney diseases (WHO, 2023). These determinants are important to understand to help identify key socioeconomic, sociodemographic, and lifestyle factors that increase the susceptibility to hypertension. Globally, hypertension is the leading avoidable risk factor for cardiovascular disease and all-cause mortality and has a significant burden on global health outcomes (GBD 2017 Risk Factor Collaborators, 2018). It affects one in every three adults without showing any symptoms, and in 2019, more than 50% of all cardiovascular deaths were due to high SBP (WHO, 2023).

Boakye et al.'s (2023) cross-sectional survey of NCDs among adults from 18 to 64 years at Ledzokuku-Krowor Municipal Assembly (LEKMA) Hospital in Ghana revealed that hypertension (22.7%) had the highest prevalence among the NCDs under study. This was a cross-sectional and institution-based survey, and they performed a multivariable logistic regression analysis to determine the factors associated with NCDs. They found that the observed prevalence of hypertension increased with age.

Tannor et al. (2022) also found from their cross-sectional May Measurement Month initiative survey in the Ashanti region of Ghana that hypertension prevalence was 27.3%. They also used simple and multiple logistic regression models to determine the predictors of hypertension. In investigating the sociodemographic and socioeconomic patterns of chronic NCDs among 4,724 older adults in Ghana, Minicuci et al. (2014) found that the prevalence of hypertension was 14.2% based on self-report and 51.1% based on field-measured data.

According to a systematic review and meta-analysis conducted by Bosu et al. (2019) to estimate hypertension prevalence among older adults in Africa aged 50 years and above, the

overall pooled prevalence rate was 57%. They, however, found that the prevalence was not significantly different between men and women, nor did it vary by place of residence or African sub-region. In Indonesia, a family life survey indicated a high prevalence of 62.5% among older people (Turana et al., 2021), whereas, in Bangladesh, Ghosh et al. (2023) noted an increase in the prevalence of hypertension to 40.4% in 2018 from 29.5% in 2011 during the 6th and 8th Bangladesh Demographic and Health Survey (DHS). Unlike Tannor (2022) and Boakye et al. (2023), Ghosh et al. (2023) employed the hierarchical mixed-effects sequential Poisson regression model to determine factors associated with hypertension.

In High-Income Countries (HICs) like Canada, a study that also examined chronic diseases among senior citizens who are 65 years and older identified about two-thirds (65.5%) of senior citizens to be diagnosed with hypertension, where people aged 85 years and above had the highest prevalence (Tam, 2020). Between 1988 and 2010, Bromfield et al. (2014) also found that controlled hypertension rose from 30.4% to 53.1%. Despite a well-set-up health system of HICs, hypertension remains a significant challenge (Nakagomi et al., 2022).

The definition of hypertension in population studies varies. While some scholars only analysed people who are aware or have been diagnosed that they have hypertension, for instance, Tetteh et al. (2020) in Ghana, others relied on only community screening or blood pressure measurements on the field, such as Drame et al. (2018) in Benin, and Aheto and Dagne (2021) in Ghana. Other studies also analyse both types of hypertension definitions. For instance, Calys-Tagoe et al. (2020) analysed hypertension prevalence in Ghana by examining both field-measured blood pressure and self-reported doctor-diagnosed hypertension in their studies. The field measurement of blood pressure complements already diagnosed hypertension to provide a broader assessment of hypertension.

2.6 Risk Factors of Hypertension

Many studies have researched the determinants of hypertension, especially among older people. These include examining socioeconomic, sociodemographic, lifestyle factors and other risk factors that are associated with the occurrence of hypertension. According to WHO (2017), a household member's health status is determined by their circumstances and environment (social and economic environment, physical environment and an individual's characteristics and behaviours), and individuals cannot control many of them. These are expanded into income, social status, education, physical environment, social support networks, genetics, gender and access to and use of health services. While access to and use of health services are important, their impact on health has less effect compared to factors such as geographical location, environmental conditions, genetic predisposition, income, education levels and social networks (WHO, 2017). Therefore, this study aims to examine the determinants that have a more significant influence on people's health outcomes.

2.7 Socio-Demographic, Socio-Economic Factors and Other Risk Factors

2.7.1 Age and Hypertension

The risk of developing hypertension increases significantly with age, making it a major health concern among older people (Buford, 2016; Cheng, 2022). Age is a key determinant of hypertension in older people (Hasan et al, 2018). As individuals age, their arteries stiffen, leading to increased Systolic Blood Pressure (SBP), which can culminate in hypertension (Kaess et al., 2012). Consequently, it is reasonable to expect that the older an individual gets, the higher the likelihood of developing hypertension. A cross-sectional study by Drame et al. (2018) in Benin found a significant association between age and hypertension. Research

revealed that individuals aged 60-69 had a higher hypertension rate compared to younger age groups, which aligns with the notion that hypertension tends to increase with age.

In Kenya, a national survey by Mohamed et al. (2018) examined the determinants and prevalence of hypertension in 47 counties. Using multiple logistic regression analysis, they found that older age was a significant determinant of hypertension. Individuals aged 50 years and above were significantly more than 5 times more likely to be hypertensive compared to those aged 18-24 years. Both studies by Drame et al. (2018) and Mohamed et al. (2018) focused on adults aged 18-69 years. Unlike their study, which targeted younger individuals, this study focuses on a specific age range of older adults aged 50 years and above. This target population still enables the study to achieve the objective of investigating whether hypertension prevalence continues to increase with age, as the literature suggests.

Tannor et al. (2022) screened 3080 participants in a cross-sectional survey in Ghana and discovered that, similarly, increasing age was a predictor of hypertension. They used simple and multiple logistic regression in their analysis. Although various studies have established the significant impact of age on hypertension, Cohen et al.'s (2012) study finds slightly different results. Their study used 78,590 nurses as the study population and followed them up for over 26 years. They found that as people get older, the link between certain modifiable factors, such as overweight, inadequate physical activity and others that can increase the risk of getting hypertension, becomes weaker. To find more grounded answers from various sources, Bosu et al. (2019) systematically reviewed 23 primary and multiple publications from 1980 to 2018 to determine risk factors for hypertension among older people aged 50 years and above. The mean ages were 62.7 ± 9 years to 76.9 ± 8.4 years. They found that the older age group was a key determinant of hypertension, like in other studies (Drame et al., 2018; Tannor et al., 2022;

Mohamed et al., 2018). This study examines individuals in Ghana 50 years and above to find out if similar predictions with age occur as has been established in other countries, such as Mohamed et al. (2018) in Kenya and Drame et al. (2018) in Benin, since both are LMICs.

2.7.2 Gender and Hypertension

Gender plays a key role in determining hypertension among men and women. Research indicates that there are significant disparities that exist between men and women in terms of the epidemiology and clinical characteristics of hypertension. These are not only reflected in the prevalence of hypertension but in the underlying risk factors that affect gender, for instance, age (Song et al., 2020). Men generally have a higher blood pressure than women throughout much of their lives, irrespective of ethnicity or race (Sandberg & Ji, 2012).

A cross-sectional survey conducted by Abegunde and Owoaje (2013) studied adults aged 60 and above living in urban and rural communities in Nigeria. Their analysis used logistic regression to establish that female gender was a significant predictor of hypertension in both rural and urban locations. Also in Benin, Drame et al. (2018) conducted studies on the determinants of HBP in three regions of Benin in 2015, revealing a significant association with higher hypertension prevalence among men compared to women. In Nepal, males were more likely to develop hypertension than their female counterparts (Hasan et al., 2018). Everett and Zajacova (2015), on the other hand, studied the gender differences in hypertension among young adults in the United States and discovered that women were less likely to have hypertension compared to men. However, Bantas and Gayatri's (2019) study found that this difference is only applicable to women who are less than 30 years old and that the incidence is higher among women than men. This largely occurs because, as women grow older and reach the menopausal stage, their blood pressure increases higher than in men (Leggio et al. 2017;

Reckelhoff, 2001). This study aims to investigate the difference in hypertension between men and women in Ghana, shedding light on the complex relationship between gender and hypertension.

In contrast to the findings of Hasan et al. (2018) and Everett and Zajacova (2015), Houinato et al. (2012) discovered that gender was not a significant risk factor for hypertension in Benin. Also, Bernabe-Ortiz et al. (2012) found no evidence of association between gender and hypertension in Peru until adjustments for variables were applied.

2.7.3 Marital Status and Hypertension

The literature reports mixed findings about the association between marital status and health. Marriage is a mutual social affiliation and support for many people, although singlehood may also be recognised as offering some stability and/or independence. Generally, married persons have better health advantages and outcomes than unmarried people (Amato, 2014; Huntington, 2022; Lawrence et al., 2019; Schoenborn, 2004; Verbrugge, 1979). Verbrugge's (1979) study revealed that people who are separated and divorced often have a worse health status, followed by people who are single and widowed, with people who are married showing a generally healthy status.

In contrast, other studies found no statistically significant association between marital status and health and well-being (Bosu et al.,2019; Dai et al., 2022; Schwandt et al., 2010). Bosu et al. (2019) reviewed 23 studies and concluded that marital status was of no importance to hypertension prevalence. In terms of effect, Karimi et al. (2025) studied the risk factors of type 2 diabetes among middle-aged and elderly populations. They found that divorced and widowed individuals were less likely to develop diabetes compared to those who were married. Also,

Tuoyire and Ayetey (2019) discovered that married, previously married, and cohabitating women had an increased risk of hypertension compared to single women. It is important to note, however, that health outcomes may be influenced not just by marital status itself. The quality of marriage and the marital environment do matter to health outcomes (Holt-Lunstad et al., 2008; Lawrence et al., 2019; Robards et al., 2012). Addai et al. (2015) explain that marital strain and a lack of commitment and support within the marriage can destabilise marriage, which could have a consequential effect on health.

2.7.4 Educational Status and Hypertension

Research incessantly depicts an inverse relationship between educational level and hypertension occurrence. According to Zacher (2023), the Health and Retirement Study dataset examines education disparities in hypertension prevalence and blood pressure among older people aged 50 years and above in the United States. He found that less educated older people were more likely to have hypertension than those who had more schooling years, using linear and unconditional quantile regression models. Drame et al. (2018) also found a highly statistically significant inverse relationship between higher education and hypertension in Benin, where those with primary education were less likely to have hypertension compared to those with less than primary education. Similarly, Capistrant et al. (2019) found that people with no formal education in South Africa were associated with higher odds of hypertension, but lower odds in Ghana.

In contrast to the above findings by Zacher (2023) and Drame et al. (2018), Abba et al. (2021) found a positive relationship between education levels and hypertension risk. Abba et al. (2021) used 2011 to 2018 DHS data from 12 countries, including Ghana. Some authors, however, did

not find any effect of education on hypertension risk (Dai et al., 2022; Bosu et al., 2019; Peltzer & Phaswana-Mafuya, 2013).

2.7.5 Residence and Hypertension

The residential status of individuals has also emerged as an important predictor of hypertension, with studies suggesting that residing in urban areas is associated with a higher prevalence of hypertension compared to rural areas. This could be related to lifestyle, diet and even access to healthcare between the two settings. The Ghana Statistical Service reported lower BP levels in rural areas compared to urban areas (Ghana Statistical Service, 2014). A bivariate analysis by Bosu et al. (2019) showed that hypertension was more frequent among older people residing in urban areas compared to people residing in rural areas, just like Wu et al. (2015) and Drame et al. (2018).

Addo et al. (2006) investigated four rural communities in Ghana's capital, Accra. Their study found that hypertension was no longer a rare disease in rural Accra, contrary to what was popularly known. Akpan et al. (2015) corroborated the findings of Addo et al. (2006) that hypertension prevalence was significantly higher among rural residents (44.3%) in Akwa Ibom State, Nigeria, compared to urban residents (28.6%). In Jilin province in China, as well, statistics from a cross-sectional study showed that rural areas (25.93%) showed significantly higher rates than urban areas (22.73%) (Wang et al., 2018). Could the findings of Addo et al. (2006), Wang et al. (2018), and Akpan et al. (2015) suggest a shifting epidemiological trend in hypertension prevalence? This study examines whether residing in an urban or rural area influences hypertension risk among older adults in Ghana.

2.7.6 Working Status and Hypertension

Research on the relationship between employment or working status and hypertension has revealed mixed results. An individual's working status can influence living conditions, income, stress levels, and access to healthcare services. Evidence suggests that the economic activity of older adults is associated with their risk of developing hypertension. Houle et al. (2021) found in South Africa that older people who were employed had a higher risk of hypertension, possibly due to work-related stress and unhealthy diet behaviours. On the contrary, a study in the United States by Aijaz et al. (2022) also reported that being employed was associated with a reduced odds of hypertension compared to being unemployed, highlighting the context-specific nature of this association. Similarly, Tetteh et al. (2020) reported that older adults in Ghana who were unemployed had a higher risk of hypertension compared to those who were employed.

Older adults who were not working were found to be unaware they had hypertension in Ghana, compared to individuals who were working (Calys-Tagoe et al.,2020), while Otieku et al. (2020) found that older adults who worked and retired before 60 years or worked fewer days per week experienced increased odds of hypertension. Contrary to some findings from LMICs, a retrospective cohort study in 13 countries in Europe found no association between working status and hypertension among older adults (Rumball-Smith et al., 2014). This suggests that the association between employment and hypertension may be influenced by some broader systemic factors, such as access to healthcare or the nature of the work, among others.

This study investigates whether being engaged in work is either protective or harmful for older adults in relation to hypertension in Ghana. It seeks to explore how the employment status may

influence the odds of hypertension among older adults using the WHO SAGE WAVE II dataset.

2.7.7 Ethnicity and Hypertension

Earlier studies have produced mixed results about ethnicity and hypertension. Ethnicity can be associated with genetic differences that can affect an individual's susceptibility to blood pressure changes and hypertension. Also, certain ethnic or cultural practices with dietary and lifestyle habits may contribute to behaviours that exacerbate hypertension. This study examines whether ethnicity is a significant risk factor for hypertension in Ghana.

Some researchers have shown that certain diseases are either restricted or highly common among different races and ethnicities. Neel (1997) discusses how crucial and significant ethnic differences exist in the frequency of some diseases among whites and blacks. He argues that blacks, for instance, have more susceptibility to sickle cell and hemolytic anaemia than white people based on genetics. Kurian and Cardarelli (2007), during their review of race and ethnic differences in cardiovascular disease risk factors, found that ethnicity was significantly associated with hypertension in blacks than in whites. Similarly, in South Africa, Phaswana-Mafuya et al. (2013) discovered from their investigation into the prevalence of NCDs among older adults in South Africa that the disease was highest among African Blacks (71.8%). Vaidya (2010) asserts that there are ethnic variations in blood pressure distributions that cause differences in hypertension prevalence, and observed that there were differences in hypertension prevalence between the Indo-Aryan and Tibeto-Burman groups in Nepal.

In Ghana, Bosu et al. (2019) found that ethnicity was among the risk factors associated with hypertension, although it was just a few studies that evaluated ethnicity as part of the

determinants of hypertension. A study in Calabar, Nigeria, revealed that the prevalence of hypertension among the people of the Efik ethnic group was significantly higher than people from other ethnic groups studied (Ekpo et al., 1992). In contrast to the studies that confirm a significant relationship between ethnicity and hypertension, Opoku et al. (2020) found that ethnicity was an insignificant determinant of hypertension.

2.8 Lifestyle and Other Risk Factors

The risk of hypertension can also be linked to lifestyle and behaviours. It is crucial to explore the relationship between modifiable risk factors such as dietary habits, alcohol consumption, smoking, and physical activity, and their potential to prevent, control, or manage hypertension. These modifiable risk factors have been collectively also referred to as health behaviours.

2.8.1 Body Mass Index (BMI) and Hypertension

Body Mass Index (BMI) is considered a metric for assessing the risk of certain diseases, including chronic diseases and a higher BMI is associated with an increased risk of developing these conditions (WHO, 2000). Based on an individual's height and weight, BMI can be calculated as weight divided by height (squared). The WHO has defined BMI for people older than 20 years to fall within one of the categories: below 18.5 is underweight; between 18.5-24.9 is normal weight; 25.0-29.9 is pre-obesity; 30.0-34.9 is obesity class I; 35.0-39.9 is obesity class II; above 40 is obesity class III (WHO, 2000).

Drame et al. (2018) noticed that in Benin, individuals who were obese were more likely to have hypertension than non-obese individuals in multivariate analysis. Bosu (2010) found from his systematic review of scholarly works on hypertension that obese people had 6.9 times the odds

of having hypertension as those with normal BMI. In a similar study by Mohamed et al. (2018), they found that BMI was a significant determinant of hypertension in both males and females. There was a positive association between hypertension and overweight and obesity in Kenya, such that individuals who were overweight and obese were close to two and three times more likely to be hypertensive compared to individuals with a normal weight. Hammami et al. (2011) studied elderly people in Tunisia and found that elderly people with hypertension had higher BMI. Minicuci et al. (2014) found that BMI was a common determinant of hypertension among older people in Ghana. On the other hand, Ukawa et al. (2015) found that both high and low BMI at the age of 65 increased the risk of hypertension over the next five years in men. In this study, BMI is expected to have a positive relationship with hypertension among older people.

2.8.2 Physical Activity and Hypertension

Physical activities such as walking, riding, stretching, and dancing have significant health benefits in reducing the risk of cardiovascular diseases like hypertension. It is an activity that increases movement in the muscles and helps in blood regulation (WHO, 2020). Thus, a lack of or inadequate physical activity is not good for health. The WHO (2020) provides guidelines on physical activity for older adults. It recommends that adults engage in at least 150 to 300 minutes of moderate-intensity aerobic exercise per week, or at least 75-150 minutes of vigorous-intensity aerobic exercise per week, or an equivalent combination of both, for numerous health benefits. This study examines whether older people in Ghana can meet these recommendations to reduce hypertension prevalence.

In Benin, people engaged in low physical activity were more likely to have hypertension compared to people who were involved in adequate physical activity (Drame et al., 2018). Diaz et al. (2017) also found that moderate-to-vigorous physical activity is associated with a reduced

risk of developing hypertension in African Americans. In contrast, no significant association was observed between physical activity levels and hypertension prevalence among older adults in South Africa (Gebreselassie & Padyab, 2015; Peltzer & Phaswana-Mafuya, 2012).

Despite the significant body of research highlighting the importance of physical activity in reducing the risk of cardiovascular diseases, including hypertension, some studies have overlooked its inclusion as a key determinant of these conditions (Calys-Tagoe et al., 2020; Tetteh et al., 2020). However, other studies have emphasised the importance of incorporating physical activity into healthcare models, just like Myers et al. (2015), who argue that physical activity has a significant impact on cardiovascular risk profiles and overall health outcomes and should be included in healthcare models.

2.8.3 Dietary habits (Fruit and Vegetables)

Fruit and vegetables are good for health, and an insufficient consumption of them is a contributor to the rising NCD burden globally (GBD 2017 Risk Factor Collaborators, 2018; Smith et al., 2022; Tachi et al., 2020). WHO emphasises that fruit and vegetable intake lower the risk of cardiovascular diseases, including hypertension (WHO, 2016). It is recommended to eat more than 400 grams (five portions) of fruits and vegetables each day to improve health and reduce the risk of cardiovascular diseases. (WHO, 2016).

A high fruit and vegetable intake is associated with a reduced hypertension risk in West Africa (Batubo et al., 2023; Drame et al., 2018). A similar discovery was made during the three-cohort study by Borgi et al. (2015), where a higher consumption of six or more servings of fruit per day was associated with lower hypertension risk. Akpa et al. (2022) studied the association between vegetable consumption and odds of hypertension in five African countries – Ghana, Nigeria, South Africa, Kenya and Burkina Faso. They discovered that individuals who

consumed at least 12 servings of vegetables a week were less likely to be hypertensive, especially among males and young adults. Moreover, Sumaila et al. (2021) found that a reduced fruit and vegetable intake was significantly associated with the risk of hypertension in Ghana. In Ghana, a study by Okyere et al. (2024) found no significant correlation between fruit and vegetable consumption and hypertension among older people, mirroring two findings from South Africa, which also found no significant association between fruit and vegetable consumption and hypertension risk (Peltzer & Phaswana-Mafuya, 2013; Tyrovolas et al., 2015).

2.8.4 Salt/Sodium Intake and Hypertension

Salt intake increases the risk of hypertension (WHO, 2023); thus, reducing salt intake can essentially reduce blood pressure. Batubo et al. (2023), in their systematic review of studies on salt consumption and hypertension in West Africa, found that high salt consumption was associated with increased odds of hypertension. Addo et al. (2012) also reviewed many studies in Ghana and found that salt was a significant risk factor for hypertension. Grillo et al. (2019) posit that a reduction in salt intake significantly reduces blood pressure and the incidence of hypertension. Interestingly, Agrawal et al. (2023) found from their study in India that older people who consumed far too little salt were likely to develop hypertension compared to older people who consumed far too much amount of salt. On the contrary, a study in Japan found no association between salt intake and blood pressure among the elderly (Yoshida et al., 2023).

2.8.5 Smoking and Alcohol and Hypertension

Sumaila et al. (2021) found that smoking was significantly associated with hypertension. Li et al. (2017) found that in China, current smoking was associated with an increased risk of

hypertension, whereas no association was found between past smoking and hypertension. On the other hand, Halperin et al. (2008) found that people who were past smokers and current smokers were more likely to develop hypertension than those who had never smoked. Addo et al. (2006) found that smoking status was not associated with hypertension in Ghana. Sumaila et al. (2021) discovered that alcohol intake was significantly associated with developing hypertension. Mohamed et al. (2018) found that the use of alcohol was positively associated with hypertension compared to non-use in Kenya. In contrast, Abegunde's (2013) and Addo et al.'s (2006) studies revealed no significant association between alcohol and hypertension in Nigeria and Ghana, respectively.

2.9 Comorbidities

Hypertension does not occur in isolation. It is frequently accompanied by comorbidities, which significantly impact the health of individuals. Comorbidities refer to the presence of one or more additional diseases occurring concomitantly with a primary disease (WHO, 2016). Comorbidities also contribute to an increased risk of hypertension (Boateng et al., 2015). In sub-Saharan Africa, hypertension is high among people with comorbidities like heart failure, depression, diabetes, stroke, chronic kidney diseases, dyslipidaemia and coronary heart disease (Mohamed et al., 2021). This study investigates whether there is a comorbid relationship between depression and diabetes and the likelihood of hypertension.

2.9.1 Diabetes and Hypertension

Diabetes is associated with increased odds of being hypertensive (Hypertension Study Group, 2001; Peltzer & Phaswana-Mafuya, 2013). Ekoru et al. (2019) examined type 2 diabetic individuals from Nigeria, Ghana and Kenya and found that hypertension was the most common

health complication that diabetic patients were more prone to. Also, Meng et al.'s (2012) meta-analysis concluded that depression increases the risk of hypertension. This study investigates whether diabetes increases the risk of hypertension among older adults.

2.9.2 Depression and Hypertension

Depression can lead to some disturbances in sleep, which can elevate blood pressure. It can increase the risk of hypertension, according to Meng et al. (2012) and Jackson et al. (2016). Patients with symptoms of depression exhibited a significantly higher likelihood of being hypertensive compared to individuals without any symptoms (Maatouk et al., 2016). In contrast, Mejia-Lancheros et al.'s (2014) results showed that individuals with symptoms of depression have better blood pressure control than those without the symptoms. Other studies, such as Wiehe et al. (2006) in Brazil and Geldsetzer et al. (2018) in South Africa, found no association between depression and hypertension among older people.

2.10 Multiple Risk Factors

The increasing rate of hypertension is largely attributed to various lifestyle factors. While certain factors, such as age, gender, and ethnicity, cannot be changed (non-modifiable factors), there are other factors that people can control through their choices or behaviour (modifiable factors). These modifiable lifestyle risk factors include salt intake, alcohol consumption, physical inactivity, tobacco use, fruit and vegetable intake, and BMI. Nguyen et al. (2019) analysed the association between six lifestyle risks, including BMI, physical activity, alcohol consumption, smoking, fruit and vegetable intake, and psychological distress, and their association with hypertension among middle-aged and older adults in Australia. Their analyses revealed that engaging in a high-risk or negative lifestyle is associated with increased odds of

hypertension. Cohen et al. (2012) also analysed the association between five modifiable risk factors, including BMI, physical activity, alcohol use, use of non-narcotic analgesics, and diet. They found that engaging in healthy lifestyles, such as lowering BMI and engaging in physical activity, was associated with a lower incidence of hypertension in older women compared to younger women in the United States.

However, in Spain, Diaz-Gutiérrez et al. (2019) also found that people who engaged in lower lifestyle risk factors such as lower salt intake, low alcohol consumption, physical activity, no smoking status, strict diet adherence and healthy BMI were associated with a lower risk of hypertension. Lelong et al. (2019) assert that engaging in two, three, or all healthy lifestyle factors, including physical activity, limited alcohol consumption, healthy BMI, and a healthy diet, is associated with a lower incidence of hypertension compared to those engaged in none or just one healthy lifestyle factor. Thus, making healthy lifestyle modifications jointly reduces the development of hypertension.

Doe and Asiedu (2023) defined modifiable risk factors to include obesity, excessive salt intake, alcohol intake, high-fat diet, lack of exercise and smoking as common risk factors of hypertension. Konlan et al. (2022) discovered that multiple modifiable risk factors, including alcohol, smoking, diet, BMI, salt intake and psychological factors, were associated with increased risk of hypertension in Ghana.

2.11 Identified Gaps in Literature

Numerous studies have demonstrated that hypertension is associated with serious morbidity and mortality. The findings suggest that the risk factors for hypertension are heterogeneous and multifaceted. Particularly, the susceptibility of older people is largely shaped by a range of

characteristics, which underscores the need for a nuanced inquiry. Review of the literary works shows that there are some critical gaps that need to be addressed, ranging from geographical, sample selection, variable selection and hypertension definition, among others. This study highlights several of the gaps observed in existing studies, including those conducted in Ghana.

In Ghana, Tetteh et al. (2020) defined hypertension in their study solely on self-reported cases diagnosed by a medical professional. In another study, Aheto and Dagne (2021) analysed hypertension using only systolic blood pressure. In Benin, Drame et al. (2018) also relied exclusively on the field-measured blood pressure of participants. However, there are limited analyses in Ghana that analyse both field-measured and self-reported cases diagnosed by a medical professional, such as that of Calys-Tagoe et al. (2020), who incorporated both field-measured blood pressure and self-diagnosed cases diagnosed by a professional for their analyses. Though their study covered both self-reported and field-measured hypertension, it did not include lifestyle factors such as drinking habits, smoking, and physical activity, among others, as part of their independent variables. In this study, these variables are included to analyse both self-reported and field-measured hypertension.

Dai et al. (2022) analysed the WHO SAGE Wave 1 dataset collected from 2007-2010, to investigate risk factors associated with hypertension among older people. However, their study did not account for other significant factors, including ethnicity and salt intake, which have been established to be key risk factors for hypertension. Drame et al.'s (2018) study in Benin defined old people as individuals aged 18 years and above. This study, on the other hand, focuses on individuals aged 50 years and above living in Ghana. Furthermore, Tannor et al.'s (2022) analysis in Ghana defined their population to include individuals aged 18 years and above. They, however, conducted their study only in an urban area, Kumasi Metropolis, using

an opportunistic sampling method. In contrast, this study uses a multistage cluster sampling method to select a population aged 50 years and above. Again, Tannor et al. (2022) did not include salt intake, physical activity, smoking and fruit and vegetable intake as risk factors for hypertension. This study includes the variables indicated above that were not included in other studies. Sections 2.6 and 3.3 explain in detail the variables considered in this study, which include those not considered by other scholars, as highlighted above.

Mohamed et al. (2018) and Hasan et al. (2018) both studied hypertension among older people in Kenya and Nepal, respectively, defining older people as those aged 18 years and above. They used field-measured SBP and DBP to diagnose hypertension, like Aheto and Dagne (2021). This study uses both field-measured blood pressure and self-reported blood pressure diagnosed by a health professional to define hypertension. Hasan et al. (2018) did not include physical activity, salt intake, smoking, and diabetes as risk factors for hypertension. Unlike their study, we focus on individuals aged 50 years and above. The Hypertension Study Group (2001) study in Bangladesh and India did not include alcohol, depression, and ethnicity as risk factors for hypertension. This study includes these variables to provide a comprehensive understanding of the hypertension risk factors. Besides, we changed the location to use Ghana for the study to enhance geographical comparison. Capistrant et al. (2019) used the WHO SAGE Wave 1 dataset and used self-reported hypertension and field-measured blood pressure to define hypertension, like this study. However, they did not include salt, fruit and vegetable intake in their study as risk factors for hypertension.

There is also limited information on whether engaging in multiple lifestyle risk factors influences hypertension. Previous studies in Ghana and other LMICs have extensively examined modifiable risk factors for hypertension, such as alcohol intake, obesity, and

smoking, among others (Capistrant et al., 2019; Drame et al., 2018; Konlan et al., 2022; Tetteh et al., 2020; Tannor et al., 2022). While these studies are revealing, they have not specifically explored how engaging in multiple lifestyle risk factors compounds the risk of hypertension, as done in other studies in advanced regions like Australia, the United States and Spain (Cohen et al., 2012; Diaz-Gutiérrez et al., 2019; Nguyen et al., 2019). Nguyen et al. (2019), for instance, included psychological distress as part of the modifiable lifestyle risk factors. However, this study does not recognise psychological distress as a modifiable risk factor because it is seen as a mental condition rather than a behaviour or lifestyle. Cohen et al. (2012) also only examined the effect of lifestyle risk factors concerning women, while also omitting tobacco and salt intake, which are two known lifestyle risk factors. Although several authors - such as Aheto & Dagne (2021), Calys-Tagoe et al. (2020), Tetteh et al. (2020), Menyanu et al. (2021), and Ware et al. (2019) – have used the WHO SAGE WAVE datasets to explore risk factors of hypertension but they did not analyse the cumulative effect of the modifiable risk factors on hypertension.

Thus, there are research gaps to be addressed by this study in the context of Ghana, where hypertension is increasing among older adults. It is important to understand this combined effect of modifiable lifestyle risk factors because it is critical for hypertension discussion and interventions. In this study, the modifiable lifestyle risk factors are physical activity, smoking status, BMI, fruit and vegetable intake, alcohol consumption, and salt intake. Further information on how these variables were defined or categorised is discussed in section 3.9.

2.12 Theoretical Model

The theoretical model for the study is founded on the Biopsychosocial Health Model, which offers a structured framework for analysing the complex interaction between risk factors and

the occurrence of hypertension. The model guides the methodology of this study, which will be detailed in Chapter Three, and provides a pathway for the findings in Chapter Four.

2.12.1 Biopsychosocial Model of Health

The Biopsychosocial Model of Health was propounded by George Engel (1977) as a response to the limitations of the traditional biomedical model used by clinicians, which assumed that chemistry and physics would ultimately explain biological phenomena and the development of a disease. The biomedical model solely focused on the disease, emphasising the associated symptoms, laboratory tests, and the treatment of the illness; it exclusively considered medicinal remedies. Engle (1977) argued that health and diseases cannot be fully understood through medicinal remedies alone or by focusing only on the disease, without considering other factors. According to him, before a disease is diagnosed and symptoms are recognised, followed by clinical manifestations, people experience certain circumstances that influence the disease outcome. Engel categorised these circumstances into three main areas: biological, social and psychological factors, including individual lifestyle behaviours. This addresses the reductionist and linear causation approach of the biomedical model. Engel argues that these factors interact to predict or influence health outcomes (Engel, 1977).

The biological factors involve the aspects of biology and physiology, including genetic makeup, that influence health (Engel, 1977; Schneiderman et al., 2005). The psychological aspect involves the emotional and mental factors that play a crucial role in determining an individual's health. The social factors capture a broader range of socioeconomic determinants of health and the social context in which the individual lives (Engel, 1977; Schneiderman et al., 2005). Bolton and Gillett (2019) assert that psychological factors can include lifestyle factors comprising attitudes and behaviours such as exercise stress, alcohol use, smoking and

diet. They argue that psychological factors influence lifestyle behaviours, justifying why the two are closely related. Habtewold et al. (2016) also support this analogy and group psychological and lifestyle factors together, validating their close relations. The elements of the model are interconnected, where the biological factors can affect the psychological thoughts or lifestyle behaviours, which can also affect or be affected by socioeconomic factors, and the cycle continues.

The Biopsychological model offers a framework for understanding the determinants of diseases and subsequently developing effective treatment strategies by considering not only the biological factors but also the patient's characteristics and the social context in which they live (Engel, 1977). Further research has enhanced the model over the years. For instance, Bolton and Gillett (2019) emphasise the importance of understanding disease risk factors within the broader context of disease dynamics. They argue that, during the early times when Engle propounded the model, knowledge about the causes and complexities of disease was limited, compared with the current epidemiological findings available in recent times. Therefore, behavioural or lifestyle factors like alcohol and smoking, dietary habits, and exercise have since become critical areas in understanding disease risks and patterns. In practice, the model involves recognising the subjective experiences of the patient as a crucial element in achieving accurate diagnosis, improving health outcomes and ensuring compassionate care (Borrell-Carrío et al., 2004).

According to Havelka, Despot Lučanin and Lučanin (2009), the model has provided valuable utility in addressing chronic NCDs and promoting patient-oriented care. Despite its usefulness, it has come under some criticism for being vague and lacking scientific rigour, leading to misuse (Weiner, 2008; Roberts, 2023). However, Gatchel and Turk (2008) assert that these

criticisms are superficial and eulogise the biopsychosocial model's effectiveness in enhancing disease assessment and treatment methodologies.

The model has had implications for health research and practice. It has consistently shown that hypertension is influenced by a multiplicity of biological, psychological/lifestyle and socioeconomic factors, and not only biological factors as asserted by the traditional biomedical model. They span across various sociodemographic, socioeconomic, lifestyle or cultural habits and comorbidities in the literature (Bosu et al., 2019; Minicuci et al., 2014; Peltzer & Phaswana-Mafuya, 2013). The factors can act together or independently in causing the occurrence of illness, regardless of the biological predisposition of the individual.

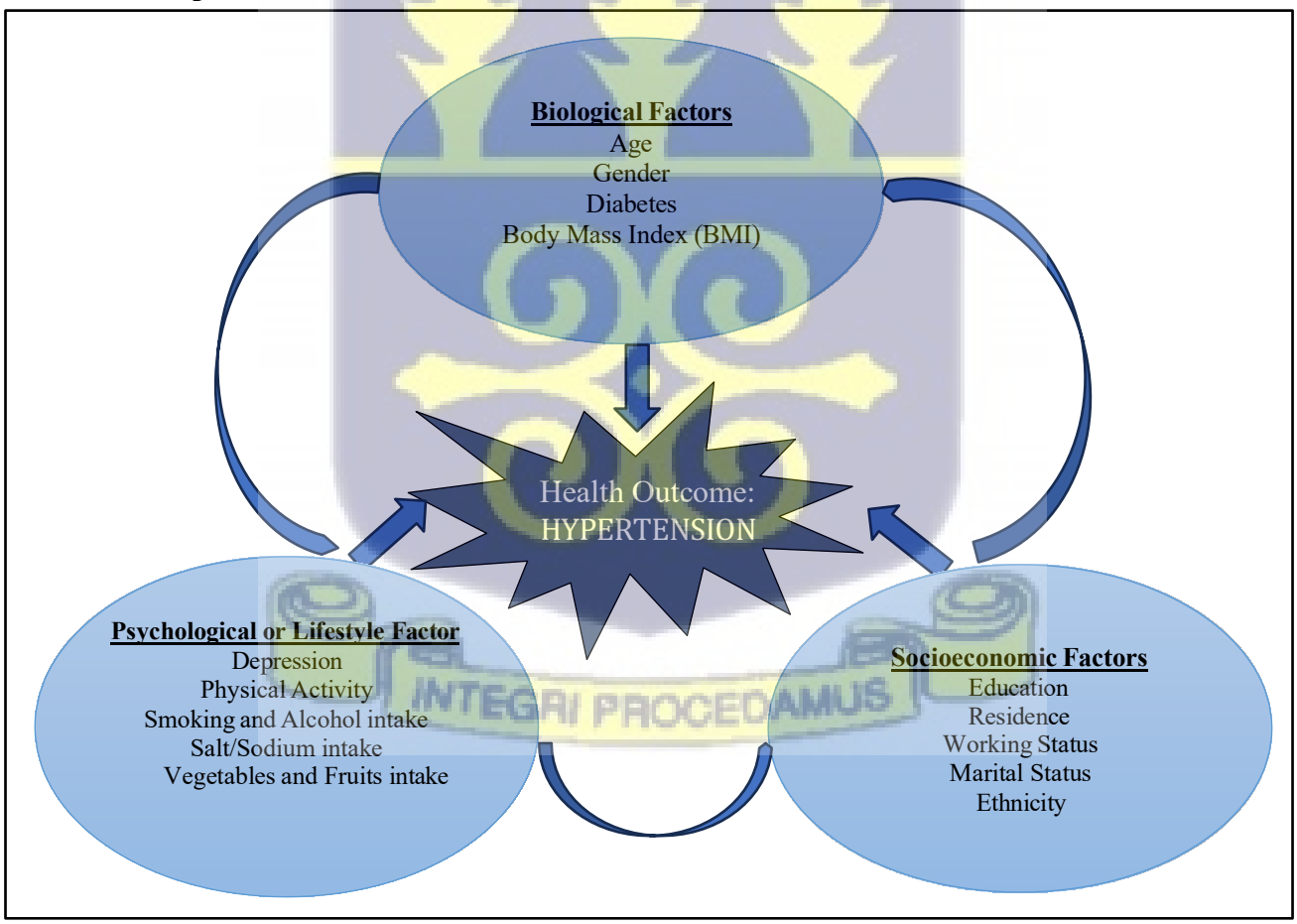
The risk factors associated with hypertension are strongly linked to the biopsychosocial model of health. Recognising the significance of these factors is crucial for acknowledging their potential for hypertension development among older people. Thus, establishing a relationship between these factors and the risk of the disease is essential for informing effective prevention and treatment strategies that can not only shape policies but also guide clinicians in diagnosing and managing the illness. This study agrees with Engel (1977) that assigning single blame to biological factors for a disease's development and progression is insufficient, as it fails to account for the complex social and behavioural factors that contributed to the person's illness.

2.12.2 Theoretical Framework

Based on the Biopsychosocial Model of Health, this study theorises a framework to investigate the complex factors influencing hypertension in older adults. The framework illustrates that the risk of hypertension among older adults is determined by biological factors, socioeconomic and psychological/lifestyle risk factors. Figure 2.1 highlights the biological factors like age,

gender, diabetes, BMI and blood pressure. These factors are intrinsic and measurable characteristics that reflect the internal functioning of an individual's physiological state and body functioning. They also reflect the internal functioning of people's physiological state and body functioning that can affect health outcomes. Physical activity, smoking, salt, fruit and vegetable intake and alcohol intake are behavioural or lifestyle factors that either cause illness or exacerbate it. Depression is a mental health disorder that affects an individual's behaviour and thoughts. Psychological and lifestyle factors are grouped together because of the similarities they share, as explained by Habtewold et al. (2016) and Bolton and Gillett (2019). Socioeconomic factors include ethnicity, working status (employment), education, residence, and marital status, as they represent the social and economic contexts that affect health.

Figure 2.1: Biopsychosocial Model of Health: Determinants of Hypertension among Older People



Source: Developed by the Author based on Engle's (1977) Biopsychosocial Model of Health

Figure 2.1 illustrates the interconnectedness between these factors, which have been examined in the literature to influence hypertension. An individual's biological, psychological or lifestyle and socioeconomic characteristics can influence their risk of developing hypertension. Research has shown that factors such as age, gender and place of residence, and others, are associated with the risk of hypertension. For instance, women may be at a higher risk of hypertension compared to men. Also, individuals living in urban areas may be highly exposed to the disease risk compared to those living in rural areas. There may also be an interaction of multiple factors that can shape the risk. For instance, a 70-year-old unmarried woman living in an urban area may be at a higher risk compared to others in contrasting situations. The biopsychosocial model of health, therefore, provides the lens through which the odds of hypertension could be examined by analysing the interplay among the biological, social and psychological factors.

CHAPTER THREE

METHODOLOGY AND DATA SOURCES

3.1 Introduction

This chapter provides a detailed methodology and sources of data used in the study. Two types of hypertension diagnosis are considered: self-reported hypertension (SRH), where individuals have been diagnosed by a doctor, and field-measured hypertension (FMH), which identifies hypertension cases through measurement of blood pressure on the field, providing a full scope of hypertension prevalence. From the literature review, scholars used various methodologies to examine this issue, including primary data, secondary data or both. The chapter breaks down the estimation technique that is used for the study to obtain the best approximation for the population based on the sample data. The diagnostic check was conducted to ensure that the results obtained were consistent, efficient and reliable. The rationale behind the selection of the variables is also explained in this chapter, although this has been partially discussed in sections 2.7, 2.8 and 2.9.

3.2 Data

3.2.1 Study Design and Study Population

This study used the WHO SAGE Wave II (2014/2015) dataset: i.e., a nationally representative cross-sectional survey within a multi-country longitudinal survey. The SAGE Wave II comprises individual and household data on the health and well-being of adult populations across six countries (China, Ghana, Mexico, India, South Africa, and Russia). This study analysed the dataset from Ghana, which serves as secondary data since it was collected originally by another researcher or institution. The analyses of secondary data allow

researchers to answer different or additional research questions than were originally intended (Schutt, 2007).

Health research, like hypertension studies, has a complex nature in terms of design and costs, among others. This complexity has been effectively addressed by the WHO and its researchers in the survey using standardised research protocols (Kowal et al., 2012). Thus, the datasets for the study provided valuable insights and an efficient alternative to primary data collection. The dataset was selected due to its nationally representative nature, allowing for a comprehensive understanding of the study population. It provides statistics that reflect Ghana's demographic and socioeconomic statuses, allowing researchers to explore patterns, prevalence, risk factors, and other key variables relevant to health research, including studies on hypertension like this one. The survey was supported by the WHO and the Division of Behavioural and Social Research of the United States National Institute on Ageing. Specifically, the Ghana survey was a collaboration between the WHO and the Department of Community Health, the University of Ghana, and the Ministry of Health (WHO, 2015).

SAGE Wave II is the third survey in a series of surveys, following Wave 0 (2002-2004) and Wave I (2007–2010). The dataset captures information on adults aged 50 years and above, with a small sample of younger adults aged 18 to 49 years. The total sample size of the Ghana survey was 4,704 with household and individual questionnaires on chronic health conditions and health services coverage; health care utilisation; subjective well-being and quality of life; perceived health status; risk factors and preventive health behaviours; socio-demographic and work history; and social cohesion (Kowal, 2012; WHO, 2015). This study only analysed the data of older adults aged 50 years and above using the individual datasets. For SRH, there were 3,251 samples, while for FMH, there were 2,122. The WHO SAGE dataset has been analysed

by several authors (Agrawal et al., 2023; Aheto & Dagne, 2021; Calys-Tagoe et al., 2020; Dai et al., 2022; Minicuci et al., 2014).

As the study uses secondary data, there are some limitations that must be acknowledged. The dataset included various types of questions through a structured interview assessment module: Self-reported responses, such as whether participants were previously diagnosed with hypertension, how much salt they consumed, and their highest education level completed; direct physical measurements, such as anthropometric weight and height; and interviewer assessment, such as evaluating the accuracy of answers from participants, and assessing participant's cooperation. Responses from these question types were used in generating the full data for the WHO SAGE WAVE II. Although the self-reported data is subjective, the structured approach of the survey using standardised questionnaires and trained interviewers enhances the reliability of the responses. Participants were assumed to be capable of answering or reporting their experiences and behaviours accurately. The trained interviewers evaluated that more than 90% of participants were cooperative during the survey, while more than 75% also provided reliable information reflecting strong participant engagement and validation and which supports the general reliability of the data to be used for analysis. Exclusion criteria for this study included missing data on both dependent and independent variables and incomplete questionnaires.

3.2.2 Sampling Procedure and Technique

A multistage cluster sampling procedure was used to select the participants across the rural and urban areas in Ghana. In the first stage, the sampling units were stratified by Ghana's 10 administrative regions by then, including Upper East, Upper West, Northern, Brong Ahafo, Eastern, Ashanti, Volta, Western, Central and Greater Accra regions, across rural and urban

areas from each region. In the second stage, 20 households were selected from each cluster (WHO, 2015). The interview was conducted face-to-face using standardised questionnaires by trained interviewers. The questions focused on health and well-being, as mentioned earlier.

The design was well-suited for investigating the risk factors of hypertension among older people for several reasons. First, the dataset is comprehensive and includes many variables related to biological, socioeconomic and psychological factors, including lifestyle factors that contribute to the risk of hypertension. Secondly, the large sample size enhanced the representativeness of the estimates for the older adult population of Ghana.

Despite its utility in estimating disease prevalence and assessing disease risk factors, the cross-sectional design of the WHO SAGE survey II presents issues with establishing cause-and-effect relations between the variables of interest (Levin, 2006; Lloyd-Sherlock et al., 2014; Udofia et al., 2019). Moreover, while the dataset includes some self-reported measures, certain anthropometric measurements such as the blood pressure, weight and height of participants were recorded by trained personnel. The self-reported data obtained from participants may be subject to recall biases, particularly among older adults who might inaccurately report whether they have been diagnosed with hypertension by a medical professional. However, this limitation is addressed by the inclusion of the field-measured blood pressure readings taken by the trained personnel, which complement self-reported hypertension data and enhance the overall reliability of the hypertension estimates.

The data were analysed using some descriptive statistics to generate frequencies and measures of association between variables. We performed some inferential statistics on the data using multivariable logistic regression to determine the risk factors of hypertension. Multivariable

logistic regression is an analytical technique useful in determining the relationship between multiple independent variables and a binary dependent variable (Grant et al., 2019). It is very useful and popular in medical research in determining the factors that explain the development of a disease (Katz, 2003). Thus, it is a useful technique for this study because the outcome variable, hypertension, is binary, and the objective is to assess independent risk factors and their odds of association with hypertension. It is also theoretically consistent with the biopsychosocial model of health, which suggests that health outcomes like hypertension result from the interplay of multiple related factors. Given the binary nature of the dependent variable, whether hypertensive or not, multivariable logistic regression is an appropriate analytical method for estimating the odds of hypertension based on the conceptual framework and its biological, social and psychological variables. The multivariable logistic regression has been widely used in recent health studies that explore predictors of hypertension using secondary sources (Aheto & Dagne, 2021; Drame et al., 2018; Tannor et al., 2022; Tetteh et al., 2020).

Correlation analysis was also performed between the dependent and independent variables to test for the strength and direction of the association. Correlation analysis identifies potential associations between risk factors and outcomes, and plays a vital role in the variable selection process to help in modelling and checking for multicollinearity before running regression analysis (Senthilnathan, 2019). These methods were appropriate for the datasets, as they allowed for effective analysis of the multiple risk factors and the outcome variable. The analyses and testing were done with STATA/IC 16.

3.3 Ethical Clearance

The WHO SAGE Wave II survey was approved by the WHO's Ethical Review Board (reference number RPC149) and the Ethical and Protocol Review Committee of the College of

Health Sciences, University of Ghana. Thus, this study did not require separate ethics approval. The participants of the study provided written informed consent for the survey, which confirmed that participants understood and were made aware of the procedures and purpose of the study. Consent for the research of this nature is a necessary step that allows participants the opportunity to voluntarily engage in the study.

3.4 Description of Variables

This section presents a description of the key variables of the study, categorised into dependent and independent variables. The dependent variable is the outcome variable the study intends to investigate, while the independent variables are those that will help to determine the outcome. We elaborate on them below. These variables are all generated from the WHO SAGE Wave II Survey to enable us to achieve the objectives of the study.

3.4.1 Dependent Variable

1. **Hypertension**

   The dependent variable in this study is hypertension, which is defined as high blood pressure (HBP) among older adults. Hypertension, also known as high blood pressure, is a condition in which the pressure in the blood vessels is too high, defined as a Systolic Blood Pressure (SBP) level of 140 mmHg or above and/or Diastolic Blood Pressure (DBP) level of 90 mmHg or above (WHO, 2023). During the survey, participants were asked, "Have you been told by a doctor or healthcare professional that you have high blood pressure (hypertension)?" with responses Yes or No. These were defined as Self-Reported Hypertension (SRH). They were coded as 0 for 'No' and 1 for 'Yes'.

However, SRH only captured people who are aware that they have hypertension after having been told by a doctor or medical professional, suggesting that there may be other people who have hypertension but have not yet been diagnosed by a doctor. According to the WHO 2023 hypertension report, only 54 percent of adults with hypertension are diagnosed (WHO, 2023). This means about 50 percent of cases remain undiagnosed. To address this potential bias, field-measured hypertension (FMH) is included to account for undiagnosed hypertension through blood pressure measurement. Relying solely on SRH may lead to significant lacuna in understanding the full scope and dynamics of hypertension among older adults. Moreso, SRH may only present reporting errors and recall bias regarding people's hypertension status.

In the SAGE Wave II methodology, blood pressure was measured directly for all respondents, referred to as Field-Measured Hypertension (FMH). Trained personnel conducted three anthropometric measurements of SBP and DBP using validated wrist-worn BP devices, with participants seated and relaxed, with one-minute intervals between each measurement. Participants whose blood pressure measurements were 190/90 mmHg were regarded as hypertensive, coded as 1 and 0 for otherwise. Similar to other authors who analysed blood pressure in their studies, the first measurement was discarded and the mean of the last two measurements of blood pressure (Calys-Tagoe et al., 2020; Lloyd-Sherlock et al., 2014; Minicuci et al.,2014).

The rationale behind the addition of the field-measured hypertension is to allow the study to capture a large and/or other participants who have hypertension but have not self-reported as having been formally diagnosed by a professional. Limited studies in Ghana, such as that of Calys-Tagoe et al. (2020) and Minicuci et al. (2014), have used

both self-reported hypertension and field-measurement blood pressure to assess hypertension prevalence and risk factors. Calys-Tagoe et al. (2020) assert that self-reported hypertension is not sensitive enough to identify hypertensives in Africa. This means that people who are unaware of their hypertension status would also be captured by the field-measured hypertension procedure.

3.4.2 Independent Variables

We considered biological, socioeconomic and psychological factors, which are spread among demographic, socioeconomic and behavioural factors. These factors have been found in the literature to have an association with hypertension prevalence.

3.4.2.1 Biological Factors

1. **Age:** Age is a key demographic biological factor in the study. This is measured as a continuous variable recorded in years. As individuals age, the risk of developing hypertension increases, as captured in the literature (Hasan et al, 2018; Bosu et al., 2019). This suggests that older adults aged 80-90 years are likely to have more hypertension risk levels compared to those who are 70-80 years and 60-70 years, in that order. Cohen et al. (2012), however, find contrasting results to those of Hasan et al. (2018) and Bosu et al. (2019). If we understand the role played by age, it will help in identifying the group that is at greater risk, and interventions can be sought for them. Participants were asked, "How old are you now?". In this study, age has been categorised into 50-60 years, 61-70 years, 71-80 years, 81 years and above. Thus, the study investigates which age categories have the most significant risk of hypertension. The reference group is 50-60 years old. Older people and older adults are used interchangeably.

2. **Gender:** Gender refers to male and female, and these are mutually exclusive categories. Gender is also a demographic and biological variable. Interviewers recorded the gender of the participants as either Male or Female. Gender is categorised as a binary variable. The relationship between gender and hypertension risk is complex, producing varying results between women and men. While gender differences play a significant role in determining an individual's risk level, the literature is not uniformly consistent across the sexes, producing varying results. For instance, Hasan et al. (2018) found men at higher hypertension risk than women, whereas Abegunde and Owoaje (2013) found contrasting findings that women are more at risk of hypertension than men. These differing outcomes emphasise the complexity of the relationship between gender and risk of hypertension. The male gender is coded as 0 and the female gender is coded as 1.

3. **Diabetes:** Diabetes is a chronic disease which is a defect in insulin secretion and action to regulate blood glucose in the body (WHO, 2023). It can cause damage to the arteries and increase blood pressure (Climie et al., 2019). It is a hypertension comorbidity which can increase susceptibility to hypertension. This relationship has been well-documented in works of the WHO (2023) and the Hypertension Study Group (2001). In this study, participants were asked, "Since the last time we spoke, have you been diagnosed with diabetes (high blood sugar)?". Participants were made to answer 'Yes' for being diabetic or 'No' for non-diabetic, coded as 1 and 0, respectively.

4. **Body Mass Index (BMI):** BMI is a biological factor associated with hypertension risk. It is calculated as weight in kilograms divided by height in meters squared

(kg/m²). Anthropometric measurements of height in centimetres and weight in kilograms were taken on the field by trained research personnel. We use the results of the height and weight in calculating BMI. Height in centimetres was converted to meters to obtain a square meter (m²), whereas weight was already captured in kilograms (kg) by the data. BMI has been a strong predictor of hypertension, especially in older adults (Minicuci et al., 2014). In this study, BMI was recorded as a continuous variable and compared against WHO guidelines and classification on BMI for people older than 20 years: below 18.5 is underweight; between 18.5-24.9 is normal or healthy weight; 25.0-29.9 is overweight or pre-obesity; 30.0 and above is obesity (WHO, 2000). In this study, from the BMI calculations obtained from height and weight measurements, BMI is categorised according to the WHO guidelines above.

3.4.2.2 Socioeconomic Factors

1. **Marital Status:** Marital status is a socioeconomic variable that falls under the socioeconomic factors of the biopsychosocial health model. The marital status of an individual can affect their health, impacting hypertension risk. Some scholars report that people who have a history of partnership, such as marriage or cohabitation generally have better health outcomes than those with contrary relationship status (Amato, 2014; Huntington, 2022; Lawrence et al., 2019; Schoenborn, 2004; Verbrugge, 1979) while others hold found contrary results in their studies (Karimi et al., 2025; Tuoyire and Ayetey, 2019). In this study, participants were asked, "What is your current marital status?" The options were 'Never married', 'Currently married', 'Cohabiting', 'Separated/Divorced', and 'Widowed'. Never married, separated/divorced and widowed were grouped as 'not married', whereas currently married and cohabiting were grouped as 'married.

Therefore, Marital status was categorised into 'Married' and 'Not Married', coded as 1 and 0, respectively, in the study. The categorisation helps us understand how the two different types of marital status can affect health outcomes, herein hypertension.

2. **Education Status:** Education level is an important socioeconomic variable. There is an argument in the literature that the education level of individuals can also affect their health outcomes. Zacher (2023) found hypertension to be more prevalent among less educated individuals than educated individuals, whereas Peltzer and Phaswana-Mafuya (2013) found no association between education level and hypertension risk. In this study, participants were asked "Have you ever been to school?". Participants who answered 'No' were labelled as those with no formal education. Those who answered 'Yes' were asked a follow up question "What is the highest level of education that you have completed?" with options "Less than primary", "Primary School Completed", "Secondary School Completed", "High School Completed", "College/Pre-University/University Completed", "Post-graduate Degree Completed". For analytic purposes, the education categories were recoded into five categories. "0" = Less than Primary, "1" = Completed Primary, "2" = Completed High School (a merger of Secondary School Completed and High School Completed), and "3" = Completed Tertiary (a merger of College/Pre-University Completed and Post-graduate Degree Completed). "No education" = "5" was the other category for those who had no education, and was treated as the lowest level of education reported.

3. **Residence:** The type of locality where people live can influence their health outcomes based on some environmental factors and access to healthcare. Residence

is a sociodemographic variable under socioeconomic factors. In this study, residence was categorised as "0" for rural residence, defined as an area with less than 5,000 individuals, and "1" for urban residence, defined as an area with a population of 5,000 or more individuals. This classification is based on the official national classification of localities by the Ghana Statistical Service and used in the WHO SAGE surveys (Ghana Statistical Service, 2002; Minicuci et al., 2014). Field personnel indicated the place of residence of participants during the interview. Although individuals in urban areas can get access to healthcare easily compared to those in rural areas, which can improve health outcomes, they are also exposed to more pollution, stress and consumption of processed foods, some of which can contribute to hypertension.

4. **Working Status:** Employment or working status is an important socioeconomic variable that can help to determine the employment status of individuals and can also influence health outcomes. Relatively, individuals who are working may have access to economic resources than those who are not working. Consequently, they can be able to purchase healthcare to influence health outcomes. In other words, working status can influence hypertension by either being protective – offering individuals greater access to healthcare, or being harmful – exposing individuals to poor rest, stress and economic insecurities. Working status was used to determine the employment situation of older people in this study by asking the question, "Have you worked for at least 2 days during the last 7 days?" The question presented a proxy for the most recent engagement by older adults, as it captured those who were economically active. Although it did not explicitly indicate long-term employment, it is a good measure for identifying who was engaged in work, whether part-time, full-time, informal, formal or self-employed, at the time of the interview. Besides,

this measure has been applied in other studies, including those that analysed WHO SAGE WAVE data. They include Calys-Tagoe et al. (2020), Tetteh et al. (2020), Otieku et al. (2020), and Houle et al. (2021). In this study, working status was categorised into 0 for 'Not Working' and 1 for 'Working'.

5. **Ethnicity:** Ethnicity is the self-identification of a group. The literature suggests that certain diseases are more prevalent or specific to a particular population of ethnic groups. Although often considered a socioeconomic factor, ethnicity also carries genetic associations, as ethnic groups share an ancestral lineage. This shared lineage may influence behaviours, preferences, and ideologies, which may affect health outcomes. The prevalence varies among different ethnic groups (Bosu et al., 2019). In this study, participants were asked "What is your background or ethnic group?, with answers "Akan, Ga-Adangbe, Ewe, Guan, Gruma, Mole-Dagbon, Grusi, Mande-Busanga, and others. Ethnicity is coded as 0 for 'Akan', 1 for 'Ga-Adangbe', 2 for 'Ewe', 3 for 'Guan', and 4 for Gruma, Mole-Dagbon, Grusi, and Mande-Busanga grouped into 'Northern'. A composite variable was generated as 'Northern', to merge Gruma, Mole-Dagbon, Grusi and Mande-Busanga into one to provide a comparator.

3.4.2.3 Psychological and Lifestyle Factors

1. **Depression:** Depression can contribute to hypertension through stress and related behaviours. This can result in an increased risk of hypertension. Individuals were asked whether they had been told by a doctor that they had depression. To ascertain the seriousness of participants' depression levels and find an in-depth association with hypertension risk, some questions were asked to determine depression status.

In this study, depression is measured as a binary variable with responses 1 for 'Yes' and 0 for 'No'. Depression can lead to poor adherence to medication and harmful eating habits, exacerbated by sadness and lack of interest. These can disrupt normal blood pressure regulation. Refer to the Appendix for full depression questions.

2. **Physical Activity:** A lack of physical activity is not good for health. Adults should, thus, undertake regular physical exercise for good health outcomes. According to WHO (2020) guidelines on physical activity and sedentary behaviour, adults should engage weekly in at least vigorous-intensity or moderate-intensity physical activity, or an equivalent combination of both through recreation and sports, transportation and work or household chores. In this study, physical activity was determined based on several questions. In this study, three different items, including moderate activity, vigorous activity, and walking, were used to measure physical activity. For vigorous activity, individuals were asked whether they engage in work or vigorous intensity sports that cause large increases in breathing or heart rate for at least 10 minutes continuously. For moderate activity, individuals were asked whether they engage in work or moderate-intensity sports that cause small increases in breathing or heart rate for at least 10 minutes continuously. Lastly, for walking, individuals were asked if they walk or use a bicycle for at least 10 minutes continuously. In this study, for individuals who answered "Yes" to at least one of the questions, it is coded as 0 for 'Physically Active', and for those who answered 'No' to all, it is coded as 1 for 'Physically Inactive'.

3. **Smoking:** Tobacco negatively affects health and is a significant risk factor for hypertension, as the literature suggests (Li et al., 2017; Sumaila et al., 2021). In this

study, participants were asked, “Do you currently smoke any tobacco products? Responses were ‘Yes’, Yes but not daily’, and ‘Not at all’. A follow-up question was asked whether ‘In the past, did you ever smoke tobacco?” Responses were ‘Yes’, Yes but not daily’, and ‘No’. From the two questions, smoking status was then coded as 0 for ‘Non-Smokers’, 1 for ‘Current Smokers’ and 2 for ‘Past Smokers’.

4. **Alcohol intake:** Alcohol is also a common risk factor for hypertension (Sumaila et al., 2021), while Abegunde (2013) reported no association between the two. In this study, participants were asked, “Have you ever consumed a drink that contains alcohol (such as beer, wine, spirits)?” with “Yes” and “No” answer options. Answers were recoded: ‘0’ as No ‘Non-Drinkers’ and ‘1’ as Yes ‘Drinkers’.

5. **Salt/Sodium intake:** Salt is a risk factor for hypertension in the literature (Addo et al., 2012; Agrawal et al., 2023), although others also find no correlation (Yoshida et al., 2023). Salt consumption is a significant behavioural and lifestyle factor that can influence health, and studies have shown that perceived salt intake can shape dietary behaviours linked to the risk of hypertension. In this study, an objective measure of salt intake, such as a urine sample test, was not available in the dataset. Rather, the questionnaire focused on participants’ self-reported perceptions of their salt consumption, which provided answers to the level of consumption of salt consumption. Participants were asked about how much salt they consumed. Responses were ‘Far too much’, ‘Too much’, ‘Just the right amount’, ‘Too little’ and ‘Far too little’. The responses were recoded into a binary by combining ‘far too much’ and ‘too much’ as 1 (Too much) and ‘just the right amount’, ‘too little’ and ‘far too little’ as 0 (Not too Much). Other studies, such as Agrawal et al. (2023),

have used similar variables which analysed how much salt people consume and its association with hypertension risk.

6. **Fruit and Vegetable (FnV) intake:** Nutrition is important, and consumption of vegetables and fruits as part of a diet can be protective and reduce hypertension risk as they provide essential nutrients needed to improve health. The WHO recommends that we consume more than 400 grams (five portions) of FnV each day to improve health and reduce the risk of cardiovascular diseases (WHO, 2016). This serves as a guideline to confirm whether participants consumed the required servings of FnV. Participants were asked, "How many servings of fruit do you eat on a typical day? This can include a slice or bowl of fresh fruit." and "How many servings of vegetables do you eat on a typical day? This can include Kontomire leaves, carrots, garden eggs (aubergine/eggplant), cabbage, and green beans." In this study, a binary variable was created; a total of less than 5 servings of FnV per day was coded as '1' to represent inadequate FnV intake, whereas a total of 5 or more servings of FnV per day was coded as '0' to represent 'Adequate FnV intake.

Table 3.1: Variables and Expected Effect on Hypertension

Variables	Categories	Expected Relationship with Hypertension
Age	Continuous age groups (50-59, 60-69, 70-79,80+)	Positive (Increases with age)
Gender	Categorical (Male, Female)	Mixed (Hypertension may increase at a higher age for women than men)
Marital Status	Categorical (Married, Not married)	Mixed (Social support from marriage can influence hypertension)
Residence	Categorical (Rural, Urban)	Positive for Urban
Education level completed	Categorical (No Education, Less than Primary, Completed Primary, Completed High School, Completed Tertiary)	Negative (Higher education for better health outcome)
Ethnicity	Categorical (Akan, Ga-Adangbe, Ewe, Guan, Northern ethnic groups)	Mixed (Cultural factors may vary)
Working Status	Categorical (Currently working, Not working)	Mixed (Working group may be able to afford good health)
Smoking Status	Categorical (Non-Smoker, Current Smokers, Past Smokers)	Positive (Smoking deteriorates health and increases blood pressure)
Alcohol Consumption	Categorical (Drinkers, Non-Drinkers)	Positive (Alcohol consumption can increase blood pressure)
Salt Intake	Categorical (Too Much Salt, Not too much salt)	Positive (Too much salt intake contributes to hypertension)
Fruit and Vegetable (FnV) Intake	Categorical (Inadequate FnV, Adequate FnV)	Negative (low intake increases hypertension)
Physical Activity	Categorical (Physically Active, Not physically active)	Negative (Low physical activity increases hypertension risk)
Diabetes	Categorical (Diabetic, Not diabetic)	Positive (Comorbidity)
Depression	Categorical (Depressed, Not depressed)	Positive (Comorbidity)
Body Mass Index	Categorical (Underweight, Healthy Weight, Overweight, Obesity)	Positive (Higher BMI increases blood pressure)

Table 3.1 presents a summary of the various independent variables associated with hypertension. It is expected that variables such as age, residence, smoking, alcohol, salt intake, diabetes, depression and BMI will have a positive relationship with hypertension, whereas education level, fruit and vegetable intake, and physical activity will have a negative relationship. It is also expected that variables such as gender, marital status, ethnicity, and working status will have a mixed relationship with hypertension.

3.5 Diagnostic Test

A multicollinearity test was conducted to check if the risk factors that influence hypertension among older people in Ghana are unbiased and that the model can be relied on for credible estimation. Multicollinearity refers to the situation whereby two or more independent variables in a regression model are highly correlated with each other, which causes difficulty in determining how each independent variable affects the dependent variable (Wooldridge, 2016). This means that if there is multicollinearity, it increases the standard errors of the regression coefficients, which causes them to be unreliable because we cannot know the true effect of each independent variable (Daniels & Minot, 2020). Therefore, in this study, it is ensured that two or more independent variables are not highly correlated with each other.

The multicollinearity test was conducted using the Variance Inflation Factor (VIF) tool to ensure that the biological, socioeconomic and psychological/lifestyle factors are not highly correlated with each other. The VIF measures or quantifies how much the variance of a regression coefficient is inflated due to correlations among the independent variables (Montgomery, 2021).

3.6 Prevalence of Hypertension

In calculating the prevalence of hypertension, a frequency technique is applied as below. Prevalence is defined as the proportion of individuals in a population who have a particular disease at a specific point in time (Riffenburgh, 2012). The percentage is calculated as;

$$\text{Prevalence} = *\frac{\text{Number of people with hypertension}}{\text{Total Population}}: * 100$$

To obtain the prevalence per 1,000, it is multiplied by 1,000 to enhance clarity in public health reporting. Thus;

$$\text{Prevalence per 1,000} = >\frac{\text{Number of people with hypertension}}{\text{Total Population}}) * 1000$$

Both percentage results and per 1000 statistics enhance clarity for discussing the prevalence of diseases in epidemiological studies. Per 1000 statistics provide a clear count that provides more contextual population-level data for hypertension, whereas the percentages easily convey statistics on proportion and trends that can be compared with other populations.

3.7 Empirical Estimation

It has been elaborated in this study that the interest is to explore the factors that determine hypertension among older people. From the biopsychosocial model of health that guides the study, explained in section 2.11.1, it is estimated that:

Health outcome (H) = f (B, P, S)..... (1)

Then we can have a new equation:

Hyp = f (B, P, S)..... (2)

Where:

H is the health outcome

B is for biological factors

P is for psychological/lifestyle factors

S is for socioeconomic factors

f is a function that describes how the factors influence health outcomes

Hyp is Hypertension among older people

To investigate risk factors for hypertension, this study starts to develop a simplified health model to help us understand the foundational concept for the logistic regression model in Section 3.5. In the simplified general model;

$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i \quad , \qquad i = 1,2,3, \dots n$ ..... (3)

Where:

Y_i is the vector of the dependent variable for the $_i$-th observation.

β_0 is the intercept term representing the expected value of the dependent variable when x=0.

β_1 is the vector of the slope coefficient, representing the change in Y for a unit change in x.

x_i is the vector of the independent variable for the $_i$-th observation.

ε_i is the error term which explains the variability in Y that cannot be explained by the linear relationship with x.

This model helps us to understand how changes in x affect Y.

Based on (2) and (3), we substitute the variables to derive (4) below;

$Hyp_i = \beta_0 + \beta_1 Ag_i + \beta_2 Ge_i + \beta_3 Mar_i + \beta_4 Ed_i + \beta_5 Res_i + \beta_6 Wo_i + \beta_7 Eth_i + \beta_8 BMI_i + \beta_9 Phy_i +$

$\beta_{10} Sa_i + \beta_{11} Sm_i + \beta_{12} Al_i + \beta_{13} Di_i + \beta_{14} De_i + \beta_{15} Fv_i + \varepsilon_i$ ……..(4)

Where:

Hyp, β_0 and ε_i are previously defined. β_{1-15} represent the coefficients of the various independent variables. Ag is the Age of older people, Ge is their Gender, Mar is their marital status, Ed is their education level, Res is their residential location, Wo is their working status,

Eth is their ethnicity, BMI is their body mass index, Phy is their physical activity, Sa is their salt intake, Sm is their level of smoking, Al is their alcohol consumption, Di is diabetes comorbidity, De is depression, and Fv is fruit and vegetable intake. They represent the biological, psychological/lifestyle and socioeconomic factors considered to predict hypertension among older people in this study. Thus, a change in any variable would change the outcome variable. However, the hypertension outcome is binary, whether an older person is hypertensive or not. Therefore, the OLS regression model may be inadequate as it can predict probabilities outside 0 and 1.

3.8 Estimation Techniques

The main objective of the study is to determine the likelihood of specific variables as risk factors for hypertension among older adults. Logistic regression is used to estimate the probability of hypertension among older adults based on various risk factors grouped into biological, psychological/lifestyle and socioeconomic factors. Hypertension has a binary outcome with Yes or No (1,0) responses, thus logistic regression is suited for such an operation. Logistic regression estimates the probability of the two outcomes which fall within the range of 0 to 1 and also generates odds ratios to determine the strength and association between risk factors and the outcome variable (Boateng & Abaye, 2019). We therefore derive the binary logistic regression model based on the estimation equation. The estimates of the coefficients of each independent variable, explained in section 3.3, help to determine their effect on the probability of hypertension among older people. Under the model, we obtain the odds ratio, which is useful for interpreting the strength and the direction of the association between the predictor variables and the likelihood of hypertension. The logistic regression model is widely used in other similar studies where the dependent variable has a binary outcome (Bellavia et al., 2020; Boateng & Abaye, 2019; Kleinbaum et al., 1982).

We consider the logistic regression model below:

The outcome variable is Y_i, where:

$Y_i = 1$ indicates the event occurs (an individual has hypertension).

$Y_i = 0$ indicates the event does not occur (an individual does not have hypertension).

Thus, in defining the probabilities, the probability that the event occurs (an individual i has hypertension) is denoted by $P(Y_i = 1)$ while the probability that the event does not occur (an individual i does not have hypertension) is denoted by $1 - P(Y_i = 1)$.

The odds of having hypertension are the ratio of the probability that the individual has hypertension to the probability that they do not:

$$\text{Odds} = \frac{P(\text{F}_i=1)}{1-P(\text{F}_i=1)} \quad \ldots\ldots(5)$$

where if the odds are ≥ 1, it means the event (having hypertension) is more likely to occur than not occur.

Based on equation (5), we derive the logit function as

$$\text{logit}(\text{P}(\text{Y}_i=1)) = \text{In} > \frac{P(\text{F}i=1)}{1-P(\text{F}_i=1)}) \ldots\ldots$$

(6)

$$\text{logit}(\text{P}(\text{Y}_i=1)) = \text{In} > \frac{P(\text{F}i=1)}{1-P(\text{F}_i=1)}) = \beta_0+\beta_1X_{1i} + \beta_2X_{2i} + \cdots + \beta_nX_{ni} \ldots\ldots(7)$$

Based on equations (6) and (7), the logistic regression model becomes:

$$\text{logit}(\text{P}(\text{Y}_i=1)) = \beta_0+\beta_1X_{1i} + \beta_2X_{2i} + \cdots + \beta_n \ldots\ldots(8)$$

modelled as a linear combination of the independent predictor variables of hypertension.

Where:

Y_i is the binary outcome variable if the event occurs, 0 if otherwise, $Y_i = 1, or\ Y_i = 0$.

$X_{1i}, \ldots, \ldots, X_{ni}$ are the independent variables

β_0 is the intercept

$\beta_1, \beta_2 \ldots \beta_n$ are the coefficients of the independent variables to be estimated

We eliminate the logarithm and return to the odds, we exponentiate both sides of (4) to derive

$$\frac{P(F_i=1)}{1-P(F_i=1)} = e^{\beta_0+\beta_1X_{1i}+\beta_2X_{2i}+\cdots+\beta_nX_{ni}} \quad (9)$$

Equation (9) enables us to express the odds of an event occurring (having hypertension).

We then solve for probability $P(Y_i = 1)$;

$$P(Y_i = 1) = \frac{e^{\beta_0+\beta_1X_{1i}+\beta_2X_{2i}+\cdots+\beta_nX_{ni}}}{1+e^{\beta_0+\beta_1X_{1i}+\beta_2X_{2i}+\cdots+\beta_nX_{ni}}} \quad (10)$$

Equation (10) gives us the likelihood that an individual has hypertension based on the independent variables.

The dependent variable Y_i represents the occurrence or absence of hypertension. The independent variables are grouped into biological, psychological/lifestyle and socioeconomic, which has been extensively discussed in sections 3.3.2 and 2.7. From the initial empirical estimation, Health outcome (Hypertension)= *f* (*B, P, S*)

Where B represents Biological, P represents Psychological, and S represents socioeconomic factors. Biological factors include Age, Gender, Diabetes, and Body Mass Index. Psychological factors include depression, physical activity, smoking and alcohol intake, salt intake, and fruit and vegetable intake. Socioeconomic factors include, education, residence, working status, marital status and ethnicity.

Therefore, Integrating the empirical variables into equation (10):

$$P(Hypertension_i = 1) = \frac{e^{\beta_0+\beta_1B_i+\beta_2P_i+\beta_3S_i}}{1+e^{\beta_0+\beta_1B_i+\beta_2P_i+\beta_3S_i}} \quad (11)$$

Where:

B_i represents biological factors for an i-th individual

P_i represents psychological/lifestyle factors for the i-th individual

S_i represents socioeconomic factors for the i-th individual

Equation (7) presents the logistic formulae to estimate the probability of an individual having hypertension based on the biological, psychological/lifestyle and socioeconomic predictor factors. Including the various independent variables such as age, gender, BMI, smoking, and other biological, socioeconomic and psychological/lifestyle factors enables the model to account for the multifaceted nature of hypertension. Based on any i-th older person aged 50 years and above, it can be ascertained whether or not they have hypertension, based on their unique characteristics (independent variables). The coefficients of the independent variables will quantify the effect of the corresponding predictor on the log odds of having hypertension. Thus, each factor can be assessed on how it influences the likelihood of the outcome, hypertension.

3.9 Multiple Lifestyle Risk Factors Estimation

The third objective seeks to estimate whether engaging in multiple lifestyle-modifiable risk factors could increase the risk of hypertension among older people in Ghana. The lifestyle factors considered in this study include salt intake, alcohol consumption, smoking status, BMI, physical activity and fruit and vegetable intake. The variables are recoded where variables with more than two categories were collapsed as a binary to either define the presence or absence, or engaging in an act or not. For salt intake, it is coded as 0 for 'Not too much salt intake' and 1 for 'Too much salt intake'. Alcohol is coded 0 for 'Non-Drinkers' and 1 for 'Drinker'. For smoking, it is coded as 0 for 'Non-Smokers' and 1 for 'Smokers' who are past and current smokers. BMI is also coded 0 for 'Healthy and Underweight' and 1 for 'Overweight and Obesity'. Physical activity is coded 0 for 'Physically Active' and 1 for 'Not Physically Active'. Fruit and Vegetable intake is also coded 0 for 'Adequate intake' and 1 for 'Inadequate intake'.

A composite variable was generated that combines the independent variables to create a single summary measure. The measures for how the variables were categorised can be found in 3.4.2.

From equation (3) above, the multiple lifestyle risk factor estimation becomes;

$\text{Hyp}_i = \beta_0 + \beta_1 lifestlye\ factors + \varepsilon_i$ ..... (3a)

We fit (3a) into (11) above to derive $P(Hypertension_i = 1) = \frac{e^{(\beta 0 + \beta 1 Lifestlyefactors)}}{1 + e^{(\beta 0 + \beta 1 Lifestlyefactors)}}$ ...(12)

Thus, (12) will enable us to estimate whether engaging in multiple risk factors increases the odds of hypertension.

3.10 Conclusion

This chapter has discussed the data, its source and sampling procedure and the dependent and independent variables of interest. To understand how theory impacts practice, the biopsychosocial model of health and the generated framework were discussed to assess how they align with the study objectives. Further, statistical and empirical estimations are worked out to arrive at scientific results, which are presented and discussed in the results in Chapter 4.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 Introduction

The findings from the WHO SAGE WAVE II datasets, explained in Chapter Three, are presented and discussed in this chapter. The chapter also discusses the risk factors for Self-reported hypertension (SRH) and Field-measured hypertension (FMH) among older adults. The descriptive statistics of the variables, the association test and the diagnostic test are captured in this chapter as well. Finally, the results of the statistical estimations are analysed, along with the examination of the multiple lifestyle risk factors and their effect on hypertension among older adults. We compare them with previous studies conducted and discussed in Chapter Three.

4.2 Descriptive Statistics

This section presents a quantitative summary of descriptive statistics on the dependent variable, hypertension and the independent variables. Self-reported Hypertension (SRH) consists of participants who said they have been diagnosed with hypertension, and Field-measured Hypertension (FMH) consists of participants whose blood pressure was 140/90 mmHg and above. For the independent variables, Pearson's Chi-square test was used to establish associations with the dependent variables. More details on how the two hypertension variables are defined, how the independent variables were ascertained, and how the variables were recoded and categorised have been extensively discussed in Chapter Three.

Table 4. 1: Descriptive Statistics for Hypertension Prevalence

Dependent Variables	Frequency	Percent	Cumulative Frequency
Self-Reported Hypertension			
Not Hypertensive	1905	86.32	86.32
Hypertensive	302	13.68	100.00
Field-Measured Hypertension			
Not Hypertensive	2217	66.08	66.08
Hypertensive	1138	33.92	100.00

Source: Author's computation from the WHO SAGE WAVE II

Table 4.1 presents a quantitative summary of hypertension prevalence among older people. It provides an overview of hypertension among older adults concerning SRH and FMH. For SRH, 302 older adults representing 13.68 percent reported being diagnosed by a doctor to be hypertensive, while 1,905, representing a large proportion of 86.32 percent reported that they were not diagnosed by a doctor to have hypertension. Practically, this means that per every 1,000 older adults, about 137 have hypertension. For FMH, the results show that 1,138 (33.92 percent) older adults were found to be hypertensive, while 2,217 (66 percent) were not found to be hypertensive. For FMH, the results highlight a significant prevalence of hypertension, suggesting that per every 1,000 older adults, about 339 people have hypertension. Thus, 1 in every 3 older adults has hypertension. The significant difference between the SRH and FMH prevalence suggests a significant proportion of older adults have undiagnosed hypertension.

The results from Table 4.1 show significant hypertension prevalence rates. FMH shows a significantly higher rate of 33.92 percent compared to the SRH prevalence rate of 13.68 percent. This difference highlights that FMH has a wider coverage of hypertension prevalence in the population, including cases of undiagnosed or unaware hypertension among older adults. The observed prevalence of 13.68 percent and 33.92 percent for both SRH and FMH can be compared to those of other African LMICs. We find that it was 18 percent in Burkina Faso

(Soubeiga et al., 2017), 24.5 percent in Kenya (Mohamed et al., 2018) and 31 percent in Nigeria (Ogah et al., 2013). The variation could be due to the different settings, study designs and the independent variable selection.

Table 4. 2: Prevalence and Associated Risk Factors of Self-Reported Hypertension

Individual Variables	Self-reported Hypertension (SRH)		Pearson's Chi-square (P-value)
	No	Yes	
Age			4.72(0.1938)
50-59 years	88.11	11.89	
60-69 years	85.07	14.93	
70-79 years	85.00	15.00	
80 and above	88.64	11.36	
Gender			28.12(0.0000)
Male	90.36	9.64	
Female	82.59	17.41	
Marital Status			14.50(0.0001)
Not Married	83.44	16.56	
Married	89.02	10.98	
Residence			93.33(0.0000)
Urban	77.70	22.30	
Rural	92.12	7.88	
Education Completed			45.75(0.0000)
No Education	91.04	8.96	
Less than Primary	84.29	15.71	
Completed Primary	83.00	17.00	
Completed High School	81.63	18.37	
Completed Tertiary	72.84	27.16	
Ethnicity			24.58(0.000)
Akan	85.56	14.44	
Ga-Adangbe	81.25	18.75	
Ewe	82.05	17.95	
Guan	77.78	22.22	
Northern	91.28	8.72	
Working Status			23.13(0.0000)
Not Working	81.77	18.23	
Working	89.19	10.81	
Smoking Status			
Non-Smokers	86.32	13.68	11.62(0.0030)
Current Smokers	93.07	6.93	
Past Smokers	73.08	26.92	
Alcohol Consumption			
Non-Drinkers	85.57	14.43	2.17(0.141)
Drinkers	87.86	12.14	
Salt Intake			
Too Much	93.88	6.12	4.93(0.026)
Not Too Much	86.00	14.00	

Fruit and Vegetable (FnV) Intake			
Inadequate FnV Intake	86.09	13.91	0.75(0.3861)
Adequate FnV Intake	88.11	11.89	
Physical Activity			
Not Physically Active	86.43	13.57	1.69(0.1934)
Physically Active	77.78	22.22	
Diabetes			
Not Diabetic	87.93	12.07	120.04(0.0000)
Diabetic	46.51	53.49	
Depression			
Not Depressed	84.72	15.28	0.16(0.689)
Depressed	86.37	13.63	
Body Mass Index (BMI)			
Underweight	93.10	6.90	
Healthy Weight	90.67	9.33	98.90(0.000)
Overweight	77.58	22.42	
Obesity	72.69	27.31	

Source: Author's computation from the WHO SAGE WAVE II

Table 4.2 provides the descriptive statistics for self-reported hypertension (SRH). It displays the Pearson's Chi-square results that examine the association between the independent variables and SRH. It also shows the proportions of the independent variables for SRH. The findings indicate that variables such as gender, marital status, place of residence, education level, ethnicity, working status, smoking status, salt intake, diabetes, and BMI have some level of association with hypertension.

From Table 4.2, more females (17.41%) than males (9.64%) report they have been told by a doctor that they have hypertension. Nearly 17 percent (16.56%) of older people not married had hypertension compared to 10.98 percent of older married people who reported they have hypertension. The results also show that hypertension was higher in urban areas (22.30%) than in rural areas (7.88%). For education level, the prevalence increased with education level. For instance, 8.96 percent of older people with no formal education have hypertension. This figure increases to 15.71 percent among those who have completed less than primary education and reaches 27.16 percent for those who have completed tertiary education. More than half

(53.49%) of older people with diabetes have hypertension. Guans represent the highest proportion of older people with hypertension, with a 22.22 percent prevalence.

Table 4.2 further indicates that 10.81 percent of those who are working have hypertension compared to 18.23 who are not working but have hypertension. More than a quarter (26.92%) of older people who have smoked in the past have hypertension compared to just 6.93 percent of current smokers who have hypertension. Regarding BMI, hypertension increased with the weight from 6.90 percent prevalence for older people who are underweight to 27.31 percent for older people with obesity

Table 4. 3: Prevalence and Associated Risk Factors of Field-Measured Hypertension

Individual Variables	Field-Measured Hypertension (FMH)		Pearson's Chi-square (P-value)
	No	Yes	
Age			53.62(0.000)
50-59 years	73.74	26.26	
60-69 years	62.78	37.22	
70-79 years	60.00	40.00	
80 and above	60.83	39.17	
Gender			3.03(0.0816)
Male	67.76	32.24	
Female	64.87	35.13	
Marital Status			35.20(0.0000)
Not Married	60.41	39.59	
Married	70.23	29.77	
Residence			27.84(0.0000)
Urban	60.63	39.37	
Rural	69.50	30.50	
Education Completed			3.62(0.460)
No Education	66.08	33.92	
Less than Primary	66.52	33.48	
Completed Primary	67.85	32.15	
Completed High School	66.23	33.77	
Completed Tertiary	58.18	41.82	
Ethnicity			25.02(0.0000)
Akan	67.58	32.42	
Ga-Adangbe	53.65	46.35	
Ewe	61.48	38.52	
Guan	56.41	43.59	
Northern	68.60	31.40	

Working Status			48.50 (0.0000)
Not Working	57.80	42.20	
Working	70.07	29.93	
Smoking Status			0.71(0.702)
Non-Smokers	66.13	33.87	
Current Smokers	67.11	32.89	
Past Smokers	61.29	38.71	
Alcohol Consumption			0.80(0.372)
Non-Drinkers	66.58	33.42	
Drinkers	64.99	35.01	
Salt Intake			0.15(0.6973)
Too Much	67.59	32.41	
Not Too Much	66.02	33.98	
Fruit and Vegetable (FnV) Intake			2.70(0.1003)
Inadequate FnV Intake	65.60	34.40	
Adequate FnV Intake	69.87	30.13	
Physical Activity			0.09(0.765)
Not Physically Active	66.07	33.93	
Physically Active	68.29	31.71	
Diabetes			13.34(0.0003)
Not Diabetic	66.56	33.44	
Diabetic	47.67	52.33	
Depression			4.19(0.041)
Not Depressed	56.73	43.27	
Depressed	66.38	33.62	
Body Mass Index (BMI)			24.65(0.000)
Underweight	68.71	31.29	
Healthy Weight	68.82	31.18	
Overweight	61.76	38.24	
Obesity	58.02	41.98	

Source: Author's computation from the WHO SAGE WAVE II

Table 4.3 also provides similar descriptive statistics for field-measured hypertension (FMH) and displays the Pearson's Chi-square results that examine the association between the independent variables and FMH. It also shows the proportions of the independent variables for FMH. The findings indicate that variables such as age, marital status, place of residence, ethnicity, working status, diabetes, depression and BMI have some level of association with hypertension are associated with hypertension.

Table 4.3 shows that hypertension prevalence increases with age. For instance, 39.17 percent of older people aged 80 years and above had hypertension compared to 26.26 percent of people aged between 50-59 years. More females (35.13%) are seen to have more hypertension compared to males (32.24%), while non-married and non-working older people also have higher rates of hypertension. Hypertension is higher in urban areas (39.37%) than in rural areas (30.50%). Older people with higher education had more hypertension (41.82%) than those with lower education (33.87%). Some ethnic disparities exist, as Ga-Adangbes (46.35%) and Guans (43.59%) have high proportions of hypertension. Concerning smoking and alcohol consumption, past smokers and drinkers had higher proportions of hypertension, with 38.71% and 35.01% respectively. Also, about half (52.33%) of older people with diabetes have hypertension. For BMI, hypertension increased with weight.

These results confirm the multifaceted biological, socioeconomic, and psychological or lifestyle factors associated with hypertension. Notably, both FMH and SRH results reveal similar associations with hypertension concerning marital status, place of residence, ethnicity, diabetes and BMI.

4.3 Diagnostic Test

In logistic regression, it is important to conduct a diagnostic test to check for multicollinearity among the variables. Diagnostic tests help assess the validity of a model and avoid misleading conclusions (Daniels & Minot, 2020). The test revealed variables that are fitting to be used to estimate the model for the study, which has been presented below in Table 4.4. The Variance Inflation Factor (VIF) was used to test for multicollinearity to examine whether the independent variables predicting hypertension are not highly correlated with each other. If high multicollinearity is present, it can distort the coefficient estimates and disturb the stability of

the model (Montgomery, 2021). Multicollinearity exists when the VIF is higher than 5 to 10 (Kim, 2019; Shrestha, 2020).

Table 4. 4: Variance Inflation Factor (VIF) Test for Multicollinearity

Independent Variables	Categories	Self-Reported Hypertension	Field-Measured Hypertension
		VIF	VIF
Age (ref: 50-59 years)	60-69 years	1.59	1.35
	70-79 years	1.75	1.48
	80 years and above	1.69	1.46
Gender (ref: Male)	Female	2.03	1.68
Marital Status (ref: Not Married)	Married	1.63	1.32
Residence (ref: Urban)	Rural	1.17	1.17
Education Completed (ref: no education)	Less than Primary	1.21	1.23
	Completed Primary	1.32	1.29
	Completed High School	1.62	1.59
	Completed Tertiary	1.16	1.14
Ethnicity (ref: Northern)	Akan	1.81	1.74
	Ga-Adangbe	1.32	1.28
	Ewe	1.51	1.46
	Guan	1.11	1.09
Working Status (ref: Working)	Not Working	1.23	1.21
Smoking Status (ref: Non-Smokers)	Current Smokers	1.09	1.10
	Past Smokers	1.07	1.05
Alcohol Consumption (ref: Drinkers)	Non-Drinkers	1.20	1.23
Salt Intake (ref: Not too much)	Too much	1.03	1.02
Fruit and Vegetable (FnV) Intake (ref: Adequate FnV Intake)	Inadequate FnV Intake	1.04	1.03
Physical Activity (ref: Physically Active)	Not Physically Active	1.04	1.03
Diabetes (Not Diabetic)	Diabetic	1.04	1.03
Depression (ref: Not Depressed)	Depressed	1.02	1.02
Body Mass Index (ref: Underweight)	Healthy Weight	2.36	2.44
	Overweight	2.16	2.22
	Obesity	1.92	1.94
Mean VIF		**1.43**	**1.37**

Source: Author's computation from the WHO SAGE WAVE II

From Table 4.4, the independent variables show VIF less than 5 to 10, signifying that no independent variable is highly correlated with another. Thus, the VIF results for both SRH and FMH are good to be used for the estimation.

4.4 Estimation Results

The study examined the risk factors of hypertension among older people in Ghana. Specifically, it used both SRH and FMH with estimates displayed in Table 4.5. Additionally, the study examined whether engaging in multiple risk factors increases the likelihood of hypertension for older people, also captured in Table 4.6. Tables 4.5 and 4.6 show details of the odds ratio, p-values and confidence intervals are presented.

Table 4.5: Logistic Regression Results of Hypertension Risk Factors

Risk Factor Predictor Variables	Self-Reported Hypertension				Field-Measured Hypertension			
			95% CI				95%CI	
	AOR	P-value	Lower	Upper	AOR	P-value	Lower	Upper
Age								
50-59 years	**Ref**				**Ref**			
60-69 years	1.79	0.079	[0.93	3.42] *	1.44	0.007	[1.10	1.88] ***
70-79 years	1.89	0.009	[1.17	3.04]***	1.43	0.013	[1.08	1.89] **
80 and above	1.47	0.246	[0.77	2.83]	1.38	0.084	[0.96	2.00] *
Gender								
Male	**Ref**				**Ref**			
Female	1.77	0.068	[0.960	3.25] *	0.93	0.605	[0.69	1.25]
Marital Status								
Not Married	**Ref**				**Ref**			
Married	0.94	0.736	[0.64	1.37]	0.79	0.036	[0.63	0.98] **
Residence								
Urban	**Ref**				**Ref**			
Rural	0.38	0.000	[0.24	0.60] ***	0.61	0.000	[0.48	0.77] ***
Education Completed								
No Education	**Ref**				**Ref**			
Less than Primary	1.45	0.349	[0.66	3.19]	1.39	0.187	[0.85	2.27]
CompletedPrimary	1.48	0.289	[0.72	3.05]	1.20	0.352	[0.82	1.75]

Completed High School	1.72	0.138	[0.84	3.53]	0.91	0.586	[0.64	1.29]
CompletedTertiary	2.84	0.063	[0.94	8.54] *	1.00	0.99	[0.51	1.94]
Ethnicity								
Northern	**Ref**				**Ref**			
Akan	0.82	0.486	[0.47	1.43]	0.79	0.100	[0.59	1.05]
Ga-Adangbe	1.27	0.491	[0.64	2.51]	1.58	0.192	[0.79	3.16]
Ewe	1.08	0.828	[0.56	2.07]	1.11	0.577	[0.76	1.63]
Guan	1.59	0.275	[0.69	3.65]	1.51	0.083	[0.59	2.39] *
Working Status								
Currently Working	**Ref**				**Ref**			
Not Working	1.19	0.404	[0.79	1.77]	1.46	0.000	[1.19	1.80] ***
Smoking Status								
Non-Smokers	**Ref**				**Ref**			
Current Smokers	0.63	0.484	[0.18	2.27]	1.38	0.289	[0.76	2.49]
Past Smokers	2.25	0.101	[0.85	5.94]	1.36	0.394	[0.67	2.76]
Alcohol Consumption								
Drinkers	**Ref**				**Ref**			
Non-Drinkers	0.70	0.238	[.038	1.27]	0.94	0.616	[0.75	1.19]
Salt Intake								
Not Too Much	**Ref**				**Ref**			
Too much	0.56	0.361	[0.16	1.96]	0.89	0.641	[0.54	1.46]
Fruit and Vegetable Intake								
Adequate FnV Intake	**Ref**				**Ref**			
Inadequate Intake	1.52	0.135	[0.88	2.65]	1.46	0.012	[1.09	1.96] **
Physical Activity								
Physically Active	**Ref**				**Ref**			
Not Physically Active	0.79	0.751	[0.18	3.42]	1.77	0.592	[0.29	2.03]
Diabetes								
Not Diabetic	**Ref**				**Ref**			
Diabetic	5.20	0.000	[2.90	9.319]***	2.37	0.004	[1.31	4.30] ***
Depression								
Not Depressed	**Ref**				**Ref**			
Depressed	0.88	0.771	[0.355	2.16]	0.90	0.69	[0.54	1.50]
Body Mass Index (BMI)								
Underweight	**Ref**				**Ref**			
Healthy Weight	1.09	0.816	[0.54	2.19]	1.09	0.527	[0.83	1.44]
Overweight	1.62	0.171	[0.81	3.25]	1.70	0.003	[1.21	2.41] ***
Obesity	2.63	0.017	[1.91	5.78] **	1.51	0.038	[1.02	2.23] **
Constant	0.08	0.043	[0.01	0.92] **	0.50	0.262	[1.15	1.69]

**** p<.01, ** p<.05, * p<.1 Significance level* AOR: Adjusted Odds Ratio
SRH Observations: 2,122
FMH Observations: 3,251
Source: Author's computation from the WHO SAGE WAVE II

Table 4.5 displays results from the estimation of risk factors of hypertension using the two definitions: those who reported that they have been diagnosed by a medical professional they having hypertension (SRH) and those who were measured on the field to be hypertensive (FMH). Several factors were found to be significant in predicting hypertension among older people presented below.

4.4.1 Age and Risk of Hypertension

Age recorded consistent results across the two measures of hypertension. Across nearly all age groups, statistically significant differences were recorded for both self-reported hypertension (SRH) and field-measured hypertension (FMH), except for individuals aged 80 years and above in the case of SRH. The level of significance was stronger for FMH, with results significant at the 1 percent level for adults aged 60-69 years, at the 5 percent level for those aged 70-79 years, and at the 10 percent level for those aged 80 years and above. In contrast, SRH showed weaker significance, with only the 60-69 and 70-79 age groups reaching significance at the 10 percent and 1 percent levels, respectively. Specifically, among those who self-reported being diagnosed with hypertension (SRH), adults aged 60-69 had 79% higher odds of having hypertension compared to those aged 50-59, while those aged 70-79 had 89 percent higher odds relative to the same reference group. For FMH, older adults aged 60-69 years and 70-79 years had 44 percent and 43 percent higher odds of hypertension, respectively, compared to those aged 50-59 years. Additionally, those aged 80 years and above had 38 percent higher odds of hypertension relative to the 50–59-year age group.

The above results indicate that age is a significant risk factor for hypertension. Notably, the odds ratio and significance levels are higher for FMH compared to SRH, suggesting that a substantial number of older adults may be unaware of their hypertensive status until it is

detected through the field measurement or community screenings. A possible explanation for the increased risk with increasing age is that, as people grow older, their immune system becomes weaker and susceptible to various NCDs, such as hypertension. Moreover, their body may not be able to effectively regulate or maintain optimal blood pressure compared to younger people. Kaess et al. (2012) explain that the arteries in the body stiffen as people age, which increases SBP.

This finding highlights the underdiagnosis of hypertension among older adults from the SRH measure. This underscores the need for regular health screening to identify the true hypertension burden among older populations. This study's findings are consistent with other studies conducted in LMICs. For instance, Tetteh et al. (2020) and Tannor et al. (2022) found that among older Ghanaians, the higher the age of an individual, the more likely they are to be at risk of hypertension. Drame et al. (2018) also reported that in Benin, age was a significant predictor of hypertension, with individuals aged between 60 - 69 years more likely to develop hypertension compared to those found in younger age groups. Similarly, Mohamed et al. (2018) found that older Kenyans aged 50 years and above were more than 5 times more likely to be hypertensive compared to younger people.

4.4.2 Gender and Risk of Hypertension

In this study, gender did not have a significant association with hypertension for FMH, whereas it was highly significant at 1 percent for SRH. The odds of hypertension were significantly higher among older female adults compared to their male counterparts. Specifically, older female adults had 77 percent higher odds of hypertension compared to older male adults. The results are consistent with other findings from Nigeria and Ghana, where female gender was a significant predictor of hypertension among older adults (Abegunde & Owoaje, 2013; Tetteh

et al., 2020). The observed results could be attributed to the fact that women in LMICs like Ghana usually assume multiple roles, balancing both paid and unpaid labour outside the home alongside domestic duties to the family. They accumulate stress and weakness in the body for a long period, which can elevate their blood pressure in their old age. Bantas and Gayatri (2019) also explain that the reason for the gender differences in hypertension is that when women reach their menopause stage, their blood pressure is usually higher. Results from this study, however, contrast with Hasan et al. (2018), who found that older females had a reduced odds of hypertension compared to their male counterparts in Nepal.

4.4.3 Marital Status and Risk of Hypertension

Marital status also appeared statistically insignificant for SRH, while significant for FMH. The odds of developing hypertension were 21 percent lower for older adults who were married compared to older adults who were unmarried. These results could be due to the protective effect of marriage, whereby married people can support and keenly monitor each other's health behaviours, which can ultimately reduce disease risks and improve health outcomes. It is, however, important to caution that this observation may work well for working marriages rather than marriages that are characterised by conflicts. This result, however, is consistent with Aheto and Dagne (2021), who also found that married and cohabitating couples were less likely to have hypertension compared to their unmarried counterparts in Ghana. Other studies, such as Dai et al. (2022) and Bosu et al. (2019), found contrasting results where unmarried older individuals are less likely to develop hypertension compared to married couples.

4.4.4 Residence and Risk of Hypertension

The results of the place of residence showed highly statistically significant associations with hypertension for both SRH and FH, each at the 1 percent significance level. The findings

indicate that older adults residing in urban areas had significantly higher odds of hypertension compared to those in rural areas. Specifically, for SRH, adults living in rural areas had 62 percent lower odds of hypertension compared to those living in the urban areas, whereas for FMH, there was a 39 percent reduced odds of hypertension for older adults living in rural areas compared to those living in the urban areas. The possible reasons for this outcome are that people living in rural areas of Ghana are more likely to be active. They are more likely to have an active lifestyle such as walking, engaging in agricultural work, communal labour, and eating fresh and organic foods, which altogether can regulate and maintain blood pressure compared to those living in the urban areas who rather are more likely to live a sedentary lifestyle, eat unhealthy diet and engage in less physical activity. Scholars such as Bosu et al. (2019) and Drame et al. (2018) report similar results from their studies in Ghana and Benin, respectively, where urban residence is associated with an increased risk of hypertension compared to rural residence.

4.4.5 Education Level and Risk of Hypertension

Education was a statistically insignificant predictor of hypertension among older adults for FMH. In contrast, under SRH, a statistically significant association was observed between education level completed and the likelihood of hypertension. Older adults who had completed tertiary education had 2.84 times higher odds of hypertension compared to those with no formal education. This translates to a 184% increase in odds, and the results are marginally statistically significant at the 10 percent level. This study expected that higher education would have increased health literacy and rather have a negative relationship with hypertension due to informed ways of living a healthy life. However, these results could suggest that individuals with higher education, like tertiary, are more likely to occupy higher positions at their

workplaces, which come with greater responsibilities and expectations, which can result in sedentary lifestyles, increased chronic stress and elevated blood pressure levels.

Abba et al.'s (2021) analyses also found that the odds of developing hypertension increased with a higher educational level, and that participants with secondary education or higher were four times more likely to have hypertension compared to those with no education. Furthermore, highly educated people are expected to occupy high positions at work. They may adopt sedentary lifestyles due to their demanding work schedules. These include inadequate physical activity and consumption of convenience foods or processed foods, which are usually high in fat and salt, which can increase hypertension. Those with lower education may be engaged in work that is more physically demanding and active.

4.4.6 Ethnicity and Risk of Hypertension

For ethnicity, the odds of SRH and FMH did not show statistically significant differences across the ethic groups, except for one marginal difference observed under FMH at 10 percent. For FMH, older adults belonging to the Guan ethnic group had 51 percent reduced odds of hypertension compared to older adults from the northern ethnic groups, which was marginally significant at 10 percent. Although older adults belonging to the Ewes and Ga-Adangbe ethnic groups also showed higher odds of hypertension compared to older adults from a northern ethnic group, this relationship was not statistically significant.

A systematic review by Bosu and Bosu (2021) revealed that the prevalence of hypertension is higher in coastal and geo-ecological parts of Ghana. It is, therefore, not surprising that this study finds that Guans, primarily located in the coastal regions, are at increased odds of hypertension compared to those from the northern ethnic groups. There could be some ethnic

variations in blood pressure, which could cause the ethnic differences observed, as asserted by Vaidya (2010) and Neel (1997). The findings from this study confirm that of other scholars who found significant differences between ethnicity and hypertension in Nigeria, Ghana and South Africa (Ekpo et al., 1992; Opoku et al., 2020; Phaswana-Mafuya et al., 2013).

4.4.7 Working Status and Hypertension

In terms of employment, working status was highly statistically significant for FMH at 1, while not statistically significant for SRH. For SRH, individuals who were not working had 46 percent increased odds of hypertension compared to individuals who were working or employed. The significance indicates a strong and meaningful relationship between not working and having undiagnosed hypertension. This finding is consistent with previous studies in the United States by Aijaz et al. (2022) and in Ghana by Tetteh et al. (2022) that reported that not working or being unemployed was associated with hypertension risk, although they are inconsistent with Houle et al. (2021), who reported contrary findings from South Africa. Plausible reasons may cause this observed relationship. First, older adults who are not working may experience financial hardships, which may limit their ability to afford healthcare or maintain regular check-ups. Furthermore, economic insecurity can lead to chronic psychological stress, which is a risk factor for high blood pressure. Unemployment may reduce access to healthy diets, increasing vulnerability to NCDs such as hypertension. These results provide insight into how working status, through providing economic stability and well-managed health behaviours, may shape hypertension outcomes among older adults.

4.4.8 Lifestyle and Behavioural Factors

The lifestyle factors considered in this study included physical activity, salt intake, smoking and alcohol consumption, BMI and fruit and vegetable intake. From Table 4.5, smoking status,

alcohol, salt intake, and physical activity were not significant for SRH and FMH. These findings aligned with previous research that no significant association existed between hypertension and salt intake or alcohol consumption in Ghana and South Africa (Addo et al., 2006; Gebreselassie & Padyah, 2015). Also, Gebreselassie and Padyah's (2015) study in South Africa revealed an insignificant association between physical activity and hypertension. However, fruit and vegetable consumption, and BMI were statistically significant in predicting hypertension, and are explained below.

4.4.8.1 Fruit and Vegetables and Risk of Hypertension

Fruit and vegetable intake (FnV) was examined as a lifestyle factor associated with hypertension. For SRH, older adults with inadequate FnV intake had 52 percent higher odds of hypertension, but this association was not statistically significant, indicating no strong evidence of a relationship. However, FMH results indicated that older adults who did not consume enough FnV had 46 percent increased odds of hypertension compared to individuals who consumed the recommended servings of FnV. This was recorded at a 5 percent significance level. The results could be attributed to the role that fruit and vegetables play in promoting overall health. A diet rich in FnV is associated with better cardiovascular functioning and improved pressure regulation. This result supports the existing literature and recommendation by the WHO that the consumption of FnV was significant in influencing hypertension. Consuming the right amount provides the nutrients that could help regulate blood pressure and protect people from hypertension and other NCDs in Ghana and other countries (Akpa et al., 2022; Batubo et al., 2023; Drame et al., 2018; Sumaila et al., 2021; Tachi et al., 2020; WHO, 2016).

4.4.8.2 Body Mass Index (BMI) and Risk of Hypertension

The Body Mass Index (BMI) was found to be significantly associated with hypertension across most categories of both SRH and FMH, with a clear trend of increasing odds of hypertension with higher BMI categories. For SRH, individuals who were obese had 2.63 times higher odds of hypertension, which translates to 163 percent increased odds of hypertension compared to those who were underweight. Being overweight was also observed to be insignificant, although it showed a positive relationship with hypertension. For FMH, the odds of hypertension were consistent with more robust significance. Older adults who were overweight had 70 percent higher odds of being hypertensive compared to underweight individuals. Similarly, being obese had 51 percent higher odds of hypertension compared to those who are underweight significant at 5 percent. The results underscore the effect of higher BMI on hypertension, and the findings of the study support similar claims made by other authors (Drame et al., 2018; Minicuci et al., 2014; Mohamed et al., 2018; WHO, 2000). Furthermore, risk estimates indicate that at least two-thirds of hypertension can be directly attributed to obesity (Narkiewicz, 2006). Obesity and overweight explain excess weight gain and body fat, which puts pressure on the heart to supply blood to the cells. The analysis confirms the study's hypothesis that older adults in Ghana with higher BMI are more likely to have hypertension compared to those with lower BMI.

4.4.9 Comorbidities

4.4.9.1 Diabetes and Risk of Hypertension

The association between diabetes and hypertension was found to be highly statistically significant for both SRH and FMH, with both recording significant outcomes at the 1 percent level. For SRH, older adults who reported being diabetic had 5.2 times higher odds of hypertension compared to their non-diabetic counterparts, which translates to a 420 percent

increase in the likelihood of hypertension. Similarly, for FMH, diabetic older adults had 2.37 times higher odds of being hypertensive, indicating a 137 percent increase in odds compared to non-diabetic individuals. Both results from SRH and FMH in relation to diabetic individuals support the hypothesis of the study that diabetic older adults are more likely to have hypertension compared to non-diabetic older adults. This could be because the immune system of diabetic older adults may already be compromised, and so they become susceptible to other chronic diseases like hypertension. Also, diabetic patients, like hypertension patients, share similar symptoms such as inflammation and arterial stiffness, which means it's easier to contract one disease when you are affected by the other. The results are consistent with other findings that also report that hypertension and diabetes are comorbidities that coexist in older adults and that diabetes is a major risk factor for hypertension among older adults (Boateng et al., 2015; Hypertension Study Group, 2001).

Table 4.5 depicts the estimations of risk factors for hypertension among older adults using the multivariable logistic regression. The results show notable differences between the self-reported hypertension (SRH) and the field-measured hypertension (FMH) among older adults in Ghana. The patterns in the estimation of the risk factors (Table 4.5) reveal that the statistical significance of the risk factors varied between the two measures. Overall, the FMH method identified a higher hypertension prevalence than self-reported hypertension, as seen in Table 4.1. This means more people could be unaware they have the condition. From table 4.5, the FMH model also appears more robust and statistically informative, capturing more statistically significant associations with predictor variables compared to the SRH model. Specifically, age, marital status, place of residence, fruit and vegetable intake, working status, diabetes, BMI, and some ethnic groupings showed statistically significant associations with FMH. In contrast, the SRH model had fewer significant predictors, although some associations, such as diabetes,

age, and obesity, still reached strong levels of significance. Calys-Tagoe et al. (2020) in their study also reported that FMH was more robust and effective in diagnosing hypertension, which is consistent with this study.

Furthermore, there were some key distinctions in the consistency and strength of the associations. For instance, while age was a significant predictor in both models, the FMH model showed more consistent significance across all age groups. Relatedly, working status and fruit and vegetable intake were only significant in the FMH model, underscoring its potential to detect risk factors that may go unreported in SRH. With regards to the socioeconomic variables, such as education and ethnicity, neither the SRH nor the FMH presented strong evidence or statistical significance, though completing tertiary education showed marginal significance in SRH.

For comorbidities, diabetes emerged as a strong predictor in both models, with high adjusted odds ratios and significance at the 1 percent level, reinforcing the well-known relationship between diabetes and hypertension as two related chronic diseases. Similarly, BMI, particularly obesity, showed consistent and significant associations with both SRH and FMH, although the estimates obtained were more stable in the FMH model.

In conclusion, while SRH provides valuable insights, especially into the known hypertension status of individuals, FMH appears to offer a more comprehensive and objective overview of hypertension status, capturing both diagnosed and undiagnosed hypertension cases. The broader coverage of statistically significant variables and stronger model robustness in FMH suggest that community screening and measurement of blood pressure of people, particularly older adults, may be better for identifying hypertension prevalence and its associated risk

factors. That notwithstanding, SRH remains an important determinant of hypertension as it is usually diagnosed at the health facility, but one would need to have visited the place before being diagnosed, unlike the FMH. Therefore, both approaches are complementary, and their combined use can enhance hypertension surveillance and public health interventions.

4.4 Multiple Lifestyle Risk Factors

The third objective was to find out if engaging in multiple lifestyle risk factors or behaviours increases hypertension risk. In this section, multiple lifestyle-modifiable risk factors are examined to ascertain whether they increase the development of hypertension among older adults. As previously established, lifestyle risk factors are the risk factors that people usually have control over and can alter (Aheto & Dagne, 2021; WHO, 2023). Analysing multiple lifestyle risk factors is essential in hypertension studies, as it helps to understand how engaging in modifiable lifestyle choices can affect health. The risk factors are salt intake, alcohol consumption, smoking status, BMI, physical activity and fruit and vegetable intake. Details about multiple risk factors are explained in sections 2.10 and 3.9.

Table 4. 6: Multiple Lifestyle Risk Factors and Hypertension Among Older People

Multiple Risk Factor Predictor Variables	Self-Reported Hypertension				Field-Measured Hypertension			
			95% CI				95%CI	
	AOR	P-value	Lower	Upper	AOR	P-value	Lower	Upper
Risk Level								
No Risk	**Ref**				**Ref**			
One Risk	1.59	0.053	[1.00	2.54] *	1.34	0.052	[1.00	1.79] *
Two Risks	2.25	0.003	[1.319	3.85] ***	1.26	0.177	[0.90	1.77]
Three or more risks	3.45	0.013	[1.30	9.16] **	2.42	0.011	[1.23	4.76] **
Constant	0.12	0.018	[0.09	0.16] ***	0.44	0.000	[0.36	0.53] ***

*** *p<.01,* ** *p<.05,* * *p<.1* AOR: Adjusted Odds Ratio
SRH Observations: 2,169
FMH Observations: 3,300

Source: Author's computation from the WHO SAGE WAVE II

Table 4.6 presents the results of multiple risk factors and their association with hypertension among older adults. These lifestyle risk factors were salt intake, alcohol consumption, smoking status, BMI, physical activity and fruit and vegetable intake. The study observed statistical significance for both SRH and FMH. The results indicate that as lifestyle risk factors or behaviours increase, the odds of hypertension also increase for both measures, although some differences exist in the patterns and statistical significance.

For SRH, older adults engaged in only one lifestyle risk behaviour had 59 percent increased odds of hypertension compared to those with no lifestyle risk behaviour. For individuals engaged in two lifestyle risk behaviours, they had 2.25 times higher odds of hypertension, which translates to 125 percent higher odds of hypertension compared to those engaged in no lifestyle risk behaviours. The odds continue to increase further among those engaged in three or more lifestyle risk behaviours, who were 3.45 times more likely, representing a 245 percent increase in odds, compared to those engaged in no lifestyle risk behaviour. This result suggests that engaging in even a single lifestyle risk behaviour – such as excessive salt intake – or two lifestyle behaviours – such as alcohol intake and inadequate fruit and vegetable intake – can significantly increase hypertension risk compared to individuals who do not engage in any of the lifestyle behaviour.

In the FMH model, individuals engaged in one lifestyle risk behaviour have 34 percent higher odds of hypertension compared to those engaged in no lifestyle risk behaviour. The odds increased further for individuals engaged in three or more lifestyle risk behaviours. The results show they were 2.42 times more likely, or had a 142 percent higher likelihood of hypertension, compared to individuals with no lifestyle risk behaviour. For instance, an individual who is

obese, consumes alcohol and takes in high amounts of salt stands a high risk of hypertension compared to an individual who is not engaged in any lifestyle risk behaviour.

Both results from SRH and FMH have indicated that as the number of lifestyle risk factors increases, the risk of hypertension becomes higher. SRH, however, showed more statistically significant associations. The two indicators of hypertension have shown the ability to identify hypertension among older adults. Both indicators highlight the strong association between engaging in multiple risk factors and the risk of hypertension. The results are consistent with the findings of other scholars who found that individuals engaged in multiple risk factors stand a high risk of developing hypertension (Diaz-Gutiérrez et al., 2019; Lelong et al., 2019; Nguyen et al., 2019).

4.6 Conclusion

This chapter has analysed the risk factors associated with hypertension among older adults in Ghana. For the first objective, this study found that hypertension prevalence was higher (33.92 percent) during the field measurement (FMH) of the blood pressure of participants than self-reported hypertension (SRH) (13.68 percent), suggesting that many people have unaware or undiagnosed hypertension. This reinforces the idea that FMH enhances the diagnosis of hypertension. Thus, it identified older adults who had not yet formally been diagnosed by a medical professional at a health facility. It also justifies the study design and methodology to conduct on-field measurements of blood pressure to determine hypertension among participants.

The second objective was to identify the risk factors of hypertension. The results indicate that there are significant risk factors that determine hypertension among older adults. FMH was

more robust in identifying hypertension prevalence and associated risk factors compared to SRH. Specifically, age, marital status, place of residence, fruit and vegetable intake, diabetes, working status, and BMI showed statistically significant associations with FMH. In contrast, the SRH model had fewer significant predictors, although some associations, such as diabetes, age, and obesity, still reached strong levels of significance. Comorbidities like diabetes influence hypertension risk among older adults in both indicators.

The third objective was to investigate whether engaging in multiple lifestyle risk behaviours increased hypertension among older adults. It was found that indeed engaging in multiple lifestyle risk factors, such as smoking, physical inactivity, low fruit and vegetable intake, high salt intake, and higher BMI, increased hypertension risk compared to not engaging in any lifestyle risk factor. It is important to consider these observations and the impact they can have on health outcomes. Therefore, there should be measures to curtail or reduce the engagement in lifestyle risk factors among older adults. This can be achieved through broader and more effective policies to address hypertension risk factors and improve health outcomes. These policy recommendations are discussed in Chapter Five.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Chapter five provides a summary of findings and conclusions for the study with recommendations for policy and future research. The study addresses the summary of findings and the conclusion of the study. From the literature review and findings, the study proposes some recommendations to influence policy and also suggests other areas for health and gerontological research in the future.

5.2 Summary of Findings

5.2.1 Prevalence of Hypertension

The first objective of the study was to determine the prevalence of hypertension among older people in Ghana. The analysis of hypertension prevalence among older adults in Ghana revealed that older adults are at risk of hypertension. The findings also revealed that more people were unaware they had hypertension, as field-measured blood pressure (FMH) for hypertension revealed about 3 times those who reported they had formally been told by a medical professional that they have hypertension (SRH). Among those who self-reported, there was a 13.68 percent prevalence rate, meaning that per every 1000 older adults, there were about 137 people with hypertension, whereas, for FMH, the result showed that prevalence was 33.92 percent, representing 339 people with hypertension for every 1000 older adults. Thus, the community health screening field measurement of blood pressure should be enhanced.

5.2.2 Risk Factors of Hypertension

The second objective of this study was to identify and analyse the risk factors associated with hypertension using self-reported hypertension (SRH) and on-field-measured hypertension (FMH). The independent categorical factors that were examined to ascertain the risk factors of hypertension prevalence were age, gender, marital status, residence, education, ethnicity, working status, smoking status, alcohol consumption, salt intake, fruit and vegetable intake, physical activity, diabetes, and BMI. The Chi-Square test was used to find a significant association between the categorical dependent variables and hypertension. There was no multicollinearity among the variables, confirmed by the Variance Inflation Factor diagnostic test.

The multivariable logistic regression indicated that age, gender, marital status, place of residence, ethnicity, education status, fruit and vegetable, working status, diabetes and BMI have significant associations with hypertension prevalence for both SRH and FMH, while depression, salt intake, smoking, physical inactivity, and alcohol intake were not statistically significant in both indicators. The study employed the use of the biopsychosocial model of health to analyse the risk factors for hypertension. The model's complexity provided a structured framework for the analysis of the risk factors. It suggested that to examine epidemiological cases such as hypertension among older people, analyses should transcend just the biological or clinical diagnosis of the existence of the disease by a medical professional. It is suggested that a comprehensive assessment of a disease should consider the psychological/lifestyle and socioeconomic factors that determine health. The study following the model specification ensured that the factors considered in this study covered biological, socioeconomic and lifestyle/psychological areas.

5.2.3 Multiple Risk Factors

The third objective of this study was to find out whether engaging in multiple lifestyle factors increased the odds of hypertension. We considered the modifiable factors that individuals had full control to alter. These included salt intake, fruit and vegetable intake, physical activity, smoking, alcohol consumption, and BMI. We compared individuals with none, one, two and three or more lifestyle risk factors or behaviours. A multiple logistic regression revealed that older adults engaged in multiple lifestyle risk behaviours are at increased odds of hypertension compared to older adults who are not engaged in any lifestyle risk behaviours. The odds of hypertension increased with the number of lifestyle risk factors engaged in.

5.3 Conclusion

The following conclusion can be drawn from the study.

Older people in Ghana are considered vulnerable. They stand a high risk of chronic diseases. Hypertension has become a common global disease with very high morbidity and mortality in LMICs, including Ghana. In Ghana, the disease is high among older people and increases with age. There is a 13.68 percent prevalence rate for self-reported hypertension and a 33.92 percent for people who were diagnosed with hypertension using blood pressure measurements. Irrespective of which type, the rates are relatively higher than in other LMICs, as found by other scholars. The statistical difference between SRH and FMH suggests that a significant proportion of older adults may be living with undiagnosed hypertension.

It is also important to highlight that there is an increasingly older population accompanied by an increase in NCDs. The Biopsychosocial model of health reveals interesting analyses for the study of health. Older age, female gender, higher education, non-working older adults, past

smokers, individuals with inadequate fruit and vegetable intake, diabetic patients, and people with higher BMI significantly increase the likelihood of hypertension among older adults; thus, awareness creation and attention should be paid to these factors. Also, engaging in multiple lifestyle risk factors is significant in increasing the odds of hypertension. Thus, engaging in multiple healthy lifestyle habits can substantially reduce hypertension risk among older adults.

The study makes some contributions to health and development studies. First, this study has provided scholarship on the two measures of hypertension, which have not been found in most of the literature, especially for studies conducted in Ghana. Most literature has focused on either examining self-reported hypertension only or field-measured hypertension and its risk factors. Thus, this study has broadly examined and compared the two concerning the associated risk factors. Thus, the study has contributed to setting the precedent for future studies to examine both SRH and FMH to ascertain possible statistical differences, including targeting unaware hypertension.

Secondly, although some scholars have conducted extensive research on hypertension in Ghana, they have mostly examined the general risk factors and their effect on the risk of hypertension. This study has additionally examined modifiable lifestyle risk factors (salt intake, fruit and vegetable intake, physical activity, smoking, alcohol consumption, and BMI) and their combined effect on hypertension in Ghana, providing a ground for future research to expand on hypertension scholarship in Ghana and other LMICs.

In terms of general development, hypertension can impair an individual's productivity and quality of life, as they cannot engage in economic and social activities that contribute to development. When there is high hypertension prevalence, it can put the health infrastructure

under stress and also the finances of individuals. However, the relationship between risk factors and hypertension highlights the need for policy interventions that can address the risk factors and reduce the prevalence of hypertension among older people. Addressing the factors that increase prevalence can improve health outcomes and broadly align them with SDG Goal 3 of reducing one-third of premature mortality from NCDs to promote good health and well-being, as well as the United Nations' 2030 goal to leave no one behind.

5.4 Policy Recommendations

The study has assessed the determinants of hypertension among older people in Ghana. To address the burden of hypertension, individuals need to take responsibility first and adopt a healthy lifestyle and health-promoting behaviours. Generally, public health interventions should address and be guided by the multiple, interrelated risk factors as suggested by the biopsychosocial model of health – biological, psychological/lifestyle and social factors. The government, through the Ministry of Health and the Ghana Health Service, should be the leading institution in the implementation of the following recommendations, with support from the Non-Communicable Disease Control and Prevention (NCDCP) Programme and the Ministry of Gender and Social Protection.

The study found that field-measured hypertension offers a more accurate and better indication of hypertension prevalence compared to self-reported hypertension, and should therefore be prioritised by health authorities. From the findings, several factors were significantly associated with higher odds of hypertension among older adults in Ghana. These include older age, female gender, being diabetic, certain ethnic backgrounds, not being married, inadequate fruit and vegetable intake, urban residence, higher education, not working, and increased BMI. The following policy recommendations are made.

The Ghana Health Service should enhance public awareness campaigns on non-communicable diseases (NCDs, with a particular emphasis on hypertension and its risk factors, especially in urban areas where the condition is highly prevalent. These initiatives would help educate the public about the condition and promote behaviours that reduce susceptibility. Additionally, the study recommends that the Ghana Health Service provide training and, where possible, blood pressure monitoring machines to pharmacies and licensed chemical stores in urban communities. Equipping these frontline providers with both skills and tools to measure blood pressure accurately and educate older adults can enhance community-level screening efforts and improve early identification and management of hypertension outside the traditional clinical settings.

Furthermore, physical activity, especially walking, should be encouraged among older adults in Ghana. It is recommended that MMDAs develop sidewalks and recreational parks in urban areas to promote regular physical exercise. Also, it has been recommended that particular attention be paid to older adults aged 50 to 64, as they are found vulnerable. The Livelihood Empowerment Against Poverty program could be expanded to include them since they are currently not part of the National Health Insurance Scheme's premium exemption group. The MMDA's district health information unit should organise regular community health programmes within their districts to promote a healthy lifestyle among older people. Sensitisation should include education on weight maintenance, a balanced and healthy diet and regular physical activity that enhances healthy weight. They should also encourage older adults, most of whom are on a pension, to form peer support groups to foster health monitoring and mutual encouragement among the group.

5.5 Study Limitations and Future Research

Other risk factors play a significant role in determining hypertension, including family history, high cholesterol, and low potassium, among others. This study did not include them as the WHO SAGE WAVE II dataset did not have information on them. Future studies should incorporate these factors in their analysis to provide a different perspective on hypertension risk. The cross-sectional nature of the data limits the establishment of a cause-and-effect relationship between the variables of interest. Future research should consider using longitudinal research methods to help understand how this relationship changes over time. Furthermore, although marital status was included in the analysis, the dataset does not provide information on the quality of relationships, which limits the interpretation of its effect on health outcomes, as a protective or hostile relationship may have a different effect on health. Future research should incorporate instability, marital happiness, and others as key measures of relationship quality to have a better understanding of relationship types and their association with hypertension. Lastly, working status did not consider the type of work individuals engaged in, whether informal, formal, or self-employed, among others. Future research should examine the type of work people are engaged in to appreciate another perspective on the relationship between work and hypertension.

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APPENDIX

Selected questions from the WHO SAGE WAVE 2 Questionnaire for the study of risk factors associated with hypertension among older adults with evidence in Ghana.

A. DEPENDENT VARIABLE – HYPERTENSION

1. Participants Anthropometric measurements by field personnel

Field-Measured Blood Pressure	Systolic	Diastolic
Blood pressure measurement		
1st measurement	□□□.□	□□□.□
2nd measurement	□□□.□	□□□.□
3rd measurement	□□□.□	□□□.□

2. Self-Reported Hypertension

Since the last we spoke, have you been told by a doctor or health care professional that you have high blood pressure (hypertension)?	□ Yes □ No

B. INDEPENDENT VARIABLES

1. Gender

Record sex of the respondent	□ Male □ Female

2. Age

How old are you now? This would be age at last birthday.	□□□ Age in Years

3. Marital Status

What is your current marital status?	□ Never Married □ Currently Married □ Cohabitating □ Separated / Divorced □ Widowed

4. Residence

An urban area that has been legally proclaimed as being urban. such areas include towns, cities and metropolitan areas	□ Urban
All other areas that are not classified as being urban. this includes commercial farms, small settlements, rural villages and other areas which are further away from towns and cities.	□ Rural

5. Highest School Completed

	□ Less than Primary School □ Primary School Completed

What is the highest level of education that you have completed?	☐ Secondary School Completed ☐ High School (or equivalent) Completed ☐ College/Pre-University/University Completed ☐ Post Graduate Degree Completed

6. Diabetes

Since the last we spoke, have you been diagnosed with diabetes (high blood sugar)? (Not including diabetes associated with a pregnancy)	☐ Yes ☐ No

7. Working Status

Have you worked for at least 2 days during the last 7 days?	☐ Yes ☐ No

8. Ethnicity

What is your background or ethnic group?	☐ Akan ☐ Ga-Adangbe ☐ Ewe ☐ Guan ☐ Gruma ☐ Mole-Dagbon ☐ Grusi ☐ Mande-Busanga ☐ Other, Specify:

9. Depression

Since we last spoke, have you been told by a doctor that you have depression?	☐ YES ☐ NO
During the last 12 months, have you had a period lasting several days when you felt sad, empty or depressed?	☐ YES ☐ NO
Was this period [of sadness/loss of interest/low energy] for more than 2 weeks?	☐ YES ☐ NO
Was this period [of sadness/loss of interest/low energy] most of the day, nearly every day?	☐ YES ☐ NO
During this period, did you lose your appetite?	☐ YES ☐ NO
Did you notice any slowing down in your thinking?	☐ YES ☐ NO
Did you notice any problems falling asleep?	☐ YES ☐ NO
Did you notice any problems waking up too early?	☐ YES ☐ NO
During this period, did you have any difficulties concentrating; for example, listening to others, working, watching TV, listening to the radio?	☐ YES ☐ NO
Did you notice any slowing down in your moving around?	☐ YES

	☐ NO
During this period, did you feel anxious and worried most days?	☐ YES ☐ NO
During this period, were you so restless or jittery nearly every day that you paced up and down and couldn't sit still?	☐ YES ☐ NO
During this period, did you feel negative about yourself or like you had lost confidence?	☐ YES ☐ NO
Did you frequently feel hopeless - that there was no way to improve things?	☐ YES ☐ NO
During this period, did your interest in sex decrease?	☐ YES ☐ NO

10. Physical Activity

Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate, [like heavy lifting, digging or chopping wood] for at least 10 minutes continuously?	☐ YES ☐ NO
Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate [such as brisk walking, carrying light loads, cleaning, cooking, or washing clothes] for at least 10 minutes continuously?	☐ YES ☐ NO
Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places?	☐ YES ☐ NO
Do you do any vigorous intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate [like running or football], for at least 10 minutes continuously?	☐ YES ☐ NO
Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that causes a small increase in breathing or heart rate [such as brisk walking, cycling or swimming] for at least 10 minutes at a time?	☐ YES ☐ NO

11. Smoking Status

Do you currently smoke any tobacco products (such as cigarettes, bidis, cigars, pipes)?	☐ Yes, Daily ☐ Yes, but not daily ☐ No, not at all
In the past, did you ever smoke tobacco? INTERVIEWER: If respondent has done both daily and less than daily in the past, check: Yes, daily.	☐ Yes, daily ☐ Yes, but not daily ☐ No

12. Alcohol Consumption

Have you ever consumed a drink that contains alcohol (such as beer, wine, spirits)? Since we last spoke to you, have you consumed a drink that contains alcohol?	☐ YES ☐ NO

13. Salt Intake

How much salt do you think you consume?	□ Far too much □ Too much □ Just the right amount □ Too little □ Far too little □ Don't Know □ Refused

14. Fruit and Vegetable Consumption

How many servings of fruit do you eat on a typical day? This can include a slice or bowl of fresh fruit.	□□ Servings
How many servings of vegetables do you eat on a typical day? This can include Kontomire leaves, carrots, gardeneggs (aubergine/eggplant), cabbage, green beans.	□□ Servings

15. Body Mass Index

Participants	Height (in centimeters)	Weight (In Kilograms)
	□□□.□ cm	□□□.□ kg