The association between living with a disability and undiagnosed hypertension amongst South African males aged 15 years and older.

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A RESEARCH REPORT SUBMITTED TO THE SCHOOL OF SOCIAL SCIENCES, UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN DEMOGRAPHY AND POPULATION STUDIES

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ABSTRACT

Background: Hypertension is a major global issue affecting more than 1 billion people worldwide. Hypertension trends have shifted from being concentrated in high-income countries to a high prevalence in low- and middle-income countries. The World Health Organisations reports that 46% of those living with hypertension globally are unaware of their condition. Although there is adequate literature revealing that men are disproportionately (51%) affected by undiagnosed hypertension on a global scale with low hypertension treatment and control rates, and there is also enough empirical evidence on limitations towards health care access among the disabled populations; scant research has been conducted on the association between disability and undiagnosed hypertension. In South Africa, no study has addressed the prevalence of hypertension among people living with a disability, and neither has any study examined the association between living with a disability and undiagnosed hypertension.

Objective: This study aimed to determine the association between living with a disability and undiagnosed hypertension amongst South African males aged 15 years and older.

Methodology: The data source used in this study is the South African Demographic and Health Survey collected in 2016. The weighted sampled size of this study is 1014 from men who participated in DHS 2016. The main independent variable in this study was disability status, and the outcome of interest was undiagnosed hypertension. The prevalence formula, Pearson's chi-square test, and binary logistic regression models were used to determine the prevalence, statistical significance, and association between undiagnosed hypertension and living with disability amongst men in South Africa.

Results: The study found that 66% of the South African male population had undiagnosed hypertension. The prevalence of undiagnosed hypertension was highest among non-disabled men (70%). The multivariate analysis showed that there is an association between living with a disability and undiagnosed hypertension with men living with a disability being [AOR: 0.65; P<0.05; CI:0.44-0.95] less likely to have undiagnosed hypertension. The youthful age groups (15-24; 25-34 and 35-44) were significantly more likely to live with undiagnosed hypertension. Men who were in the overweight and underweight BMI category, and who were educated were significantly less likely to have undiagnosed hypertension (P<0.05). Men residing in the Free State and Mpumalanga province were significantly more likely to have undiagnosed

hypertension. The study also showed statistically significant likelihood for employed to experience undiagnosed hypertension.

Conclusion: This study showed that disabled men are at a reduced risk of living with undiagnosed hypertension compared to non-disabled men in South Africa. Therefore, the country should increase its hypertension detection in the general population to reduce the high rates of undiagnosed hypertension.

Keywords: Undiagnosed hypertension, Disability, Lifestyle factors, Socioeconomic factors

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SADHS- South African Demographic and Health Survey

WHO-World Health Organisation

BMI-Body Mass Index

SANHANES-South African National Health and Nutrition Examination Survey

SDG- Sustainable Development Goals

Stats SA- Statistics South Africa

SSA- Sub-Saharan Africa

SDH-Social Determinants of Health

ICDMS-Integrated Chronic Disease management system

DECLARATION

I, Lesiba Mohlala, hereby declare that this research report is my original work. All secondary material that has been used in this study has been acknowledged and referenced carefully according to the American Psychological Association (APA) referencing style. I proclaim that this work has not been submitted before in part or in full to other universities for examination.

Lesiba Mohlala

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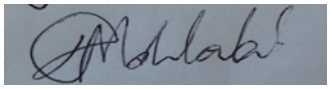

15 July 2024

DEDICATION

This research report is dedicated to my Almighty God, who has seen me through all challenges and all forms of self-doubt and guided me through, until this work's completion. My beloved parents who have always encouraged me and told me to never give up on education as it is the only entity that can brighten my future. My life partner and my siblings who have encouraged me to keep trying my best despite the difficulties.

I also dedicate this research report to Dr. Khuthala Mabetha who has taken her time to supervise this work diligently, to the Department of Demography and Population Studies at Wits University for their unwavering support provided during its time of completion, to Ms. Gloria Bowes who has always remained supportive and reliable guide from the beginning of this work until the end, and Dr. Sasha Frede and Professor Nicole De Wet-Billings for sharing guidance on research methods and statistical approaches when I would get things wrong.

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Chapter 1: Introduction

1.1 Background

Hypertension is a major global issue affecting more than 1 billion people around the world (World Health Organisation (WHO), 2020). According to the WHO (2015), hypertension is a condition in which there is a persistent occurrence of a blood pressure reading that equates to 140 mmHg and greater when the heart is beating (systolic) and a blood pressure reading that equates to 90 mmHg and greater when the heart is at rest (diastolic). Studies have posited that the global proportion of hypertension has increased from 594 million people in 1975 to 1.13 billion people in 2015 (Zhou et al., 2017). From 1975 to 2015, hypertension shifted from being concentrated in high-income countries to gaining more prevalence in low- and middle-income countries (Peer et al., 2021)). Recent worldwide hypertension trends indicate that low- and middle-income countries comprise the largest proportion of world hypertensive cases at 82% in comparison to high-income countries (Zhou et al., 2021). Among low- and middle-income countries, Africa has the greatest contribution covering 46% of the population living with hypertension (Saka et al., 2020). The transition of hypertension to low and middle-income countries is a threat to population well-being and longevity as health services in low and middle-income countries, especially sub-Saharan Africa, already suffer from a besieged health care service and an existing high burden of multiple diseases (Peer et al., 2021).

Global statistics reveal that hypertension plays an important role in mortality rates. It is responsible for 8.5 million deaths annually due to cardiovascular-related diseases (Zhou et al., 2021) because it has been linked to biological complications leading to the development of cardiovascular and cerebrovascular diseases such as stroke, myocardial infarction, and heart failure, as well as renal failure (Grotto, Huerta & Shabiri, 2008). Statistics also showed that in the United States, hypertension was responsible for 30% of the total death toll and 40% of all deaths related to cardiovascular diseases (Sliwa et al., 2014). In sub-Saharan Africa, researchers have cited that hypertension was the leading cause of death, attributable to 67% of deaths, and it has been estimated to have led to the loss of 10 million life-years in 2010 (Seedat, 2015). This demonstrates that the risk of dying from hypertension in low- and middle-income countries is more than two-fold compared to high-income countries (Undavalli, Madala & Narni, 2018). Furthermore, hypertension continued to claim 900 000 deaths in 2016 and

resulted in first-time stroke incidents where life loss was avoided (Institute of Health Metrics and Evaluations, 2019).

In response to these adverse mortality rates, public health researchers have placed ample attention to factors contributing to the etiology of hypertension. Risky individual behaviours and lifestyles, such as a high-salt diet, physical inactivity, alcohol consumption, and obesity are linked to the development of hypertension (Ibrahim, 2018). Literature also identifies the urbanisation and technological advancement processes as contributing to increasing hypertension statistics (Nawi et al., 2021). With urbanisation and technological advancement, more people adopt sedentary lifestyles, which brings about epidemiological transitions leading to non-communicable diseases such as hypertension being dominant (Nawi et al., 2021). Urbanisation also replaces relatively healthy rural diets with a higher fat and lower carbohydrate content diet (Seedat, 2015). Moreover, the disease is closely associated with increasing age, a family history of hypertension and the presence of other comorbidities such as chronic kidney disease and diabetes (Nawi et al., 2021).

Worldwide levels of undiagnosed hypertension are gradually representing the global public health crisis. Undiagnosed hypertension is defined as the presence of a hypertensive condition without knowledge of having the disease (Dejenie, Kerie and Reba, 2021). Studies classify individuals in this category when they consistently have blood pressure readings that are equal to or greater than 140 mmHg when the heart is beating, and a reading that is equal to or greater than 90 mmHg when the heart is resting without prior knowledge of living with hypertension (Boro & Benerjee, 2022). A study providing a global analysis of hypertension prevalence, detection, treatment, and control over the past 30 years revealed that of all people living with hypertension worldwide in 2019, 51% of men were living with the condition without their knowledge in (Zhou et al, 2021). This highlights the presence of staggering cases of undiagnosed hypertension on a global scale. According to the World Health Organisation (WHO) (2023), a markedly disquieting matter pertains to the fact that 30% of people with undiagnosed hypertension worldwide have systolic blood pressure measurements ≥160 mmHg or diastolic blood pressure measurements ≥100 mmHg. Superseding the threshold for hypertension (SPB≥140 mmHg, DBP≥90 mmHg), thus indicating the severity of public health deterioration and need for treatment. Similarly to hypertension, undiagnosed hypertension is a pertinent public health threat in both developed and developing countries (Dejenie et al., 2021). Most cases of undiagnosed hypertension are from low- and middle-income countries compared to high-income countries.

In a global hypertension treatment cascade by world regions, Zhou et al. (2021) revealed that high-income western regions experienced the lowest number of cases of undiagnosed hypertension at31% for men. The central and eastern European regions, 37% of men experienced undiagnosed hypertension. The high-income Asian Pacific region experiences undiagnosed hypertension in 34% of men living with hypertension (Zhou et al, 2021). Regions with the highest prevalence undiagnosed hypertension included Central Asia, the Middle East, and North Africa where 53% of men had undiagnosed hypertension. The Sub-Saharan Africa region recorded a prevalence of undiagnosed hypertension in 66% of men (Zhou et al, 2021). Based on this evidence, Sub-Saharan Africa comprises far more cases of undiagnosed hypertension in Africa. An interplay between poor health services and information, low socioeconomic status, and urbanisation contributes to the excessive undiagnosed hypertension rate in this region.

In developed countries, it has been found that people living with a disability are more likely to suffer from cardiovascular diseases (Gakidou et al., 2016; Moodley & Ross, 2015). The South African demographic and health survey reported that in 2016, 20% of the population aged five years and older lived with some level of disability in at least one of the functional domains: seeing, hearing, communicating, remembering or concentrating, self-caring, and walking or climbing steps (National Department of Health et al., 2016). However, to the best of our knowledge, no study has investigated the prevalence of hypertension among people living with disabilities and whether disability is a factor that influences awareness of living with hypertension, thus contributing to the high prevalence of undiagnosed hypertension in the country.

1.2 Problem Statement

Studies have provided evidence that South Africa is experiencing rising cases of hypertension and mortality due to hypertension-associated diseases. Kandala et al. (2021) used data from the (SANHANES) South African National Health and Nutrition Examination Survey conducted in 2012 and the (SADHS) South African Demographic and Health Survey conducted in 2016 to study provincial variations in the prevalence of hypertension in the country. In these two surveys, the prevalence of hypertension among South Africans over the age of 15 was investigated. In 2012, using the SANHANES data, the prevalence of hypertension was 38%, comparing this finding with the results found from the SADHS, a total hypertension prevalence of 48.2% was found among South Africans aged 15 years and above. This difference indicates

that there is a growing prevalence of hypertension in South Africa, as seen by the rising percentage of people living with hypertension in the country. Men in particular showed a growing prevalence from 35.2% in 2012 to 44.0% in 2016 (Berry et al., 2017; Kandala et al., 2021).

Despite the challenge that hypertension is among the top ten causes of death in South Africa, a greater threat is posed by the fact that a large population is unaware of their hypertensive condition. A study conducted in South Africa that aimed to determine the level of underdiagnosis of hypertension using the 2016 SADHS by comparing the total percentage of people who were aware of living with hypertension to the percentage of people who were found to be living with hypertension unaware indicated by blood pressure biomarker results., found that out of all 14,5 million South Africans living with hypertension during SADHS 2016, 51% (7.4 million people) were aware that they are living with hypertension and 49% (7.1 million) were living with the condition without their knowledge (Kamerman, 2022).

Furthermore, the results showed that men were almost twice as likely to be living with hypertension without their knowledge. This is because the total proportion of men who reported awareness of hypertension based on recall was 13%, while based on the blood pressure readings from the biomarkers, 38.3% of men had hypertension. This statistic shows that the difference of between the percentage of men reporting hypertension based on recall and the collective percentage of men living with hypertension according to blood pressure results was twice larger than the initial hypertension prevalence based on recall. This indicates that South Africa is struggling to detect and control hypertension within its population, especially in males. Moreover, when compared to the United States, which has a hypertension diagnosis rate of 83%, South Africa falls behind as only 51% of individuals living with hypertension were aware of their diagnosis (Kamerman, 2022).

People living with disabilities around the world are more likely to experience healthcare disparities than people without disabilities. A study conducted in Chile, South America, investigating healthcare access between disabled and non-disabled people, reported that disabled people experience greater challenges in accessing and receiving healthcare services (Rotarou & Sakellariou, 2017). Rotarou and Sakellariou found that challenges preventing disabled people from accessing healthcare included difficulties in arriving at a healthcare facility, obtaining a doctor's appointment, being attended by a physician, and difficulties in covering treatment and medication costs. The study indicated that disabled people reported

these challenges despite receiving healthcare from the public or private sector (Rotarou & Sakellariou, 2017). However, those in private healthcare experienced similar challenges except for being attended by a physician. This proved that disabled people of different socioeconomic statuses experience inequalities in accessing health care.

Sakellariou and Rotarou (2017) replicated the study in the United Kingdom, and similar results were observed when they found that people with disabilities experienced structural, financial, and attitudinal barriers in accessing health care. The challenges in this study were attributed to the fact that people with disabilities often have limited employment opportunities and thus cannot afford to pay for private health care that can exempt them from the challenges they face in the public health sector (Rotarou & Sakellariou, 2017). People living with disabilities in the United States have also reported inequalities in accessing health care. Lezzoni et al., (2021) found that physicians in the United States hold stigmatized views against people living with disabilities and believe that disabled people experience worse health challenges; as a result, physicians are not confident in treating people living with disabilities. The lack of confidence in treating people with disabilities was linked to physicians not strongly welcoming disabled people into their practices.

In the South African context, it was found that disabled people are battling with challenges in accessing and utilizing healthcare services. When comparing barriers to accessing health care among people living with disabilities to those who are not disabled in a sample selected from a rural South African community, it was found that disabled people experienced difficulty using medical services due to transport-related issues (Vergunst et al., 2017). Researchers have found that rugged terrains in rural areas and large travel distances to health care facilities make it difficult for people with disabilities to arrive at medical care facilities (Vergunst et al., 2017). As a result, many of the disabled respondents reported not receiving medical care in times of need. Furthermore, this study observed that obstacles to healthcare access decreased with increasing educational and socioeconomic status. This indicates that, among disabled people, healthcare access was a challenge to those who are poor compared to their rich and middle-income counterparts.

Mutwali and Ross (2018) observed similar findings regarding transportation as a limitation to accessing healthcare. Mutwali and Ross (2018) found that the cost of public transport and private transport, as well as poorly built roads, cause distance to health facilities to become a contributor to limited health-seeking behaviour in people living with disabilities. Mutwali and

Ross (2018) revealed that most people living with disabilities in South Africa did not have medical insurance and relied on the public health sector for their health needs. Despite the challenges of access, having a large number of the disabled population and the general population relying on the public health sector is disastrous, as studies show that the public health sector has an extremely low capacity of physicians (30%), serving over 84% of the population; therefore, it struggles to deliver quality healthcare services (Mutwali & Ross, 2018).

Thorogood et al., (2019) describes that the South African government, in attempts to manage noncommunicable diseases, have implemented an Integrated Chronic Disease management system (ICDMS). However, the model failed to produce optimal clinical outcomes for chronic diseases such as hypertension. This is because the current model obliges health workers to screen all patients visiting facilities for health checks, creating a workload burden for health workers. Making the situation worse is the patient-to-health worker ratio, resulting in a diagnosis of few cases of hypertension owing to long waiting hours and long queues at the facilities, which resulted in clinic staff not attending to the patients. Moreover, there is the use of malfunctioning electronic blood pressure machines, resulting in nurses ignoring the high blood pressure readings they get from patients, assuming that the machines are malfunctioning (Thorogood et al., 2019).

Therefore, amidst these challenges, it is worthy to investigate whether these restrictions that people living with disabilities face in accessing healthcare, exacerbated by the functional limitations that the South African public health sector is confronted with, do not play a role in the high cases of undiagnosed hypertension in South Africa. This investigation is worth undertaking because studies have narrowly focused on the risk factors of hypertension in different part of the world and in South Africa (Reddy et al., 2021; Ibrahim, 2018; Nawi et al., 2021 & Seedat, 2015) without exploring undiagnosed hypertension. In studies where risk factors for undiagnosed hypertension were investigated, the factor of disability was not accounted for in their study (Woodiwiss et al., 2023), a similar gap was observed in a study that was investigating hypertension unawareness in a single South African province (Madela et al., 2023). Wu et al., 2021 studied the prevalence of hypertension and the risk factors among people with disabilities in China but this study collected its sample from hospital designated to disabled people and also did not include the non-disabled population in the study, thus exposing a methodology gap.

1.3 Research question and sub-questions

Main Research Question:

What is the association between living with a disability and undiagnosed hypertension among South African males aged 15 years and older?

Sub-Questions:

1. What are the levels of undiagnosed hypertension among South African men aged 15 years and older?
2. What is the prevalence of diagnosed and undiagnosed hypertension by disability status among males aged 15 and older years in South Africa?
3. What is the association between disability status and undiagnosed hypertension while controlling for socio-economic, demographic and lifestyle factors among South African males aged 15 years and older?

1.4 Research objective and sub-objectives.

Main Research objective:

To determine the association between living with a disability and undiagnosed hypertension among South African males aged 15 years and older.

Sub-objectives:

1. To ascertain the levels of undiagnosed hypertension amongst South African men aged 15 years and older.

2. To determine the prevalence of diagnosed and undiagnosed hypertension by disability status among males aged 15 years and older in South Africa.

3. To examine the association between disability status and undiagnosed hypertension while controlling for socio-economic, demographic and lifestyle factors among South African males aged 15 years and older.

1.5 Justification

Hypertension is a treatable disease, and its early detection is important to help reduce the morbidity and mortality resulting from this condition. However, in recent literature, it is

apparent that there is a high prevalence of undiagnosed hypertension among adult men in South Africa, at 38.3% (Kamerman, 2022). Additionally, studies revealed that in South Africa, the population that is facing the highest burden of cardiovascular diseases are men at 64% with very low treatment levels particularly among the poor (Basu et al., 2019). Hence, this study has focused on men, as they are more likely to live with cardiovascular diseases. Considering the extensive literature proving that hypertension is the main risk factor for cardiovascular diseases (Grotto et al. 2008; Zhou et al. 2021), it is therefore important that we investigate factors that might be predisposing men to high rates of undiagnosed hypertension to protect life loss due to cardiovascular diseases exacerbated by lack of treated due not having knowledge about the disease.

In addition to the threat of increasing mortality, other studies extend to propose that hypertension has inherent societal economic costs, leading to a loss of economic productivity (Kohli-Lynch, Erzse & Hofman, 2022). The loss of healthy life years through disability, illness, and death are assigned a value to the gross domestic product per worker, which could have contributed to productivity. It is estimated that morbidity and mortality caused by hypertension cost South Africa between 29.4 million to 33.2 million rands in gross domestic product per worker (Kohli-Lynch et al., 2022). Therefore, the lost healthy life years can also negatively affect the South African economy.

Globally, people living with disabilities and functional impairments are reported to be vulnerable to chronic diseases such as hypertension. In the United States, a study was conducted to investigate hypertension among adults by disability status and type using adults aged> 19 years who participated in the National Health and Nutrition Examination Survey (Stevens et al., 2014). This study found that 34% of adults with hypertension were living with disabilities compared to 27% of adults without disabilities. Making comparisons according to disability types, it was reported that adults with mobility disability were more likely to have hypertension than adults with hearing disabilities (30% vs 40%). Moreover, when controlling for other sociodemographic factors, adults with disabilities had a 13% higher prevalence of hypertension than those without disabilities.

A recent cross-sectional study in China evidenced the vulnerability of people living with disabilities to hypertension. Of the 7348 disabled patients in Shanghai YangZhi Rehabilitation Hospital, 42.5% had hypertension (Wu et al., 2021). Among all patients with disabilities, the greatest prevalence of hypertension was found in those with physical disabilities compared to

other types of disabilities. This is because the physically disabled population, when they do not have access to personal and environmental support to meet their needs, leads a sedentary life that causes hypertension (Wu et al., 2021). Other than the challenge of physical mobility, physically disabled people are exposed to experiencing psychological stress and discrimination (Wu et al., 2021). This amplifies health concerns because psychological stress is a risk factor leading to hypertension, while discrimination restricts access to healthcare services.

One study provided consistent results, such as in Ireland, where a population of men and women older than 40 years of age living with an intellectual disability were found to have a low prevalence of hypertension compared to people with other disability types (O'Brien et al., 2021); supporting findings that hypertension is more prevalent to the physically disabled than other types of disabilities. However, in the context of South Africa, there is no understanding of either the prevalence of hypertension among the disabled population nor the relationship between disability and hypertension detection, even though a significant percentage of the country is living with disabilities (20%). This identifies a literature gap as it is evidenced that South African people living with disabilities experience challenges in accessing healthcare services (Vergunst et al., 2017; Mutwali & Ross, 2018) and thus exploring this literature gap can assist in determining whether disability contributes to the high undiagnosed hypertension prevalence in the country.

The findings of this study will assist in reaching the 2030 agenda for Sustainable Development Goals (SDG) three which aims to ensure healthy lives and promote well-being for all people (United Nations, 2018) by producing evidence that will inform potential interventions towards achieving target 3.4 of the sustainable development goal three targeting to reduce premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being (United Nations, 2018). This is because the findings from this investigation will identify whether people living in South Africa are at risk of living with hypertension without their knowledge and which demographic, socioeconomic and lifestyle factors predispose men to undiagnosed hypertension.

The findings may also be used to develop interventions or policies that can prevent premature deaths in people living with disabilities in South Africa. They will also help in achieving the National Strategic Plan for the Prevention and Control of Non-communicable Diseases 2022-2027 which aims to ensure that in South Africa, 90% of the population are aware of hypertension status, 60% of those with blood pressure receive treatment and 50% of those

receiving treatment have controlled blood pressure (National Department of Health, 2022). Furthermore, the study will contribute to the attainment of target 3.8, which aims to achieve universal coverage of access to quality essential healthcare services and access to safe, effective, quality, and affordable medicines and vaccines for all (United Nations, 2018).

The findings of this study will help us understand the characteristics of people living with undiagnosed hypertension and provide a better understanding of issues relating to hypertension detection amongst disabled people. This knowledge is crucial as it is evident in literature that in South Africa and other parts of the world, people living with disabilities experience difficulties in accessing health care compared to non-disabled people. Therefore, this means that to realise the SDG 2030 and the National Strategic Plan for prevention and Control of Non-communicable Diseases 2022-2027, people living with disabilities should also receive considerable attention for these milestones to be reached.

Chapter 2: Literature Review and Theoretical Framework:

2.1 Full review of most recent literature

Introduction

It is estimated that in 2019, hypertension affected 1.1 billion people around the world. In the same year, hypertension and tobacco were two contributing factors responsible for 10.8 million and 8,7 million deaths, respectively (Murray et al, 2020). The same sense of emergency is maintained by Mohammed et al. (2021), declaring that the 1.1 billion people living with hypertension in present times will increase to 1.5 billion by 2025, thus projecting the death toll caused by hypertension as well. From a global perspective, research demonstrates that the prevalence of hypertension is increasing in low- and -middle-income countries than high income countries and is responsible for the rising burden of mortality and morbidity in low- and -middle-income countries (Thomas, Burger & Hauck, 2018). Research attributes numerous reasons to the growing cases of hypertension in poor countries.

Most reasons that researchers agree upon are the drastic population growth in poor countries, the sedentary lifestyle and unhealthy diets encouraged by urbanisation, and the persisting inability in poor countries to detect and treat hypertension. In high-income countries, the decline in hypertension is attributed to the capacity of health systems to improve detection, treatment, and control rates of hypertension (Mohammed et al., 2021; Zhou et al., 2021). Across research, there is a consensus that poor countries experience under detection of hypertension, and it disproportionately affects men than women. Statistics report that from the year 2000 to 2010, hypertension detection and treatment was improved by ≥10% in high-income countries, whilst in poor-income countries, it was improved by ≤5% (Schutte et al., 2022).

Zhou et al. (2021) maintain the same observations; in 2019 they found that in poor countries such as sub-Saharan Africa and Oceania, 50-60% of women and 70% of men with hypertension were not aware of their condition compared to 27-30% of women and men in high-income countries.

Hypertension in Africa

High blood pressure rates have shifted from high-income countries to low-and-middle-income countries due to the epidemiological transition moving to the stage of man-made and

degenerative diseases (Ferdinand, 2020). The World Health Organization (WHO) is of the view that 46% of adults over the age of 25 in Africa are hypertensive compared to any other region in the world, and the prevalence of hypertension in Sub-Saharan Africa (SSA) ranges from 10% to 50% (Mustapha et al, 2022). When hypertension remains undiagnosed, untreated, or inadequately treated, it has consequences, such as stroke and heart disease, and the prevalence of cardiovascular diseases is estimated to double by 2030 (Kengne, Ntyintyane and Mayosi, 2012; Ataklte et al, 2015).

A nationwide survey conducted in Nigeria reported that 38% of adults were hypertensive, and the factors associated with these increased rates were attributable to demographic and lifestyle factors (Odili et al., 2020). High percentages of undiagnosed hypertension in South Africa pose a threat to the population's well-being, as unknown hypertension status may lead to low healthcare-seeking behaviour, preventing the acquisition of treatment to control hypertension and thus increasing the risk of complications, such as renal failure, myocardial infarction, heart failure, and stroke (Misganaw et al., 2017). This will increase hypertensive disease mortality in the country and may cause a decline in life expectancy, reducing the workforce in the country, which will negatively affect the economy.

Demographic factors contributing to hypertension.

Age plays an essential role in undiagnosed hypertension in developed and developing countries worldwide. Research has found that undiagnosed hypertension decreases with age increase, and people aged 30-49 years, 50-60 years, and over 70 years have lower odds of undiagnosed hypertension than younger age groups (Haider & Gupta, 2022). The declining chances of having undiagnosed hypertension with increasing age have been associated with the proximity of the elderly to the health system. Findings gathered from a meta-analysis in Africa indicate an estimated hypertension prevalence of 57% within the older adult population aged ≥ 50 years, indicating that the burden of hypertension increases with age (Bosu, Reilly, Aheto and Zucchelli, 2019). These results show that while hypertension is prevalent in older adult ages, undiagnosed hypertension, on the other hand, is more likely in the younger age groups below the age of 30 years. Another factor that decreases the chance of having undiagnosed hypertension due to proximity to the health system is being female (Mohamed et al., 2018).

Marital status has also been shown to play a role in hypertension. In Nigeria, being married and widowed increased the odds of hypertension by 88% and 57%, respectively, in both men and women (Adeke et al., 2022). Other studies find inconsistent results in terms of marital

status. According to Guerrero-Diaz et al. (2021), the prevalence of undiagnosed hypertension was found to be higher among people who never married, especially single men, than women (75 and 56%), respectively, with no relationship between marital status and undiagnosed hypertension. An earlier study showed that marital cohesion and job strain have an interaction that influences hypertension. Low marital satisfaction was seen to exacerbate the effects of job strain on high blood pressure, and high marital satisfaction lessened the effect of job strain on elevated blood pressure (Grotto et al., 2008).

In exploring the relationship between hypertension and place of residence, many countries in sub-Saharan Africa, such as Rwanda and Southern Ethiopia, studies have shown that undiagnosed hypertension is concentrated in rural areas (Mazimpaka et al., 2019; Wachamo et al., 2020). However, conflicting results were found in Nigeria where rural participants were aware of their hypertension status as compared to urban participants (Banigbe et al., 2020). This was explained by the availability of free medical missions and outreaches cancelling the barriers to health care in rural areas. Moreover, studies find that ethnic group and primary home language are correlates of undiagnosed hypertension in Mexico. Evidence indicates not having English as a primary home language was associated with a slower diagnosis rate of hypertension than English as a home language (Eamranond et al., 2007). The reason is that not using English as a primary language created communication barriers with health providers. Opposingly, in the United States, other studies find that white people experienced a far greater prevalence of undiagnosed hypertension as compared to people belonging to African American ethnicity (Johnson et al., 2014).

Socioeconomic factors contributing to hypertension.

Studies have revealed a relationship between socioeconomic status and hypertension. One study has indicated that the risk of cardiovascular disease is higher among individuals of low socioeconomic status than among those with a higher socioeconomic status (Sharma et al, 2021). This finding is unsurprising because socioeconomic status directly impacts dietary options. High poverty levels mean people cannot afford a diet with high fruits, vegetables, and low salt, which is an excellent dietary approach to prevent hypertension development, and those already suffering from this cannot control it (Seedat, 2015; Schutte et al., 2021).

The relationship between income level and hypertension is one that needs to be thoroughly explored. In a study conducted on the risk factors for hypertension in South Africa, income level was demonstrated to have a positive association with the prevalence of hypertension.

Participants with an income level greater than a thousand rands per month were more likely to be at a higher risk of hypertension (Sharma et al, 2021). Having a higher income does not imply that individuals have a healthy nutritional diet but can also mean that they are exposed to inappropriate nutritional patterns that cause cardiovascular diseases (Poti, Braga & Qin, 2017). In a South African study, income level had a stronger association with hypertension among men than women, where a weak association was observed (Thomas, Burger & Hauck, 2018). Although there is a strong association between hypertension and higher income, the opposite is found with undiagnosed hypertension. One study found that individuals with a higher income were less likely to have undiagnosed hypertension than those belonging to the poor income category (Haligamo et al., 2021). Similar results were found in a study conducted in Kenya using a sample from all 47 counties in Kenyan where it was reported that individuals in richer wealth quantiles were more likely to be aware of having hypertension in comparison to individuals from middle wealth quantile (Mohamed et al., 2018).

Educational attainment is a strong indicator of socioeconomic status and is usually fixed after young adulthood. Studies from developing countries have indicated that having a low educational level increases the risk of hypertension, while higher education increases the chances of hypertension awareness (Adeke et al., 2022). Other researchers found contradictory results, in Peru a study found that there is no association between educational level and undiagnosed hypertension. Nonetheless, the study concluded that in Peru, people with higher education had a greater prevalence of undiagnosed hypertension (Guerraro-Diaz et al. 2021).

Furthermore, difficult access to health facilities where patients are subjected to long queues comprising shortages in health care personnel, equipment, and appropriate medications in Sub-Saharan Africa leads to low detection, treatment, and control of hypertension (Seedat, 2015). These limited health provisions and services are a cause of concern for those who are unaware of having hypertension because they will not receive treatment and will suffer consequences such as cardiovascular and chronic kidney diseases, which are fatal (Dejenie et al., 2021).

Other factors contributing to hypertension.

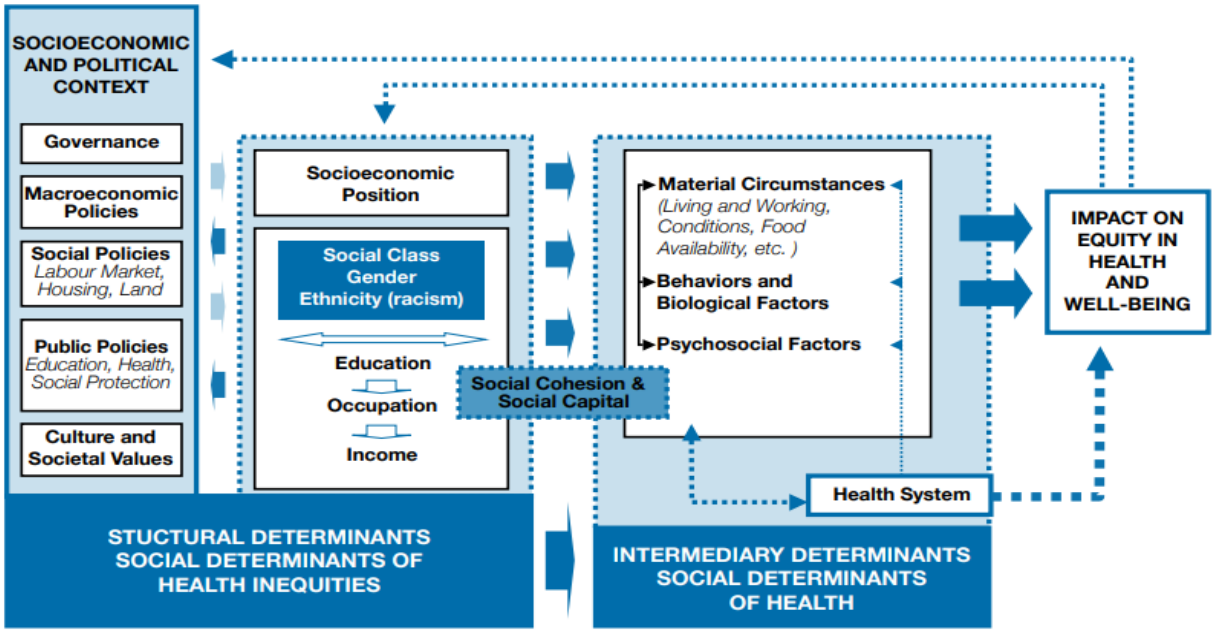
Alcohol consumption has also been associated with hypertension. A study conducted in Ethiopia, based on a sample of 662 adults, showed that the odds of being hypertensive tripled among those drinking alcohol in comparison to those who did not drink (Ayalew, Wale and Zewudie, 2022). Chronic intake of three or more alcoholic drinks per day increases the risk of hypertension (Zhou & Fang, 2019); however, based on some South African studies, a

contradiction exists, as there are reports of no association between consuming three drinks a day and developing hypertension while other authors are finding an association that high alcoholic intakes increase probabilities of developing hypertension (Reddy et al., 2021). The contradiction may emanate from the use of self-reported alcoholic intakes from study participants instead of relying on medical tests in these studies' methodologies. With regard to Body Mass Index (BMI), overweight individuals in the same study were three times more likely to be hypertensive. The increased prevalence of hypertension among overweight individuals is a consistent observation in the African context. According to a study carried out by Temu et al. (2021), adults in Kenya that are hypertensive, are 2 times more likely to be overweight/obese and 4 times more likely to have co-morbidities as compared to those with normal weight.

Researchers have placed adequate attention to traditional factors that are associated with hypertension (Zhou & Fang, 2019; Schutte et al., 2021 and Haider & Gupta, 2022, etc). Similarly, there is enough evidence to show that people who live disabilities are predisposed to cardiovascular vascular aliments including hypertension because of immobility (Stevens et al., 2014). Research has adequately established being disabled can also have hindrance on access to healthcare perpetuated by lack of accommodation of disabled people, structural and efficiency limitations faced by disabled people in both the public and private health care sector (Vergunst et al., 2017; Lezzoni et al., 2021). However, even though these limitations hindering excess to healthcare by disabled people have been well established, there has been very limited studies investigating the influence of disability on low hypertension detection rates particularly in the Sub-Saharan region. In the South Africa and Sub-Saharan region studies that have investigated factors contributing to undiagnosed hypertension have ignored the disabled population of which are worthy of investigation given the known challenges in accessing healthcare (Woodiwiss et al., 2023; Madela et al., 2023). One Study that made efforts to investigate the prevalence of hypertension among people with disabilities in China showed that it sampled its population from a hospital designated to disabled people without including non-disabled population in the study thus showing limitation in terms of making comparison with the non-disabled population group (Wu et al., 2021). Our this is going add to these gaps by determining statistical association of between undiagnosed hypertension and disability status as well as establishing prevalence undiagnosed among disabled and non-disabled population in South Africa.

2.2 Theoretical frameworks for the study

Figure 2.1 The Social Determinants of health Framework.



World Health Organisation 2010 Social Determinants of Health approach (WHO, 2010)

The theoretical framework that was adopted in this study is the social determinants of health. The social determinant of health framework (SDH) takes into consideration the impact of people's social, economic and political circumstances towards their health outcomes (WHO, 2010). This framework holds that the individual's social, economic and political circumstances in which individuals live in, is influenced by broader external structural factors which include the social, public, governance and macroeconomies policies (WHO, 2010). The external policies then create the socioeconomic characteristics which situates individuals in different positions of education, professions, wealth status, gender, social class, ethnicity groups and other factors (WHO, 2010). These different positions in societies occupied by individuals, as well as the external structural factors are then called the social determinants of health inequality (WHO, 2010). These social determinants of health in turn operate on the proximate characteristics whereby they can expose an individual to adverse health or prevent the individual's health to become compromised (WHO, 2010).

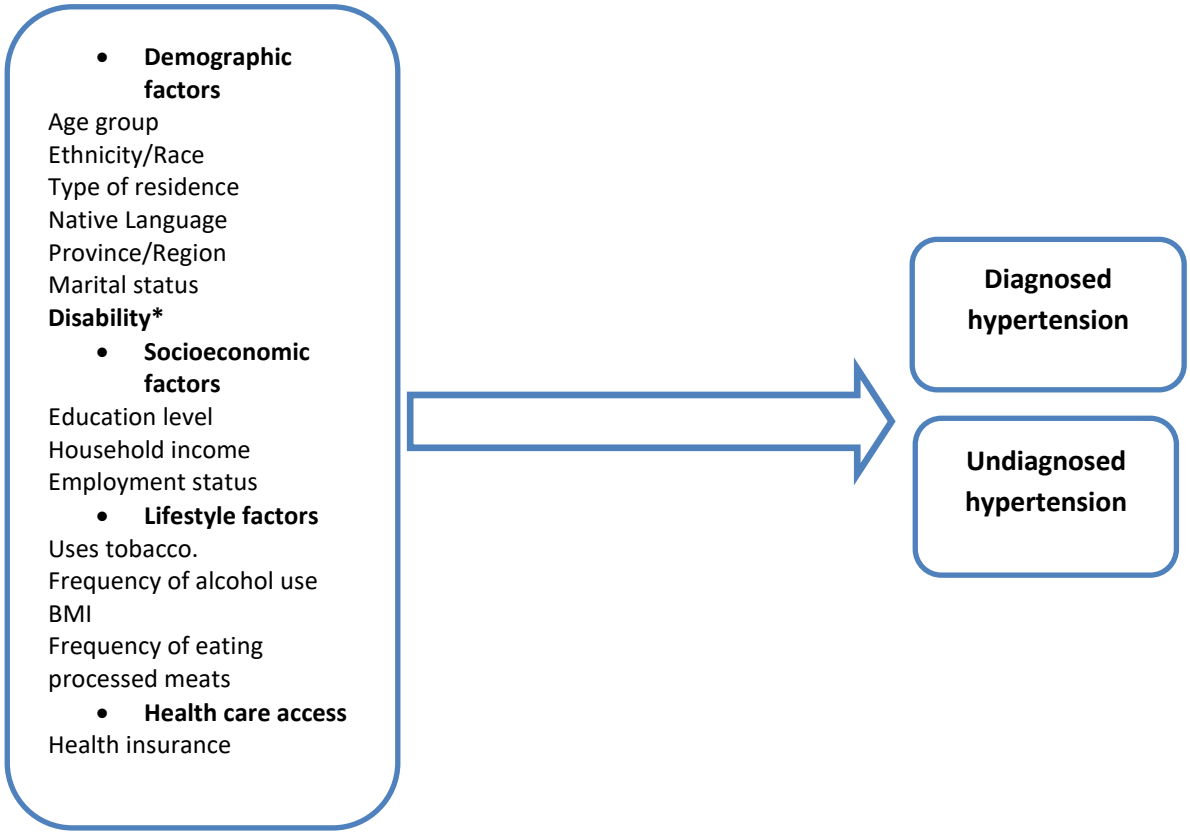
The proximate characteristics that the social determinants of health operate through are made up of the material circumstances, psychosocial characteristics, behavioural and biological characteristics. The material characteristics include factors such as housing, availability of health food, living and working conditions, and availability of resources to avoid risks (WHO,

2020). The psychosocial characteristics include factors such as the presence or absence of social support and stressful living conditions (WHO, 2010). Lastly, the behavioural and biological characteristics include health behaviours and genetics threatening or improving an individual's health (WHO, 2021).

Therefore, this means that the external social, economic and political factors have an indirect influence on health. This is because they must first operate through the proximate characteristics that will in turn have a direct on the wellbeing of an individual (WHO, 2010). Ultimately, the proximate characteristics such as income levels, levels of education, health behaviour and social support are factors having a direct influence on health and wellbeing (WHO, 2010). In this study, the Socia Determinants of Health Framework is adopted to the health outcome undiagnosed hypertension. Another factor in the interaction affecting people's well-being is the health system itself. The health system has an impact on health outcomes as it plays a role in ensuring that people have access to its services by being inclusive in its coverage in a non-discriminatory fashion (WHO, 2010).

2.3 Conceptual framework for the study

Figure 2.2 Adaptation/Modification of the Social Determinants of Health Approach



***** Main predictor variable

Using the Social Determinants of Health Framework, this study only focused on the demographic, socioeconomic, behavioural and health care access factors in figure 2.2 above as this were factors applicable to this study's objectives and its design. The modified conceptual framework indicates how demographic, disability, socioeconomic, household, and lifestyle factors, together with healthcare access, affect a person's health outcome, which in this study is undiagnosed hypertension. These covariates are proximate characteristics which could directly influence an individual's hypertension detection. However, in this study they were adapted to become the proximate determinants of the health outcome "undiagnosed hypertension" without intermediary factors that come before. This is because socioeconomic (such as household income), demographic (such as disability) and lifestyle factors (such as tobacco use) within which an individual is situated can have a direct bearing on whether the individual attends to a blood pressure screening by a health professional or not as these factors control whether a person has the resources, the knowledge and the attitude required to access blood pressure screening. Therefore, this conceptual framework indicates how living with a disability as a social category could be associated with undiagnosed hypertension in operation with other factors influencing health and well-being.

2.4 Research hypotheses

H0- Living with a disability is not associated with undiagnosed hypertension amongst South African males aged 15 years and older.

H1- Living with a disability is associated with undiagnosed hypertension amongst South African males aged 15 years and older.

Chapter 3: Methodology

3.1 Study area

The study was conducted in South Africa among males older than 15 years who had participated in the Demographic health survey 2016 in the nine provinces of the country. South Africa is a member state of the Southern African Development Community and its neighbouring countries Zimbabwe, Botswana, Namibia, Swaziland, Lesotho, and Mozambique. According to the Mid-year population in 2016, the population of South Africa was 55.9 million, and of this population majority was the youth (Stats SA, 2016). The study aimed at studying undiagnosed hypertension in South African men because of the high rates of hypertension presenting among males (44%) (SADHS, 2016). Furthermore, the rate of hypertension in South Africa is concerning as studies show that it increased from 38.4% in 2012 to 48.2% in 2016 (Woodiwiss et al., 2023).

3.2 Study design and data source

This study utilised secondary data obtained from the 2016 South African Demographic and Health Survey (SADHS). The data used in this study were from males aged 15 years and older who reside in South Africa in both rural and urban areas, whose background information was collected through the SA DHS 2016. The SA DHS is a nationally representative survey of all nine provinces of South Africa. This study employed a quantitative research approach because ituses numerical data and statistical techniques to answer the research question (Apuke, 2017). This study used a cross-sectional design. This is because this study examines information about males living with a disability collected at a given point in time, which is the year 2016 (Kesmodel, 2018). The cross-sectional design employed in this study is both descriptive and analytical, as the study aimed to determine the prevalence of undiagnosed hypertension and examine factors associated with it (Kesmodel, 2018).

The SADHS survey collected information from five questionnaires comprising the individual women's questionnaire, household questionnaire, individual men's questionnaire, caregiver's questionnaire and biomarkers questionnaire (South African Demographic Health Survey, 2019). Two recodes were used in this present study namely the male recode and household member recode. The household records contained blood pressure results taken by trained nurses during the survey using Omron 1300 digital blood pressure measurement instruments. The measurements were taken at intervals of 3 minutes or more for three times and the third

measurement was used to classify the respondent hypertension results (South African Demographic Health Survey, 2019). The study also used the men's health questionnaire, which asks questions about the lifestyles and health of men. These recodes were merged to create a dataset with all the required dependent and independent variables.

3.3 Study population and sample size

The SADHS 2016 reported that 11,083 household participated in the survey with a response rate of 83% (National Department of Health et al., 2019). Within these individuals 10, 336 men and women who were 15 years and older were successfully interviewed for the adult health module. To obtain the sample size of this study the household recode was merged with the male recode resulting in a weighted sample of 1014 men who are 15 years and older who answered questions about their hypertension status. The weighted sample size was obtained by exercising the exclusion and inclusion criteria as follows: the study excluded men who did not successfully answer questions on their hypertensive status leading to missing values in the study and men who produced normal blood pressure readings during screening without ever being informed of having hypertension. Men eligible to participate in the study were those who were informed of having hypertension but showed normal blood pressure results, men who were informed of having hypertension and showed abnormal blood pressure results and men who were never informed of having hypertension but showed abnormal blood pressure results. In this study, sampling weights were generated using the weight variable *"mv005"* divided by *1,000 000*. The weights were applied using the syntax "*svyset mv021 [iweight=weight], strata(mv022)"*. The resulting weighted sample size produced by the syntax *"svy: tabulate hypertension outcome".*

3.4 Variables

3.4.1 Outcome/ dependent variable

The outcome variable in this study was generated from two variables in the SA DHS 2016 dataset. The survey variables used were "*sh323"* and "*sh344"*. For the variable "*sh323"*, the survey asked male respondents*, "were you ever told by a health professional that you had high blood pressure?"*. Respondents answered either yes or no. The second variable, *"sh344,*" recorded the results of the blood pressure measurements taken during the survey interviews. These results were categorised as normal and abnormal blood pressure ranges. Thereafter, the blood pressure categories were cross combined with their "yes" or "no" answers from the "sh323" variable. To this end, four groups were created: (i) a group of respondents with

abnormal blood pressure who were never told by a health professional, (ii) a group of respondents with abnormal blood pressure who were told by a health professional, (iii) a group of respondents with normal blood pressure who were told to have high blood by a health professional and (iv) a group of respondents without blood pressure and were never told to have high blood pressure by a health professional. The group that did not have high blood pressure and was never told have high blood pressure have been excluded from the study. Therefore, the remaining participants were men who presented abnormal blood pressure and were never told, men who presented abnormal blood pressure and have been told by a health practitioner, and men who presented normal blood pressure and were also told to have high blood pressure. In this study, the group of men with abnormal blood pressure but were informed by a health practitioner and the group of men with normal blood pressure but were previously informed to have hypertension were combined together and regarded to have been diagnosed with hypertension, and thus categorised as a failure of the event "0". Conversely, the successful event was created using the group of men that produced abnormal blood pressure measurements but were never informed of having hypertension by a health professional, and thus regarded undiagnosed hypertension categorised as "1". The outcome variable in this study it is therefore a binary variable. Blood pressure was considered abnormal at ≥ 140mmHg systolic and ≥ 90mmHg diastolic in this study according to WHO recommendations (Boro & Benerjee, 2022).

Table 3.4.1 Dependent variable in the study

Study variable name	Survey variable	Survey categorisation	Study categorisation
Hypertension diagnosis status	Sh344	(1) normal (optimal) (2) normal (mildly high) (3) normal (moderately high) (4) abnormal (mildly elevated) (5) abnormal (moderately elevated) (6) abnormal (severely elevated)	0) Diagnosed hypertension. 1) Undiagnosed hypertension.
	Sh323	(1) no (2) yes	

3.4.2 Independent variables

Table 3.4.2 Independent variables to be used in this study.

Study Variable name	Survey Variable name	Survey categorisation	Study categorisation
Main independent variable			
Living with disability	Hdis7	(1) No difficulty walking or climbing (2) Some difficulty (3) A lot of difficulty (4) Cannot walk or climb at all (8) Don't know	Categorical: 0) Non-disabled 1) Living with disability
	Hdis8	(1) No difficulty washing or dressing (2) Some difficulty (3) A lot of difficulty (4) Cannot wash or dress at all (8) Don't know	
	Hdis2	(1) No difficulty seeing (2) Some difficulty (3) A lot of difficulty (4) Cannot see at all (8) Don't know	
	Hdis4	(1) No difficulty hearing (2) Some difficulty (3) A lot of difficulty (4) Cannot hear at all (8) Don't know	
	Hdis6	(1) No difficulty communicating (2) Some difficulty (3) A lot of difficulty (4) Cannot communicate at all (8) Don't know	
		(1) No difficulty remembering/concentrating (2) Some difficulty (3) A lot of difficulty	

	Hdis5	(4) Cannot remember/concentrate at all (8) Don't know	
Independent variables			
Educational level	Hb66	1) No education 2) Primary 3) Secondary 4) Higher	1) No education 2) Primary 3) Secondary 4) Higher
Marital status	Mv501	1) Never married. 2) Married 3) Living with partner 4) Widowed 5) Separated 6) No longer living together	1) Never married. 2) Married
Type of residence	Mv025	(1) Urban (2) Rural	1) Urban 2) Rural
Age group	Mv012	1) Continuous	1) 15-24 2) 25-34 3) 35-44 4) 45+
Native language	Mv045c	1) English 2) Afrikaans 3) Isixhosa 4) Isizulu 5) Sesotho 6) Setswana 7) Sepedi 8) Siswati 9) Tshivenda 10) Xitsonga 11) IsiNdebele 12) other	1) English 2) Afrikaans 3) Nguni languages 4) Sotho-Tswana languages 5) Other
Ethnicity/race	mv131	1) Black/African 2) White 3) Coloured 4) Indian/Asian	1) Black/African 2) Coloured 3) White/Indian/Asian/other

		5) Other	
Province	Mv024	1) Western cape 2) Eastern cape 3) Northern cape 4) Free state 5) KwaZulu-Natal 6) North west 7) Gauteng 8) Mpumalanga 9) Limpopo	1) KwaZulu-Natal 2) Western Cape 3) Northern cape 4) Free state 5) Eastern Cape 6) North west 7) Gauteng 8) Mpumalanga 9) Limpopo
Household income	mv190	1) Poorest 2) Poor 3) Middle 4) Richer 5) Richest	1) Poor 2) Middle 3) Rich
Health insurance	Sm1101	1) No 2) Yes	1) No 2) Yes
Employment status	mv714	0) No 1) Yes	1) Unemployed 2) Employed
Frequency of eating processed meats	Sm1007	1) never 2) every day 3) at least once a week 4) occasionally	1) Never 2) Every day 3) At least once a week 4) Occasionally
Frequency of alcohol use	sm918 sm917	1) 5 or more days a week 2) 1-4 days per week 3) 1-3 days per month 4) Less often than once 0) no 1) yes	1) Never 2) Less than 5 days a week 3) 5 or more days a week
Tobacco use	mv463ab Mv463aa	1) Do not smoke. 2) Every day 3) Some days 1) Do not smoke. 2) Every day 3) Some days	1) Non-tobacco user 2) Tobacco user

BMI	hb2 hb3	Continuous	1) Normal/healthy 2) Overweight 3) Underweight

The main independent variable in this study was "living with disability". In the 2016 SADHS, participants were asked six questions relating to disability. One of the questions asked was whether they have difficulty walking or climbing which was named variable "Hdis7" in the original survey. Participants could respond to this question by indicating 1) no difficulty walking or climbing, 2) some difficulty, 3) a lot of difficulty, 4) cannot walk or climb at all and 8) don't know in then original survey responses. The second question asked whether participants had difficulty washing or dressing which was named variable "Hdis8" in the original survey and it had responses where coded as 1) no difficulty washing or dressing, 2) some difficulty, 3) a lot of difficulty, 4) cannot wash or dress at all and 8) don't know in the original survey responses. The third question asked participants whether they had difficulty seeing which was named variable "Hdis2" and it has responses coded as 1) no difficulty seeing, 2) some difficulty, 3) a lot of difficulty, 4) cannot see at all and 8) don't know. The fourth question asked whether they had difficulty hearing and it was named variable "Hdis4" in the original survey and its responses where coded as 1) no difficulty, 2) some difficulty, 3) a lot of difficulty, 4) cannot hear at all and 8) don't know.

The fifth question asked participants whether they had difficulty communicating and it was variable "Hdis6" in the original survey. Participants responses where coded as 1) no difficulty communicating, 2) some difficulty, 3) a lot of difficulty, 4) cannot communicate at all and 8) don't know. The seventh question asked participants on whether they had difficulty remembering or concentrating which was named variable "Hdis5" in the original survey and its responses coded as 1) no difficulty remembering/concentrating, 2) some difficulty, 3) a lot of difficulty, 4) cannot remember/concentrate at all and 8) don't know. A dummy main independent variable called "living with disability" was generated. This variable was coded into two categories, "0" presented the non-disabled participants and "1" presented the disabled participants. There after the principle component analysis was used to fit all responses of the above questions which were coded 2, 3 and 4 into category "1" of the generated main independent variable "living with disability" and all responses from the above questions coded 1 where fitted into category "0" of the main independent variable "living with disability". All the responses that were coded 8 representing "don't know" were excluded from the study. In

the end the main independent variable consisted of two categories "0" inclusive of all respondents who did not report any form of difficulty and "1" which was inclusive of all respondents who reported any form of difficulty to seven questions above.

The variable educated level was coined from the survey variable "men's highest education" and its categorisation had been kept the same in our study. Marital status was coined from the variable "current marital status" which was categorised into never in union, married, living with partner, widowed, divorced and no longer living together in the SADHS. In our study, participants who were never married were categorized in to "never married" and those who were married, living with a partner, widowed, separated and no longer living together were grouped into the category "married" as they have a history of having a partner.

With regards to the study variable "type of residence", it was coined from the survey variable "type of place of residence" and the same categories were used in our study. In terms of age group, it was coined using the survey variable "current age" which was continuous. The variable was recoded into "age group" with categories 15-24, 25-34, 35-44, and 45+. The study variable "native language" was created using the survey variable native language of the respondents which had 11 categories inclusive of English, Afrikaans, IsiXhosa, Sesotho, IsiZulu, Setswana, Sepedi, Siswati, Tshivenda, Xitsonga, IsiNdebele and other. In our study these language categories were grouped into Siswati, IsiZulu, Xitsonga, IsiXhosa and IsiNdebele to create the category "Nguni-languages". The Sestwana, Sesotho, Sepedi and Tshivenda native languages were grouped to create the "Sotho-Tswana language" category in our study variable. English, Afrikaans and other were included as separate categories in our study variable.

The variable ethnicity/race was created using the SADHS variable "ethnicity" which was categories into Black/African. White, Coloured, India/Asian and other in the survey. These five categories were grouped into three categories in our study variable inclusive of Black/African, Coloured and White, Indian, Asian/other. With regards to the study variable "province", its created using the survey variable "region" with nine provinces as categories. The nine categories were kept the same in our study. In terms of the study variable "household income", it was created using the survey variable "wealth index combined" which consisted of the category poorest, poorer, middle, richer and richest. These categories were grouped into Poor, middle and rich in our study variable. The study variable "health insurance" was created using the survey variable called covered by health insurance which was categorised into no and yes.

These categories were kept the same for our study variable “health insurance”. Similarly, the study variable “employment status” was created using the survey variable called “currently working” which was categorized as no and yes in the survey. The same categories were used in our study.

In terms of the study “frequency of eating processed meats”, it was created using the survey variable “frequency eat processed meats” and its categories were kept the same in our study variable. With regard to the study variable “frequency of alcohol use”, it was created using the two survey variables. The first variable is “consumed alcohol in the last 12 months” and the second variable is “frequency of alcohol consumption last 12 month”. The first variable had yes and no responses and the second variable had frequency categories inclusive of 5 or more days a week, 1 to 4 days per week, 1 to 3 days per month and less than once a month. These two variables were combined to create three categories for the study variable inclusive of never drinks alcohol, drinks less than 5 days a week and drinks 5 days or more a week.

With regards to the study variable tobacco use, it was coined using two SADHS variables that were asking frequency of using smokeless tobacco and frequency of smoking tobacco. The two questions were answered in three responses inclusive of do not smoke, every day and some days. The responses were grouped into two categories inclusive of non-tobacco user and tobacco user in our study variable called “Tobacco use”. In terms of the study variable BMI, it was generated using the continuous height variable of the survey and body weight variable of survey which were both continuous. The formula “bmi=Weight/(height/100)^2 was used to calculate BMI index which grouped underweight (less than 18.5), normal (greater than 18.5 but less than 24.9) and overweight (greater than 24.9).

3.5 Data Analysis plan

Objective 1: To ascertain levels of undiagnosed hypertension amongst South African men aged 15 years and older.

Descriptive statistics were employed to address the first objective of this study. This was achieved by using the frequency and percentage distribution of the outcome variable in the sample represented in a pie chart. Furthermore, frequencies and percentage distribution tables were used to describe how the characteristics of respondents are distributed in each selected independent variable.

Objective 2: To determine prevalence of diagnosed and undiagnosed hypertension by disability status among males aged 15 years and older in South Africa.

To address the above objective the prevalence rate formula was used to calculate the prevalence rate of diagnosed and undiagnosed hypertension in the sample population per disability status. The prevalence rates of diagnosed and undiagnosed hypertension were presented with the use of a bar graph and a table. Moreover, a bivariate analysis was presented with the use of cross-tabulations between hypertension diagnosis status and socio-economic, demographic and lifestyle factors to give the prevalence of undiagnosed hypertension in these selected population characteristics. In addition, the Pearson chi-square test of independence was conducted to test for statistical significance in the relationship between the outcome variable and each predictor variable in the study.

$$Prevalence = \frac{\#no.\ of\ persons\ in\ the\ sample\ with\ outcome\ of\ interest}{Total\ number\ of\ people\ in\ the\ population} \times 100$$

Objective 3: To examine the association between disability status and undiagnosed hypertension while controlling for socio-economic, demographic and lifestyle factors among South African males aged ≥ 15 years.

In addressing the above objective of this study, a multivariate regression analysis was used to examine the association between disability status and undiagnosed hypertension while controlling for other variables. A binary logistic regression model was selected as the generated outcome variable of this study is dichotomous with a category "diagnosed hypertension" (0), which represents a failure of the event, and a category "undiagnosed hypertension" (1), which represents the success of the event. Adjusted and unadjusted odd ratios were utilised to report the likelihood of an event occurring by selected predictor variables in the study where odds ratios<1.00 are interpreted as less likely that undiagnosed hypertension occurs and odds ratios>1.00 are interpreted as more likely that undiagnosed hypertension take place. The logistic regression for the adjusted and unadjusted model had a statistical significance level set at 5% ($p \leq 0.05$) and 95% interval confidence. These descriptive and inferential statistical analysis above were computed using the STATA v14 software program. The formula for the binary logistic equation used in this study found below:

$$\text{Logit } [P(y = 1)|Xi \ldots Xk] = \beta o + \beta 1X1 + \beta 2X2 \ldots .. \beta kXk$$

Where:

Bo= Intercept

B1= Regression Coefficient

Xi…Xk=Independent Variables

Xi= Independent Variable

3.5.1 Assumptions of binary logistic regression

Binary logistic regression relies on three important assumptions to be true in order to avoid misleading results. The assumptions require that the observations in the data set must be independent, there must be no presence of perfect multicollinearity among independent variables and that continuous predictors are linearly related to a transformed version of the outcome (linearity) (Harris, 2021).

3.5.2 Model diagnostics and validation

3.5.2.1 Test for specification of error

The test for specification of error was done to determine whether the logit outcome variable is a linear combination of independent variables and that all relevant variables have been included in the model. **Appendix A** shows that the *(_hat)* is statistically significant meaning that the logistic regression is completely specified and *(_hatsq)* is statistically non-significant showing that no variables were omitted in the model.

3.5.2.1 Test for multicollinearity

A test for multicollinearity was performed to determine whether independent variables are not correlated with each other and therefore compromising the model's reliability (Harris, 2021). Our multicollinearity results in **Appendix B** show that all the coefficients are very low and less than 65% indicating that there is no evidence of multicollinearity in the study variables.

3.5.2.1 Goodness of fit

A goodness of fit test was conducted to determine whether the fitted model adequately describes the observed outcomes experienced in the data and also to test how well the model fits the data used in the study (Archer & Lameshow, 2006). A large P-value of this test indicates that the model has been correctly specified and is a good fit for that data used (Archer & Lameshow, 2006). In **Appendix C**, our test produced a large P-value attesting that the model correctly specified and is a good fit of the data used in the study.

3.6 Ethics

This study was conducted using secondary data accessed with permission from the SADHS. The use of secondary data cleared human risks as there was no human-to-human contact. Moreover, the data is cleared of personal identifying information that could risk a confidentiality breach. As a result, an application was made for an ethical clearance waiver at the University of the Witwatersrand non-medical Human Research Council with the assistance of the Department of Demography and Population Studies. Thereafter, the ethics waiver was granted to undertake the study with ethics number: 75134/3711145.

3.6 Limitations

The limitations of this study include the inability to control sudden blood pressure spikes that can be experienced during measurements. This might affect the number of people who do not have blood pressure that were indicated as having blood pressure by the biomarker. However, during the survey they conducted multiple screenings to limit this impact. Another limitation of this study is that respondents could have failed to recall that they had been diagnosed with hypertension previously and thus misrepresent their health facts. Moreover, as a cross-sectional study, this study has a limitation in that an individual could have developed hypertension very recently and thus cannot claim that all individuals have been living with hypertension without knowing. Moreover, as a cross-sectional study, the results of this study cannot imply causation for the identified risk factors of undiagnosed hypertension

Chapter 4: Results

The main objective of this study was to determine the influence of disability on undiagnosed hypertension amongst South African men aged ≥ 15 years in 2016. In this chapter, a frequency and percentage distribution table were used to ascertain the levels of undiagnosed hypertension which are presented in a pie chart; and also to describe the characteristics of the sample population. Subsequently, descriptive statistics were used to present the prevalence rate of diagnosed and undiagnosed hypertension by disability status shown with the use of a bar graph and a table. Moreover, Cross-tabulations and Pearson chi-square test of independence were conducted to present the prevalence of undiagnosed hypertension among the socio-economic, demographic, and lifestyle factors of South African men aged ≥ 15 years. The resulting p-values were used to assess the statistical significance of the relationship between the outcome variable and each independent variable. Finally, a binary logistic regression was conducted to present the statistical association between undiagnosed hypertension and disability status while controlling for selected socio-economic, demographic, and lifestyle factors. Odds ratios were used to report the probability of living with undiagnosed hypertension in the adjusted and unadjusted regression models.

4.1 The levels of undiagnosed hypertension amongst South African men aged 15 years and older in 2016.

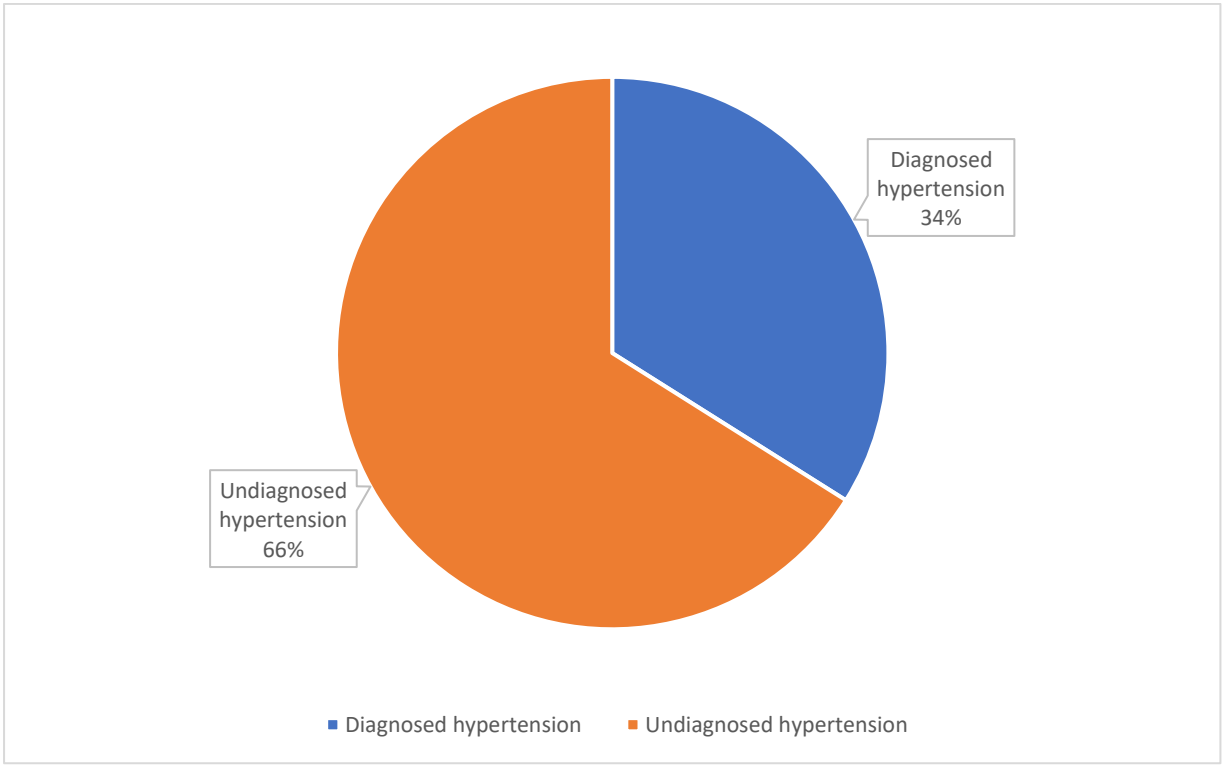


Figure 4.3 Percentage distribution of undiagnosed hypertension among men aged 15 years and older in 2016.

As depicted in figure 4.3, majority of the men had undiagnosed hypertension as they constituted 66% of the sampled population compared with men who were living with diagnosed hypertension (34%) during the 2016 period.

Table 4.1 Weighted frequency and percentage distribution of characteristics of respondents in the DHS sampled (n=1014), 2016.

Hypertension diagnosis status	**Frequency (N)**	**Percentage (%)**
Disability Status		
Non-disabled	807	79.56
Disabled	207	20.44
Total	1014	100.00
Education level		
No education	47	4.65
Primary	190	18.73
Secondary	659	64.94
Higher	118	11.67
Total	1014	100.00
Marital status		
Never married	489	48.24
Married	525	51.76
Total	1014	100.00
Age group		
15-24	190	18..71
25-34	255	25.10
35-44	265	26.17
45+	304	30.02
Total	1014	100.00
Ethnicity		
Black/African	852	83.99
Coloured	83	8.21
White/Asian/Indian/other	79	7.80
Total	1014	100.00
Native language		
English	116	11.43
Afrikaans	78	7.69
Nguni languages	520	51.29

Sesotho-Tswana languages	281	27.68
Other	20	1.92
Total	1014	100.00
Household income		
Poor	427	42.14
Middle	195	19.17
Rich	392	38.69
Total	1014	100.00
Health insurance		
No	836	82.44
Yes	178	17.56
Total	1014	100.00
Employment status		
No	475	46.84
Yes	539	53.16
Total	1014	100.00
Type of residence		
Urban residence	706	69.64
Rural residence	308	30.36
Total	1014	100.00
Province		
Western Cape	101	9.98
Kwa-Zulu Natal	205	20.24
Northern cape	27	2.68
Free state	65	6.42
Eastern cape	143	14.13
North west	67	6.58
Gauteng	260	25.63
Mpumalanga	102	10.04
Limpopo	44	4.28
Total	1014	100.00
BMI		
Normal	514	50.75
Underweight	432	42.58
Overweight	68	6.67
Total	1014	100.00
Uses tobacco		
Non-tobacco user	596	58.78
Tobacco user	418	41.22

Total	1014	100.00
Frequency of eating processed meat		
Never	90	8.89
Every day	149	14.71
At least once a week	290	28.62
Occasionally	485	47.77
Total	1014	100.00
Frequency of alcohol consumption		
Never	439	43.29
5 or more days a week	74	7.34
Less than days a week	501	49.38
Total	1014	100.00

Table 4.1 pertains to the frequency and percentage distribution of characteristics of respondents in the selected sample. Among respondents in the sampled population, majority had undiagnosed hypertension (66%), while 34% had diagnosed hypertension. In terms of disability status, the number of respondents without disabilities was a majority (80%) and respondents with disabilities was 20%. Majority of the respondents had secondary level education (65%), 19% had primary education, 5% had no education and 12% had higher education level. Furthermore, 48% of the respondents were never married before while a majority had been married (52%).

With regard to age, 30% of the participants were aged ≥ 45 years. Participants between the ages 35-44 were 26% of the sample and those aged 25-34 years made 25% of the total sample while the least number of participants were aged 15-24 years (19%). Seemingly, majority of the respondents were Black/African (84%). The Coloureds ethnic group and the White, Asian, Indian, and other groups had equal respondents in the sample (8%). In terms of native language, majority (51.2%) of the respondents were native Nguni language speakers, 28% were native Sotho-Tswana language speakers, 11% were native English speakers while 8% were native Afrikaans speakers and 2% was other languages speakers. Furthermore, respondents from poor income household were a majority (42%), 19% of the respondents were from middle income household while 38% of the respondents were form rich income household. Moreover, in terms of health insurance, majority of the respondents did not access to health insurance (82%) while only 18% of the respondents have access to health insurance.

Majority of the participants had employment (53%) while 47% were not employed. In term of type of residence, 70% of the respondents were residents of urban areas while 30% were residing in rural areas. With respects to province of residence, majority of the respondents were from Gauteng (26%), followed by Kwa-Zulu Natal (20%) and then the Eastern Cape (14%), while the Mpumalanga and Western Cape had 10% of respondents each. Free State had 6% of respondents, 7% of the respondents were from North West and Limpopo had 4%. The Northern Cape contributed the least participants (3%).

In addition, majority of the respondent were of normal weight according to body mass index (50%) while 43% were overweight and underweight constituted the least percent (7%). In respect to the use of tobacco, majority of the respondents were not using tobacco in any form (59%) while 41% used tobacco. With regards to the frequency of eating processed meats, majority of the respondents were consuming processed meats occasionally (48%), 29% of respondents consumed processed meats at least once a week, 15% consumed processed meats every day and 9% of the respondents never consumed processed meats. Lastly, respondents who drunk alcohol less than five days a week combined to 49% of the sample size while those drunk alcohol five or more days a week combined to 7% and those who never drink made up 43%.

4.2 The prevalence of diagnosed and undiagnosed hypertension by disability status among men aged 15 years and older in 2016.

Table 4.2 Frequency table of participants by disability status and hypertension status.

	Undiagnosed hypertension (N)	**Diagnosed hypertension (N)**	**Total**
Non-disabled	563	244	**807**
Disabled	107	100	**207**

Table 4.2 above displays that among non-disabled men, 244 had been diagnosed with hypertension and 563 had undiagnosed hypertension. In contrast, among men with disabilities, 100 had been diagnosed with hypertension, while 107 men had undiagnosed hypertension in 2016.

Calculating the Prevalence rate of diagnosed hypertension.

$Prevalence\ rate\ (disabled\ men) = \frac{100}{207} \times 100$ = 48.31 cases per 100 disabled men

$$Prevalence\ rate\ (non\ disabled\ men) = \frac{244}{807} \times 100 = 30.24 \text{ cases per 100 non-disabled men}$$

Calculating the prevalence rate of undiagnosed hypertension

$$Prevalence\ rate\ (disabled\ men) = \frac{107}{207} \times 100 = 51.69 \text{ cases per 100 disabled men}$$

$$Prevalence\ rate\ (non\ disabled\ men) = \frac{563}{807} \times 100 = 69.76 \text{ cases per 100 non-disabled men}$$

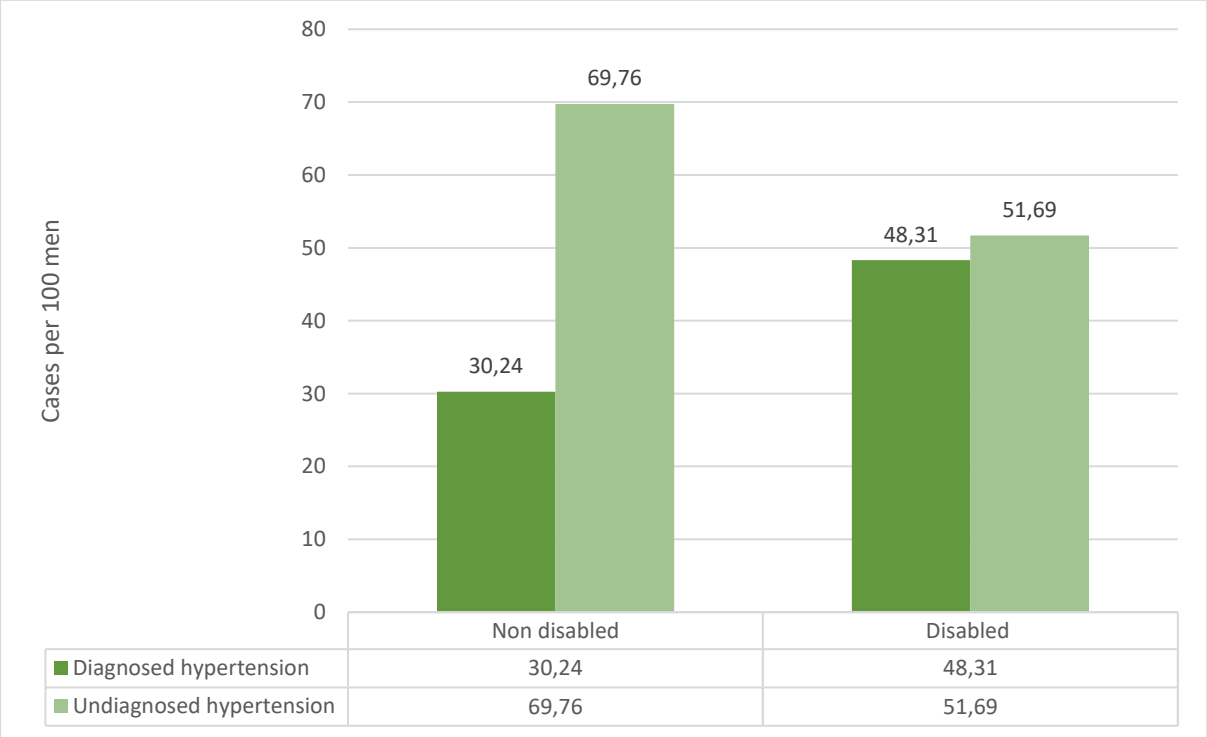


Figure 4.4 The prevalence rate of diagnosed and undiagnosed hypertension amongst South African men aged 15 years and older in 2016 by disability status.

The second objective was to determine the prevalence of diagnosed and undiagnosed hypertension by disability status among men aged ≥ 15 years in South Africa in 2016. Figure 4.4 above depicts that among the non-disabled population, 30 cases per 100 men were diagnosed with hypertension while 70 cases per 100 men were undiagnosed. Conversely, among the disabled population, 48 cases per 100 men were diagnosed with hypertension, whereas 52 cases per 100 men were undiagnosed hypertension.

Table 4.3 Percentage distribution of undiagnosed hypertension by socio-economic, demographic and lifestyle factors of men aged 15 years and older in 2016 (Weighted).

	Undiagnosed hypertension	**Diagnosed hypertension**	
Education level	**n (%)**	**n (%)**	

No education	34 (71.59)	13 (28.41)	
Primary	109 (57.15)	81 (42.85)	
Secondary	455 (69)	204 (31)	
Higher	73 (61.78)	45 (38.22)	*P-value=0.079*
Marital status			
Never married	352 (72)	137 (28)	
Married	318 (60.52)	207 (39.48)	*P-value=0.003*
Age group			
15-24	141 (74.29)	49 (25.71)	
25-34	191 (75.16)	63 (24.84)	
35-44	181 (68.08)	85 (31.92)	
45+	157 (51.55)	148 (48.45)	*P-value=0.000*
Ethnicity			
Black/African	582 (68.27)	270 (31.73)	
Coloured	46 (55.54)	37 (44.46)	
White/Asian/Indian/other	42 (53.27)	37 (46.73)	*P-value=0.044*
Native Language			
English	70 (60.71)	46 (39.29)	
Afrikaans	39 (50.34)	39 (49.66)	
Nguni languages	353 (67.94)	167 (32.06)	
Sotho-Tswana language	190 (67.71)	91 (32.29)	
Other	17 (86.69)	3 (13.31)	*P-value=0.064*
Household income			
Poor	305 (71.31)	123 (28.69)	
middle	121 (62.39)	73 (37.61)	
Rich	244 (62.15)	149 (37.85)	*P-value=0.094*
Health Insurance			
No	570 (68.14)	266 (31.86)	
Yes	100 (56.27)	78 (43.73)	*P-value=0.028*
Employment status			
Unemployed	299 (62.87)	176 (37.13)	
Employed	371 (68.86)	168 (31.14)	*P-value=0.122*

Type of residence			
Urban	462 (65.43)	244 (34.57)	
Rural	208 (67.5)	100 (32.50)	*P-value=0.642*
Province			
Western Cape	54 (53.64)	47 (46.36)	
Kwa-Zulu Natal	115 (55.92)	91 (44.08)	
Northern Cape	18 (65.70)	9 (34.30)	
Free State	47 (71.86)	18 (28.14)	
Eastern Cape	102 (71.42)	41 (28.58)	
North West	47 (69.97)	20 (30.03)	
Gauteng	172 (66.17)	88 (33.83)	
Mpumalanga	84 (82.39)	18 (17.61)	
Limpopo	31 (71.76)	12 (28.24)	*P-value=0.003*
BMI			
Normal	376 (73.05)	139 (26.95)	
Overweight	258 (59.75)	174 (40.25)	
underweight	36 (53.13)	32 (46.87)	*P-value=0.000*
Uses-tobacco			
Non-tobacco use	388 (65.10)	208 (34.90)	
Tobacco user	282 (67.41)	136 (32.59)	*P-value=0.564*
Frequency of eating processed meats			
Never	56 (61.54)	35 (38.46)	
Every day	100 (67.24)	49 (32.76)	
At least once a week	197 (67.68)	94 (32.32)	
Occasionally	318 (65.56)	167 (34.44)	*P-value=0.823*
Frequency of alcohol use			
Never	288 (65.67)	151 (34.33)	
5 or more days a week	40 (53.53)	35 (46.47)	
Less than 5 days a week	342 (68.26)	159 (31.74)	*P-value=0.233*

In Table 4.3, a bivariate analysis further illustrated the prevalence of undiagnosed hypertension by socio-economic, demographic, and lifestyle factors among South African men aged 15 years

and older in 2016. With reference to educational level, undiagnosed hypertension was greatest among men without education (72%), followed by those with secondary education (69%). Furthermore, men with higher education and those with primary education constituted the lowest percentage of men with undiagnosed hypertension (62% and 57% respectively). In contrast, men with primary education and those with higher education contributed the highest percentage of men living with diagnosed hypertension (43% and 38 % respectively) while men without education and those with only secondary education had the lowest percentages of diagnosed hypertension (28% and 31% respectively). The Pearson Chi-square test of independence showed that the relationship between undiagnosed hypertension and education level is statistically insignificant (P-value=0.079).

Regarding marital status, undiagnosed hypertension was significantly greater (72%) among men who were never married, while men who were currently or previously married had the lowest levels of undiagnosed hypertension (61%). Conversely, cases of diagnosed hypertension were high among currently/previously married men and lowest among men who had never married at 39% and 28% respectively with evidence showing a statistically significant association (P-value=0.003).

The variable age group had showed a statistically significant relationship with undiagnosed hypertension (P-value≤0.05). The youngest age group had the highest percentage of men with undiagnosed hypertension compared with the older age groups. 75% of men aged 25-34 years had undiagnosed hypertension, followed by men from ages 15-24 (74%), and those aged 35-44 (68%). The lowest percentage of men with undiagnosed hypertension (52%) was found in those aged 45 years and older. In relation to diagnosed hypertension, the youngest age group comprised the lowest percentage compared to the older age groups. Only 25% of the men aged 25-34 years were diagnosed with hypertension, followed by 26% and 32% of the men aged 15-24 years and 35-44 years respectively. The group of men aged ≥ 45 years had the highest percentage of men diagnosed with hypertension (48%).

The results revealed that men from the African/Black ethnic group exhibited the highest level (68%) of undiagnosed hypertension, followed by those from the Coloured ethnic group, with 56% of men living with undiagnosed hypertension. Men belonging to the White, Asian, Indian and other ethnic groups collectively constituted the lowest proportions (53%) of men living with undiagnosed hypertension. To the contrary, the African/Black ethnic group and the coloured ethnic group constituted the least percentage of men with diagnosed hypertension

(32% and 44%, respectively), while the White, Asian, Indian and other ethnic groups showed greater levels of men with diagnosed hypertension (47%).

In terms of respondents' native language, Nguni speakers and men speaking Sotho-Tswana languages had the largest percentage of undiagnosed hypertension each at 68%. Afrikaans and English speakers constituted lower proportions of men living with undiagnosed hypertension at 50% and 61%, respectively. Conversely, Afrikaans speakers had the greatest percentage of men who were diagnosed with hypertension (50%), followed by English speakers (39%), and Nguni-language speakers and Sotho-Tswana speakers contributed the lowest percentages to men with diagnosed hypertension both at 32%.

According to household income, men belonging to the poor households exhibited a higher percentage of undiagnosed hypertension (71) than men belonging to the middle and rich income categories (62%). In relation to diagnosed hypertension, men belonging to the rich and middle incomes category had the highest prevalence both at 38%. Men from the poor income category had the lowest prevalence of diagnosed hypertension (27%). However, the relationship was proven statistically insignificant (P-value≥0.05).

Table 4.3 further indicates that the association between undiagnosed hypertension and access to health insurance is statistically significant (P-value=0.028). Furthermore, the results showed great variation in the distribution of undiagnosed hypertension among men with and without health insurance. Undiagnosed hypertension was higher (68%) in men without health insurance than in men with health insurance (56%). Conversely, men with access to health insurance had a greater percentage of diagnosed hypertension (43%) than those without health insurance (32%).

With regard to employment status, there was no evidence that it has a relationship with hypertension diagnosis status in the Pearson chi-square test of independence (P-value≥ 0.05). Undiagnosed hypertension was greater among employed men (69%) compared to unemployed men (63%). In contrast, unemployed men contributed a greater percentage of men with diagnosed hypertension (37%) than employed (31%).

Undiagnosed hypertension was predominant in both urban and rural residences. Nonetheless, men who lived in urban areas had a slightly lower percentage (65%) of men living with undiagnosed hypertension than men who lived in rural areas (68%). On the other hand, men who lived in urban areas had a greater percentage of diagnosed hypertension (35%) than those

who lived in rural areas (33%). The results revealed the relationship between undiagnosed hypertension and type of residence as statistically insignificant as P>0.05.

In terms of province, men from Mpumalanga constituted the highest percentage of men with undiagnosed hypertension (82%). Additionally, men from the Free State (72%) and Limpopo (72%) had the same percentage of men living with undiagnosed hypertension. Men from Eastern Cape constituted 71%, and North West (70%), Northern Cape (66%), and Gauteng (66%) of the men living with undiagnosed hypertension. KwaZulu-Natal (56%) and Western Cape (54%) constituted the lowest percentage of men with undiagnosed hypertension. In contrast, Mpumalanga Province comprised the least percentage (18%) of men living with diagnosed hypertension, followed by Free State and Limpopo province together comprising 28% of men with diagnosed hypertension. Northern Cape and Gauteng both comprised 34 percent of men living with diagnosed hypertension; Eastern Cape constituted 29%, and North West constituted 30%. The highest percentages of men living with diagnosed hypertension were consolidated in Western Cape (46%) and KwaZulu-Natal (44%). The Pearson's Chi-square test of independence indicated a statistically significant relationship between province of residence and hypertension diagnosis status (P=0.000).

With respect to Body Mass Index (BMI), normal weight men and overweight men contributed the largest percentage of men living with undiagnosed hypertension (73% and 60%, respectively). Men who were underweight had lower undiagnosed hypertension prevalence of 53%. In contrast, normal-weight men and overweight men constituted a significantly lower percentage of men living with diagnosed hypertension (27% and 40%, respectively), whereas underweight men comprised a greater 47% of men living with diagnosed hypertension. The relationship between Body Mass Index and undiagnosed hypertension was statistically significant (P≤0.05).

Delving into lifestyle factors such as tobacco use, 67% of men using tobacco were found to have undiagnosed hypertension compared to 65% of men who were not tobacco users. Conversely, only 33% of tobacco users were aware of living with diagnosed hypertension compared with 335% of non-tobacco users. Regarding additional lifestyle variables, the frequency of eating processed meats had a statistically insignificant association with hypertension diagnosis status (P>0.05). Men who never consumed processed meats comprised the lowest percentage of men living with undiagnosed hypertension (62%), followed by men who occasionally consumed processed meats (66%). Additionally, the highest percentage of

men with undiagnosed hypertension was found in men eating processed meats at least once a week and every day of the week (68% and 67% respectively).

Conversely, the highest percentage of men living with diagnosed hypertension was found among men who did not consume processed meat (38%), followed by men who occasionally consumed processed meat (34%). The lowest proportion of men with diagnosed hypertension was found among men who reported eating processed meats every day and once a week, 33% and 32% respectively. Finally, the results showed that there was also no statistically significant relationship between the frequency of alcohol use and hypertension diagnosis status (P>0.05). Undiagnosed hypertension was found in 68% of men using alcohol less than five days a week, in 65% of men who never drink alcohol and 54% of men using alcohol more than five days a week. In contrast, men drinking alcohol for 5 days or more in a week had a greater percentage of men with diagnosed hypertension (46%), followed by men who never drink alcohol (34%) and men drinking alcohol for less than 5 days in a week showed the lowest percentage (32%).

4.3 Multivariate analysis of the statistical relationship between living with a disability and undiagnosed hypertension among South African men aged 15 years and older.

Table 4.4Binary logistic regression modelling the unadjusted odds ratios for the relationship between undiagnosed hypertension and selected independent variables.

	UOR	**P-value**	**CI**
Disability status			
Non-disabled	RC		
Disabled	0.46	0.000**	0.323114 - 0.661460
Education level			
No education	RC		
Primary	0.53	0.078	0.260894 - 1.073864
Secondary	0.88	0.716	0.452132 - 1.724990
Higher	0.64	0.300	0.276592 - 1.487650
Marital status			
Never	RC		
Married	0.60	0.003**	0.425971 - 0.834145
Age group			
45+	RC		
35-44	2.00	0.001**	1.318057 - 3.048535

25-34	2.84	0.000**	1.786110 - 4.526124
15-24	2.71	0.000**	1.707817 - 4.315877
Ethnicity			
African/black	RC		
Coloured	0.58	0.075	0.319202 - 1.056472
White/Asian/Indian/other	0.53	0.061	0.272781 - 1.028833
Language			
English	RC		
Afrikaans	0.66	0.204	0.342203 - 1.257732
Nguni languages	1.37	0.280	0.773247 - 2.431266
Sotho-Tswana language	1.36	0.299	0.762145 - 2.415171
Other	4.21	0.139	0.625035 - 28.412670
Household income			
Poor	RC		
Middle	0.67	0.081	0.423884 - 1.051114
Rich	0.66	0.051	0.435576 - 1.002662
Health insurance			
No	RC		
Yes	0.60	0.029**	0.381322 - 0.949416
Employment status			
No	RC		
Yes	1.31	0.123	0.930369 - 1.834172
Type of residence			
Urban	RC		
Rural	1.10	0.642	0.740635 - 1.626197
Province			
Western Cape	RC		
KwaZulu-Natal	1.10	0.812	0.513884 - 2.338369
Northern Cape	1.66	0.165	0.811630 - 3.376260
Free State	2.21	0.035**	1.055698 - 4.611757
Eastern Cape	2.16	0.037**	1.048935 - 4.446960
North West	2.01	0.065	0.958139 - 4.233971
Gauteng	1.69	0.168	0.800894 - 3.568391
Mpumalanga	4.04	0.000**	1.960166 - 8.341173

Limpopo	2.20	0.064**	0.954923 - 5.049069
BMI			
Normal	RC		
Overweight	0.55	0.000**	0.390762 - 0.767476
Underweight	0.42	0.006**	0.224173 - 0.780076
Uses tobacco			
Non-tobacco user	RC		
tobacco user	1.11	0.564	0.780484 - 1.574788
Frequency of eating processed meat			
Never	RC		
Every day	1.28	0.468	0.654498 - 2.513872
Least once a week	1.31	0.406	0.693117 - 2.471265
Occasionally	1.19	0.569	0.653085 - 2.168443
Frequency of alcohol use			
Never	RC		
5 or more days a week	0.60	0.246	0.255663 - 1.419284
Less than 5 days a week	1.12	0.466	0.820318 - 1.540588

RC = reference category; UOR=Unadjusted odds ratios; ** = Statistical significant (P-value≤0.05) and CI= confidence interval at 95%.

Table 4.4 presents the unadjusted odds ratios showing the association between hypertension diagnosis status and the selected predictor variables. In terms of disability status, the unadjusted odds ratio showed that disabled men were 0.46 times less likely to live with undiagnosed hypertension compared to men who were not disabled [UOR: 0.46; CI: 0.32-0.66]. The relationship between disability status and undiagnosed hypertension was statistically significant (P≤0.05).

With regard to education level, men who have completed primary education were 0.53 times less likely to live with undiagnosed hypertension compared to men with no education [UOR: 0.53; CI: 0.26-1.07]. However, the relationship between completing only primary-level education and living with undiagnosed hypertension was not statistically significant (P-value≥0.05). Men who completed secondary school as highest education were 0.88 times less likely to live with undiagnosed hypertension compared to men with no education [UOR: 0.88; CI: 0.45-1.72]. The association between possessing secondary education level as the highest education level and living with undiagnosed hypertension was also found to be statistically insignificant in the unadjusted regression model (P-value>0.05). Additionally, men who

completed higher education were insignificantly less likely to live with undiagnosed hypertension compared to men without educational attainment [UOR: 0.64; CI: 0.28-1.49].

In terms of marital status, the unadjusted odds ratios indicate that married men were significantly less likely to live with undiagnosed hypertension compared to men who never married [UOR: 0.60; CI: 0.43-0.83]. With regards to age group, men aged 15-24 years old were 2.71 time more likely to live with undiagnosed hypertension compared to men aged 45 years and older [UOR: 2.71; CI: 1.71-4.32]. Men in the age group 25-34 years old were 2.84 times more likely to live with undiagnosed hypertension compared to aged 45 years and older [UOR: 2.84; CI: 1.79-4.53]. Furthermore, men aged 35-44 years old were 2 times more likely to live with undiagnosed hypertension compared to men aged 45 years and older [UOR: 2.00; CI: 1.32-3.04]. The unadjusted results revealed that the association between age and undiagnosed hypertension is statistically significant (P-value<0.05).

With regards to ethnicity, the unadjusted odds ratios show that belonging to the Coloured ethnic group and to the White, Asian, and Indian ethnic groups decreased the probability of living with undiagnosed hypertension compared to belonging to the black ethnic group. Coloured men were 0.58 times less likely to live with undiagnosed hypertension compared to black men [UOR: 0.58; CI: 0.31-1.06]. Men belonging to the White, Asian, Indian and other ethnic groups were 0.53 time less likely to live with undiagnosed hypertension compared to men who belonged to the black ethnic group [UOR: 0.53; CI: 0.27-1.03]. The association between ethnicity and living with undiagnosed hypertension was statistically insignificant (P-value≥0.05).

In terms of language, men speaking Afrikaans as a native language were less likely to live with undiagnosed hypertension compared to men speaking English [UOR: 0.66; CI: 0.34-1.26]. Men who are native Nguni language speakers were more likely to live with undiagnosed hypertension compared to men who speak English as a native language [UOR: 1.37; CI: 0.77-2.43]. Native Sotho-Tswana language speakers were more likely to live with undiagnosed hypertension compared to native English speakers [UOR: 1.36; CI: 0.76-2.41]. Those where speaking other languages were 4.21 time more likely to live with undiagnosed hypertension [UOR: 4.21; CI: 0.63-28.41]. The tables show that with regard to language none of the language groups was significantly associated with undiagnosed hypertension.

Regarding household income, men belonging to the middle-income category 0.67 time less likely to have undiagnosed hypertension compared to men belonging to the poor income

category [UOR: 0.67; CI: 0.42-1.05]. The relationship was found to be statistically insignificant (P≥0.05). In addition, men belonging to the rich income category were 0.66 times less likely to live with undiagnosed hypertension compared to men from the poor income category [UOR: 0.66; CI: 0.44-1.00]. The relationship between belonging to the rich income category and undiagnosed hypertension was found to be statistically significant (P-value≤0.05).

With regard to health insurance, men with health insurance were significantly less likely to have undiagnosed hypertension compared to men without health insurance [UOR: 0.60; CI: 0.38-0.95]. The unadjusted odds ratios furthermore indicates that men who were in any form of employment were more likely to have to live with undiagnosed hypertension compared to men who were not employed [UOR: 1.31; CI: 0.93-1.83]. In terms of type of residence, the unadjusted regression model indicated that men who lived in rural areas were 1.10 times more likely to live with undiagnosed hypertension compared to men who lived in urban areas [UOR: 1.10; CI: 0.74-1.63]. However, the relationship between the type of residence and undiagnosed hypertension was not found to be statistically significant (P-value≥0.05).

With regard to province, the unadjusted odds ratio indicated that men from the KwaZulu-Natal had higher odds of having undiagnosed hypertension compared to those in Western Cape [UOR: 1.10; CI: 0.51-2.33]. Men residing in Northern Cape [UOR: 1.66; CI: 0.81-3.38], Free State [UOR: 2.21; CI: 1.05-4.61], Eastern Cape [UOR: 2.16; CI: 1.05-4.45], North West [UOR: 2.01; CI: 0.96-4.23], Gauteng [UOR: 1.69; CI: 0.80-3.57], Mpumalanga [UOR: 4.04; CI: 1.97-8.34], and Limpopo [UOR: 2.20; CI: 0.95-5.04] had higher odds of having undiagnosed hypertension than those who resided in Western Cape. Table 4.4 shows that all the provinces except for KwaZulu-Natal, Northern Cape, North West and Gauteng had statistical evidence that they were associated with higher odds of having undiagnosed hypertension (P-value≤0.05).

In terms of BMI, the results showed statistical evidence that overweight men and underweight men had lower odds of living with undiagnosed hypertension compared to those with normal weight, [UOR: 0.55; P-value≤0.05; CI: 0.39-0.76] and [UOR: 0.42; P-value≤0.05; CI: 0.22-0.78], respectively. With regard to tobacco use, men who reported using tobacco were 1.11 times more likely to have undiagnosed hypertension than those who were non-tobacco users [UOR: 1.11; CI: 0.78-1.57]. The results do not show statistical evidence that tobacco use increased the odds of having undiagnosed hypertension (P-value>0.05).

With regard to the frequency of eating processed meat, men consuming processed meats everyday were more likely to live with undiagnosed hypertension compared to men who never

consumed processed meats [UOR: 1.28; CI 0.65-2.51]. Men consuming processed meats only once within a week were also more likely to have undiagnosed hypertension compared to those who never consumed processed meats [UOR: 1.31; CI: 0.69-2.47]. Men who consumed processed meats occasionally were 1.19 times more likely to have undiagnosed hypertension compared to those who never ate processed meats [UOR: 1.19; CI: 0.65-2.17]. The unadjusted model has however not indicated any evidence of a statistically significant association between the frequency of eating processed meat and undiagnosed hypertension (P-values>0.05).

In terms of frequency of alcohol use, men who drank alcohol for 5 days or more in a week were less likely to live with undiagnosed hypertension compared to men who never drink alcohol [UOR: 0.60; CI: 0.26-1.42]. Men drinking alcohol for less than 5 days in a week were more likely to live with undiagnosed hypertension [OUR: 1.12; CI: 0.82-1.54]. The association between frequency of alcohol use and undiagnosed hypertension was not statistically significant (p>0.05).

Table 4.5 Binary logistic regression modelling the adjusted odds ratios for relationship between disability status and undiagnosed hypertension while controlling for other independent variables.

variable	**AOR**	**P-value**	**CI**
Disability status			
Non-disabled	RC		
Disabled	0.65	0.024**	0.444103 - 0.945199
Education level			
No education	RC		
Primary	0.46	0.040**	0.218594 - 0.965709
Secondary	0.66	0.254	0.317695 - 1.354335
Higher	0.53	0.197	0.199069 - 1.394876
Marital Status			
Never married	RC		
Married	0.90	0.615	0.602291 - 1.350007
Age group			
45+	RC		
35-44	1.58	0.041**	1.019279 - 2.442621
25-34	2.22	0.001**	1.363807 - 3.612329
15-24	2.25	0.006**	1.264663 - 4.020117
Ethnicity			
Black/African	RC		

Coloured	1.09	0.854	0.440742 - 2.686479
White/Asian/Indian/other	0.95	0.918	0.368969 - 2.452612
Language			
English	RC		
Afrikaans	0.58	0.108	0.298328 - 1.126615
Nguni languages	1.02	0.956	0.467966 - 2.232006
Sotho-Tswana languages	0.80	0.592	0.362392 - 1.785670
Other	2.94	0.310	0.366114 - 23.574330
Household income			
Poor	RC		
Middle	0.68	0.141	0.405451 - 1.137364
Rich	0.94	0.818	0.552586 - 1.598230
Health insurance			
No	RC		
Yes	0.70	0.196	0.404581 - 1.204386
Employment Status			
No	RC		
Yes	1.59	0.022**	1.068416 - 2.351631
Type of residence			
Urban residence	RC		
Rural residence	1.07	0.765	0.668833 - 1.727613
Province			
Western Cape	RC		
KwaZulu-Natal	0.70	0.405	0.305414 - 1.614854
Northern cape	1.94	0.079	0.925966 - 4.058794
Free state	2.71	0.016**	1.203501 - 6.097438
Eastern cape	1.67	0.191	0.774120 - 3.605133
North west	1.89	0.134	0.820407 - 4.370287
Gauteng	1.72	0.191	0.762829 - 3.871802
Mpumalanga	2.66	0.015**	1.206125 - 5.844980
Limpopo	1.94	0.201	0.703153 - 5.332483
BMI			
Normal	RC		
Overweight	0.66	0.036**	0.443940 - 0.973262

Underweight	0.49	0.041**	0.246573 - 0.971732
Uses tobacco			
Non-tobacco user	RC		
Tobacco user	1.17	0.457	0.774431 - 1.763943
Frequency of eating processed meat			
Never	RC		
Every day	1.00	0.998	0.430320 - 2.319231
At least once a week	0.99	0.983	0.456461 - 2.153527
Occasionally	1.06	0.874	0.507493 - 2.218921
Frequency of alcohol use			
Never	RC		
5 or more days a week	0.53	0.164	0.218894 - 1.295406
less than 5 days a week	0.95	0.770	0.668934 - 1.346755

RC = Reference category; AOR=Adjusted odds ratio; ** =Statistical significant (P ≤0.05) and CI = Confidence interval at 95%.

The third objective of this study saw to examine the association of disability status after controlling for socio-economic, demographic, and lifestyle factors on undiagnosed hypertension. Table 4.5 illustrates that in terms of disability status, men who were living with a disability were significantly less likely to have undiagnosed hypertension compared to men who were not disabled [AOR: 0.65; CI: 0.44-0.94]. With respect to education level, men who had primary level education were significantly less likely to live with undiagnosed hypertension compared to men with no education [AOR: 0.46; CI: 0.22-0.97]. The odds ratio demonstrated that men with secondary level education were less likely to have undiagnosed hypertension compared to men without education [AOR: 0.66; CI: 0.31-1.35]. However, the relationship was not statistically significant. Additionally, men with higher education compared to men with no education were insignificantly less likely to live with undiagnosed hypertension [AOR: 0.53; CI: 0.20-1.39].

Among South African men, there was no statistically significant relationship between marital status and undiagnosed hypertension. Nonetheless, the odds ratios indicated that men who had been married before and currently married were at a lower likelihood of living with undiagnosed hypertension [AOR: 0.90; CI: 0.60-1.35] in relation to men without a history of being married. Furthermore, the results showed age was significantly associated with living with undiagnosed hypertension. Men aged between 15 and 24 years were 2.25 times more likely to have undiagnosed hypertension compared to men aged 45+ years [AOR: 2.25; CI:

1.26-4.02]. Those aged between 25 and 34 years 2.22 times more likely to have undiagnosed hypertension than those aged 45 years and older [AOR: 2.22; CI: 1.36-3.61]. Moreover, men aged 35-44 years were 1.58 times more likely [AOR: 1.58; CI: 1.02-2.44] to have undiagnosed hypertension.

Ethnicity was not significantly associated with living with undiagnosed hypertension statistically, however, the odds ratios show that Coloured men were 1.09 times more likely to live with undiagnosed hypertension compared to African/Black men [AOR: 1.09; CI: 0.44-2.68]. Whites, Asians, Indians and other were 0.95 less likely to have undiagnosed hypertension than to African/Black men [AOR: 0.95; CI: 0.37-2.45]. In the native language, men speaking Afrikaans as a native language were less likely to have undiagnosed hypertension [AOR: 0.58; CI: 0.30-1.13] than native English speakers.

In addition, native Nguni speakers were more likely to have undiagnosed hypertension compared to those speaking English as a native language [AOR: 1.02; CI: 0.47-2.23]. However, the relationship was not statistically significant for either Afrikaans or Nguni native speakers. On the other hand, men who were speaking languages categorised under Sotho-Tswana native languages were less likely to have undiagnosed hypertension than native English speakers [AOR: 0.80; CI: 0.36-1.79]. The relationship between speaking Sotho-Tswana native languages and having undiagnosed hypertension was also found statistically insignificant among South African men. Compared to English native speakers, men whom were speaking other languages were 2.94 time more likely to have undiagnosed hypertension [AOR: 2.94; CI: 0.37-23.57], without statistical significance holding for this relationship.

With regard to household income levels, men from middle-income households were less likely to live with undiagnosed hypertension than men from poor income households [AOR: 0.68; CI: 0.40-1.14]. The results also showed that men from rich income households were less likely to have undiagnosed hypertension compared to men from poor income households [AOR: 0.94; CI: 0.55-1.60]. However, no statistically significant relationship was found between belonging to any household income category and living with undiagnosed hypertension.

The results moreover depicted that the relationship between undiagnosed hypertension and health insurance was not statistically significant after controlling for other variables. Nonetheless, men with health insurance were less likely to live with undiagnosed hypertension compared to men without health insurance [AOR: 0.70; CI: 0.40-1.20]. Employment status was found to be statistically significant in the regression model. The odds ratios showed that

employed men were more likely to have undiagnosed hypertension compared to unemployed men [AOR: 1.59; CI: 1.07-2.35].

In terms of type of residence, the adjusted regression model indicates that association between type of residence and living with undiagnosed hypertension was not statistically significant (P-value≥0.05). Nonetheless, men residing in rural areas were more likely to have undiagnosed hypertension compared to men in urban residences [AOR: 1.07; CI: 0.67-1.72]. With regard to province of residence, it was found that the KwaZulu-Natal province that did not have a statistically significant association with undiagnosed hypertension, however, the odds ratios of living with undiagnosed hypertension were low [AOR:0.70; CI: 0.31-1.61].

Other than KwaZulu-Natal, the Northern Cape, Eastern Cape, North West, Gauteng and Limpopo provinces showed a statistically insignificant association with undiagnosed hypertension. Men residing in the Northern Cape province were 1.94 times more likely to have undiagnosed hypertension compared to living in Western Cape [AOR: 1.94; CI: 0.93-4.06]. The odds ratios show that men residing in the Eastern Cape were 1.67 times more likely to have undiagnosed hypertension compared to men residing in Western Cape [AOR: 1.67; CI: 0.77-3.61].

In the North West, the probability of living with undiagnosed hypertension was increased to 1.89 times compared to Western Cape [AOR: 1.89; CI: 0.82-4.37]. In the Gauteng province, men were 1.72 time more likely to have undiagnosed hypertension to men in Western Cape [AOR: 1.72; CI: 0.76-3.87]. Men who were living in Limpopo province were 1.94 times more likely to have undiagnosed hypertension compared to living in Western Cape [AOR: 1.94; CI: 0.70-5.33]. Additionally, men living in Free State and Mpumalanga also had increased chances of having undiagnosed hypertension compared to men residing in Western Cape with a statistically significant association in the model [AOR: 2.71; CI: 1.20-6.20] and [AOR: 2.66; CI: 1.20-5.84] respectively.

As it can be seen in table 4.5 the relationship between body mass index (BMI) and undiagnosed hypertension is statistically significant when controlling for other variables (P-value≤0.05). The adjusted odds ratios show that men with overweight and underweight BMI were less likely to live with undiagnosed hypertension when compared to men with normal BMI with [AOR: 0.66; CI: 0.44-0.97] and [AOR: 0.49; CI: 0.25-0.97], respectively. With regards to tobacco use, men who were using tobacco were insignificantly more likely to live with undiagnosed hypertension compared to men who were not using tobacco [AOR: 1.17; CI: 0.77-1.76].

Regarding the frequency of eating processed meat, it was found that consuming processed meats every day did not have an impact on undiagnosed hypertension [AOR: 1.00; CI: 0.43-2.32]. Men whose diet consisted of processed meats only once per week were 0.99 times less likely to live with undiagnosed hypertension compared to men whose diet never consisted of processed meats [AOR: 0.99; CI: 0.46-2.15]. Additionally, men who reported eating processed meat occasionally were 1.06 time more likely to live with undiagnosed hypertension compared to men who never ate processed meats [AOR: 1.06; CI: 0.51-0.22]. Although eating processed meats once a week and occasionally showed to decrease men's chances of living with undiagnosed hypertension when compared to men who never eat processed meats, the relationship between the frequency of eating processed meats and having undiagnosed hypertension was found to be statistically insignificant (P-value≥0.05).

Regarding the frequency of alcohol use when adjusting for independent variables, men who would drink alcohol for 5 days and more in a week were less likely live with undiagnosed hypertension compared to men who never drink alcohol [AOR: 0.53; CI: 0.22-1.30]. Men drinking alcohol less than 5 days a week were also less likely to have undiagnosed hypertension [AOR: 0.95; CI: 0.66-1.35]. However, the association between the frequency of alcohol consumption and undiagnosed hypertension was not statistically insignificant (P-value≥0.05).

4.4 Hypothesis testing

The hypothesis for this study was tested using the adjusted and unadjusted multivariate regression model analysis:

The hypothesis of this study was as follows:

H0 (null hypothesis)- Living with a disability is not associated with undiagnosed hypertension amongst South African males aged 15 years and older.

H1 (alternative hypothesis)- Living with a disability is associated with undiagnosed hypertension amongst South African males aged 15 years and older.

Assumption: Significance level: $\alpha=0.05$

It was found that in this the P-value of some of the variables in the models were less than 0.05, even though for other variables the P-value exceeded the statistical significance. This study then rejects the null hypothesis (H0) in favour of the alternative hypothesis (H1). Thus,

concluding that living with a disability is associated with undiagnosed hypertension in South African males aged 15 years and older.

Chapter 5: Discussion

Studies posit that 41% of women and 51% of men who have hypertension worldwide are undiagnosed (Zhou et al, 2021). In Sub-Saharan Africa, 66% of men and 52% of women were living with hypertension without being diagnosed in 2019. South Africa also experiences high percentages of undiagnosed hypertension among its population (38.3% of men and 36% of women) (Kamerman, 2022). In response to the prevalence of undiagnosed hypertension and the need to determine factors that might impede hypertension detection, we explored the potential relationship between disability status and undiagnosed hypertension among South African males ≥15 years in 2016. The study had three objectives; (1) to ascertain the levels of undiagnosed hypertension among South African men aged ≥15 years; (2) to determine the prevalence of diagnosed and undiagnosed hypertension by disability status among males ≥15 years and (3) to examine the association between disability status and undiagnosed hypertension while controlling for socio-economic, demographic and lifestyle factors. This chapter focuses on placing the findings from the objectives of this study in a discussion with the relevant literature and providing a conclusion and recommendations.

5.1 The levels of undiagnosed hypertension amongst South African men aged 15 years and older in 2016.

As expected, the study found that levels of undiagnosed hypertension are higher when compared to levels of diagnosed hypertension in males (66% v/s 34%, respectively). Several other studies find that levels of non-diagnosis of hypertension are disproportionately higher in males than women (Najafipour et al., 2020; Guerrero-Diaz et al., 2021; Peer et al., 2021; Pengpid &Peltzer, 2022; Woodiwiss et al., 2023). The lack of hypertension awareness among men has been well-studied. Studies report that the difference in hypertension awareness according to sex is due to frequent healthcare visits by young adult females compared to their age-matched males as a result of attending maternal and child health programmes, creating an opportunity for females to be screened for hypertension (Peer et al. 2021; Ong et al. 2020). Another attribution is that most of the male population might be constrained by working hours to attend health services during working hours, limiting chances to access blood pressure screening (Peer et al. 2021). Although the observed result is consistent with the global high prevalence of undiagnosed hypertension found in males, it shows that the levels of undiagnosed hypertension in South African males exceed the global prevalence (51%) (Zhou et al, 2021). This is highlighting the burden of undiagnosed hypertension in South Africa.

5.2 The prevalence of diagnosed and undiagnosed hypertension by disability status among men aged 15 years and older in 2016.

Findings from this study reveal that among South African men, the prevalence of undiagnosed hypertension exceeds the prevalence of diagnosed hypertension irrespective of disability status at (52% v/s 48%, respectively) for the disabled population and (70% v/s 30%, respectively), for the general non-disabled population. Although in this study, the prevalence of undiagnosed hypertension is significantly a burden in both population groups, we found that it is far greater within the non-disabled population compared to the disabled (70% v/s 52%, respectively). These findings align with a study conducted in Shanghai, China, by Wu and colleagues (2021), which found that the rate of hypertension treatment and controlled blood pressure was higher in the disabled population than in the general population. Their study could imply that the majority of the general population were unaware of their hypertensive status and thus could not begin treatment to control blood pressure. Thus, these results could be showing that people who are not disabled may be assuming that they are healthy and not participate in health screenings as (Wu et al. 2021) has that higher treatment rates in the disabled population might be linked to frequent and increased hypertension screenings and diagnosis. This frequent hypertension screening might arise from disabled people being more watchful of their health as they are more likely to have comorbidity with chronic diseases.

This study found that the prevalence of undiagnosed hypertension was considerably the highest among men with no education attainment. This finding is opposed by studies conducted by (Mirzaei, Mirzaei, Bagheri & Dehghani. 2020; Haider & Gupta, 2021), where they observed that individuals with higher educational attainment demonstrated the highest prevalence of hypertension unawareness among participants. However, other studies have found complementary results. First, a congruence is observed in Iran, where another study showed that undiagnosed hypertension was prevalent among illiterate people (Najafipour et al., 2020). Secondly, Cao et al. (2016) found that hypertension unawareness was mostly predominant in individuals of no education attainment. A shared perspective is that illiteracy and lower-level education might have been a barrier to accepting health education programs warning hypertension as a risk factor for cardiovascular disease, culminating in not attending blood pressure screenings (Cao et al. 2016). Additionally, a study in India showed that highly educated individuals were more aware of healthy lifestyles and had affordability to access health care, reducing rates of undiagnosed hypertension (Boro & Banerjee, 2022). However,

in our Study, the relationship between undiagnosed hypertension prevalence and education level was not statistically significant.

The results of the study showed that a higher prevalence of undiagnosed hypertension existed in men who were never married. Ong et al. (2020) found that 56% of men who never married were living with undetected hypertension compared to 21% of married men, which shows congruency with the results from our present study. A possible explanation was that marriage encourages health care utilization, leading a healthy lifestyle, including frequent health screenings, and that married individuals often have the potential to afford medical care costs compared to non-married people (Ong et al., 2020; Lim & Yong, 2019). As expected, the findings of our study showed that majority of men with undiagnosed hypertension were below 45 years age group in South Africa. Researchers have found corroborating results across the world, which indicate that awareness of hypertension increased as age increased, with the youngest population having the least prevalence of awareness and the highest awareness prevalence in older adults (O'Brien et al., 2021; Ghaddar et al., 2021). In one study, it was shown that only 23% of participants between the ages 25-34 years were diagnosed with hypertension compared to 42% of those aged 55-64 years (Pengpid & Peltzer, 2022). Lower prevalences of hypertension awareness in younger populations indicate that there are high proportions of undiagnosed hypertension amongst the youth.

A dearth of research investigates the prevalence of hypertension awareness per language and ethnicity. Of the few studies conducted, hypertension awareness was lowest among the Coloured ethnic group compared to Blacks (Woodiwiss et al., 2023). Thus, this implies a higher level of hypertension unawareness among Coloured participants. This finding contradicts our study. The results of our study showed the Coloured ethnic group had a higher prevalence of hypertension awareness compared to Blacks. Thus, Coloured people had a lower prevalence of undiagnosed hypertension compared to Blacks. Similarly to our results, Woodiwiss et al., (2023) found that being White, Asian or Other showed the lowest prevalence of undiagnosed hypertension. In terms of language, a previous study has shown that language plays a role in the diagnosis of hypertension. Johnson et al. (2014), when investigating factors that delay hypertension diagnosis, found individuals coming from households where English is not a primary home language experienced a delay in hypertension diagnosis. This finding endorses the results from our study as we found that people who are native African language speakers, such as Nguni and Sotho-Tswana languages, had the greatest prevalence of undiagnosed hypertension in Table 4.3 above.

Table 4.3 shows that the highest proportions of undiagnosed hypertension are found among poor-income households compared to rich and middle-income households. Several other studies in low-and middle-income countries have also found the highest prevalence of hypertension unawareness was associated with lowest-income earners and poorest-income households- indicating wealth as a protective measure against unawareness of diagnosis status (Banigbe et al. 2020; Guererro-Diaz et al. 2019; Lim & Yong, 2019). However, the measure of association between the prevalence of household income and undiagnosed hypertension was not statistically significant. Moreover, this study is inconsistent with that of Ong et al. (2020) which found that students, non-paid workers, and unemployed participants had the highest percentage of undetected hypertension (61%). Researchers have also found evidence in support of our study in China, where the prevalence of undetected hypertension was low within the unemployed population (19%) (Zhang et al., 2017). Researchers from Singapore share similar sentiments that having access to healthcare is not always congruent with utilization. Man et al., (2019) found that in Singapore, which is a developed and most urbanized country in the world with easy access to quality healthcare and health information, had more majority of its population with cardiovascular diseases unaware of their conditions (Man et al., 2019).

Cisse, Kouanda, Wallant and Kirakoya-Samadoulougou (2021) investigated the prevalence of awareness of hypertension in Burkina Faso and found that 24% of adults who lived in urban areas were aware of their status and a decrease was seen in rural areas (13%). Similar results were also observed in middle-income countries where 72% of rural residents had undiagnosed hypertension, whereas the prevalence was 65% in urban areas (Guerrero-Diaz et al. 2021), corroborating with findings from our present study. In comparing undiagnosed hypertension prevalence based on provincial divisions, the Western Cape showed the lowest prevalence in our study. A recent study in South Africa showed corroborating findings where the Western Cape had the highest prevalence of hypertension awareness than the other eight provinces of the country (Woodiwiss et al., 2023). An explanation in part could be that men from the Western Cape have better healthcare access compared to other provinces. Prevailing evidence in differing contexts indicates access to health insurance as a preventative factor towards the increased prevalence of undiagnosed hypertension, which supports our present study's findings. In Iran, 51% vs 30% of hypertension awareness was seen between those with health insurance and those without it, respectively, reflecting that majority of those without health insurance are unaware of their status (Mirzaei et al. 2020). Similarly, our present study showed us that 68% of participants without health insurance were not aware of their hypertension status. The

statistical significance between health insurance and the prevalence rate of undiagnosed hypertension was not evident in the bivariate analysis.

The bivariate analysis also revealed that undiagnosed hypertension prevalence is concentrated within participants with normal BMI. In support of this finding, Haider and Gupta (2021) found that the normal BMI class had the highest prevalence of undiagnosed hypertension (59.3%) in relation to the overweight and obese (47.5%) BMI classes. Moreover, there is discrepancies in reports about the prevalence of hypertension awareness status among smokers. Other studies provide evidence in support to our findings that most of tobacco users are unaware of their hypertension status (Cisse et al. 2021; Ghadder et al. 2020; Guerroro-Diaz et al. 2021; Lee 2017) while other studies provide opposing evidence to our current study that non-tobacco users generally have a higher prevalence of undiagnosed hypertension (Najafipour et al. 2020).

Similar discrepancies are observed regarding the frequency of alcohol usage and the prevalence of undiagnosed hypertension. Contradictory to our results, Ghadder et al. (2020) found that drinking alcohol nearly every day of the week had the highest prevalence of undiagnosed hypertension. In our study it found that drinking alcohol for less days had the greatest prevalence of undiagnosed hypertension supported complementing Essa et al. (2022). Similarly to Ghadder et al. (2020) and Essa et al. (2022), in our present study, the chi-square test of independent association between the frequency of drinking alcohol and the prevalence of undiagnosed hypertension was statistically insignificant. A partial explanation for the statistical insignificance could be that social desirability bias could have affected participants' responses. Previous studies reported that people who do not limit their intake of processed meats show a higher prevalence of undetected hypertension in comparison to limiters (32% vs 28%) (Ong et al., 2020), thus conflicting with the findings of our study. Similarly to Ong et al., (2020) our study did not find evidence of a statistical relationship between frequency of eating processed meats the prevalence of undiagnosed hypertension.

5.3 Examining the association between disability status and undiagnosed hypertension while controlling for socio-economic, demographic and lifestyle factors.

Research across the globe and locally highlights adversities the disabled populations confront in accessing health care, medications, and medical treatment (Rotarou & Sakallariou, 2017; Lezzoni, 2021; Vergunst et al., 2017). Albeit health researchers evidenced the worse health concerns disabled people encounter compared to their counterparts (Moodley & Ross, 2015),

in our multivariate models, we found that subjects living with a disability were significantly unlikely to have undiagnosed hypertension compared to the general population. This finding suggests that despite healthcare challenges faced by the disabled community and lack of access to healthcare, disabled people are far more likely to have awareness of their medical conditions. A partial explanation might be that people with disabilities are more concerned about their health and thus participate in frequent health screenings because of the common perception that they are likely to live with comorbidities (Wu et al., 2021), which could be a protective factor against undiagnosed hypertension.

The current study, after adjusting for other characteristics, found that educated men were less likely to have undiagnosed hypertension compared to men without any form of education. This corresponds with the vast research literature in low- and middle-income countries, which finds that educated men were associated with higher chances of being aware of their hypertension status, which reflects the affordability of healthcare. Better knowledge of healthy lifestyle choices available to educated individuals and knowledge of the health complications that might result from hypertension (Boro & Banerjee, 2022; Cesse et al., 2021; Salazar et al., 2023; Cao et al., 2016; Banigbe et al., 2020). However, inconsistencies are observed in the relationship between education status and hypertension diagnosis. In one study conducted in KwaZulu-Natal, South Africa, it was reported that uneducated people showed far lesser chances of being undiagnosed than those with some level of education (Madela et al., 2023). The authors attributed the aberrated finding to the frequent contact that people with no education might have with primary health care workers as they are usually targets of public health intervention. Additionally, uneducated people might be more accessible as they are likelier to be at home than the educated.

Findings in Table 4.5 show that the odds of being undiagnosed with hypertension were insignificantly decreased for men who were married (UOR: 0.90; $P \geq 0.05$). Corresponding outcomes were found in a previous study by Lim and Yong (2019), which showed that married couples had lower odds of living with undiagnosed hypertension compared to those who were single. Another study also found that single adults demonstrated lowered odds of hypertension awareness (Alhazmi et al., 2023). Studies have explained this observation by finding that married individuals are more likely to utilize the healthcare system (Ong et al., 2020). This might result from married people having better financial resources to access health care (Lim & Yong, 2019).

One of several studies showed that older adults are associated with being aware of their hypertension because hypertension is common in their age; therefore, health policies avail more screening interventions (Liew et al., 2019). Del Rio et al. (2022) also found that individuals above 50 years were unlikely to have hypertension unawareness compared to younger participants in their study. This is because older adults have a higher healthcare utilization motivated by deteriorating health as a person age compared to younger individuals who are oblivious about their health and the effects of elevated blood pressure on their health (Casse et al., 2021; Pengpid & Peltzer, 2022; Cao et al., 2016). Additionally, the younger population is usually healthier, limiting contact with doctors and thus reducing blood pressure screenings (Woodiwiss et al., 2023). Salazar Florez et al. (2023) have echoed similar sentiments that adults aged ≥60 have a diminished risk of suffering from undiagnosed hypertension. Therefore, these studies complement the findings in Table 4.2, which showed that the probability of having undiagnosed hypertension increased significantly with decreasing age.

The research investigating the relationship between ethnicity and undetected hypertension in South Africa has been fairly scarce. Exploring this relationship is crucial because the apartheid administration in South Africa, through its racial policies, has resulted in unequal socioeconomic statuses within the different racial groups and limited access to societal resources, primarily for black South Africans (Madela et al., 2023). Even though the table 4.5 showed statistically insignificant results for ethnicity. The findings of our study show similar results to a study by Woodiwiss et al. (2023), where it was found that people of mixed race demonstrated the highest risk of undetected hypertension in relation to the Black African people. Similarly to Woodiwiss et al., (2023) the White, Indian, and other racial classifications in South Africa showed a reduced risk (AOR: 0.95; P-value>0.05) of living with undiagnosed hypertension compared to Black people. The reason for the White, Indian, and Asian South Africans to have less likelihood of experiencing undiagnosed hypertension in relation to Black South Africans when controlling for other covariates could be reflecting geographic health inequalities that resulted from grouping poor black South Africans in deprived rural areas in the country's apartheid past (Reddy et al., 2021).

The adjusted multivariate model reported that language and hypertension diagnosis status do not have a statistically significant association among South African men. Nonetheless native Afrikaans and native Sotho-Tswana speakers were less likely to suffer undiagnosed hypertension compared to native English speakers. On the other hand, native Nguni language speakers were more likely to suffer undiagnosed hypertension. This finding could suggest that

areas populated by Nguni language speakers and are exposed to hypertension conducive environment do not have access to efficient hypertension screening and diagnosis, or they experience language barriers to understanding their diagnosis from health professionals in those areas. Language barriers have been found by Johnson et al. (2014) to impede diagnosis of hypertension in the United States of America were non-English shown delays in receiving a diagnosis because of a language barrier.

In a study conducted by Thomas et al. (2018), there was no significant relationship between hypertension status awareness and income in South Africa, assuring that undetected hypertension is a public health concern for persons of all income levels. Compliantly, our study showed no evidence statistical significance between income and undiagnosed hypertension as well, however, men in the middle-income class were less likely to have undetected hypertension compared to poor men. Zhang et al. (2017) and Haider and Gupta (2021) found that people with a higher monthly income had lower odds of living with undiagnosed hypertension. A similar finding was reported in a study conducted in Malaysia by Lim and Yong (2019), where they suggested that high-income earners can have better access to medical facilities and health screenings, reducing the likelihood of living with undiagnosed hypertension. The present study also found that men belonging to the rich income class were insignificantly less likely to have undiagnosed hypertension when paralleled against poor men, although the relationship was statistically insignificant too. This finding contradicts public health research because hypertension has been seen as one of the diseases associated with a wealthy lifestyle due to exposing people to inappropriate nutritional patterns (Poti et al., 2017).

Our study reported the unadjusted odds ratios to be significantly lower to experience undiagnosed hypertension for an individual with health insurance. Lee et al. (2022) found results supporting our study, showing that health insurance was positively associated with being aware of one's hypertension status. Additionally, Guerrero-Diaz et al. (2023) found corroborating results and claimed that not having health insurance limited access to cardiovascular disease screenings such as blood pressure checks and receiving medication for those who are sick. The relationship between health insurance and undiagnosed hypertension in the adjusted model lost statistical significance but maintained odds showing low likelihood of hypertension unawareness within health insured individuals. Other studies also reported a lack of statistically significant relationship between health insurance and hypertension unawareness. This was credited to the improvements countries have made in providing government-run healthcare services, which reduced health access inequality amongst those

with and without health insurance (Cao et al., 2016). Particularly among rural dwellers who benefit more from medical outreach interventions as they are target groups because of limited hypertension healthcare management resources and facilities in rural areas (Benigbe et al., 2020).

A study conducted in China found that unemployment was associated with increased odds of undiagnosed hypertension (Zhang et al., 2017). Employment directly affects one's ability to afford health insurance, thus having an impact on one's access to health services (Fifita et al., 2024). However, our study produced conflicting results that employed people were significantly more likely to be unaware of their hypertension status. Studies show that employed people can be prone to work-related stress, which puts them at risk for hypertension (Nawi et al., 2021); combined with minimal health centre visits due to working hours could explain the increased probability of undiagnosed hypertension among employed South African men (Peer at al., 2021). These findings could reiterate that access to healthcare does not always correlate with health services utilization.

Previously, studies have postulated that rural areas in resource-constrained countries suffer from scarcity and remoteness of health services, hindering hypertension management control (Mbouemboue & Ngoufack, 2019). This could possibly hinder hypertension detection. Other than our study reporting a statistically insignificant association between type residence and hypertension diagnosis. It complements results from Mbouemboue and Ngoufack (2019) that men residing in rural areas were more likely to be unaware of their hypertension status. However, this finding conflicts with recent research indicating that in South Africa, like other low and middle-income countries, younger age groups from rural areas move to urban areas to seek employment opportunities in the cities (Schutte et al., 2021; Reddy et al., 2022; Boro & Banerjee, 2022). Therefore, leaving the population of rural areas consisting of the elderly who are more aware of their hypertension status reducing likelihood of hypertension unawareness in rural areas. Another opposing study finds that most people in rural areas are living physically active lifestyles due to part of their daily activities, which limits people from developing hypertension. In rural areas in Rwanda, people work on farms, fetch water from localized points, deliver food to marketplaces, and walk to workplaces, which increases their physical activeness, thus protecting them from hypertension (Mazimpaka et al., 2019).

In terms of provinces, our study showed that almost all provinces were more likely to have men living with undiagnosed hypertension when compared to the Western Cape. This is to the

exception with the Kwa-Zulu Natal province which showed reduced probability of living with undiagnosed hypertension. The Western Cape has shown to have better treatment and control of hypertension in previous studies (Woodiwiss et al., 2023). This can explain why all the other provinces are showing increased probabilities of undiagnosed hypertension compared to the Western Cape province. Mpumalanga and Free State were shown to be the only provinces with statistically significant evidence of being associated with increased probability of having its male population suffering from undiagnosed hypertension. The increased likelihood of living in undiagnosed hypertension in majority of the province could reflect on the reality that majority (83%) of the South African population receives health care from the public sector that is inefficient due to run down infrastructure, mismanagement and underfunding (Ngobeni et al., 2020).

This study identified that there is a significant relationship between BMI and hypertension diagnosis status in South African men. Overweight and underweight men showed decreased chances of living with undiagnosed hypertension compared to normal-weight men. Similar findings were observed by Ohwaki (2021) that people with higher BMI were associated with disease awareness because they pay close attention to their health due to constant reminders of chronic comorbid conditions with obesity by mass media and healthcare providers. Our study furthermore corroborated with findings from several other researchers indicating smoking as a factor increasing the probability of having undiagnosed hypertension (Cao et al., 2016; Ong et al., 2020; Boro & Banerjee, 2022; Pengpid & Peltzer, 2022). Attributing these increased odds of the reduced consciousness to health concerns that smokers have, hindering them from seeking blood pressure screening. Although in our study, smoking tobacco did not show a statistically significant association with undiagnosed hypertension.

Pengpid and Peltzer (2022) also reported that individuals who were heavy drinkers showed higher odds of undiagnosed hypertension. This finding contradicts our study as our results showed that people who consume alcohol were less likely to have undiagnosed hypertension to compared to non-alcohol drinkers. This discrepancy could result from desirability bias in our study as respondents could not have given a true account of their alcohol consumption per week. Additionally dietary factor such as consuming processed meats did not have a significant association with undiagnosed hypertension. Interestingly, those consuming processed everyday was not found to play a role in undiagnosed hypertension. Moreover, even though the relationship was not statistically validated, eating processed meals on occasions only increased chances of undiagnosed hypertension while restricting consumption to the extreme minimal of

once-a-week reduced chances. Thus, complementing public health research that high salt intake often found in processed meats is linked to hypertension (Ibrahim, 2018).

5.4 Conclusion

The aim of study was to investigate the quantitative statistical relationship between undiagnosed hypertension and disability status among men aged 15 years and older in South Africa. Understanding this statistical relationship is important because it could be useful in raising hypertension detection rates in South African males and establishing interventions according to disability status. Upon completing the study, the findings showed that there is an association between living with a disability and undiagnosed hypertension in South African men aged ≥ 15 years. There were also other covariates such as education level, age group and BMI which produced a P-values<0.05 in the statistical analysis, as a result, this study rejects the null hypothesis in favour of the alternative.

Based on the findings of this study, a greater population of South African men were not aware of their hypertensive status (66%). The relatively high levels of undetected hypertension indicate that the male majority is at grievous risk of mortality and ill health due to hypertension-related complications as they are not treating blood pressure. Moreover, one important contribution of this study is that it is the only study investigating the statistical relationship between disability status and undiagnosed hypertension in South Africa. Our findings showed reduced odds (AOR: 0.65; P<0.05) for disabled men to live with undiagnosed hypertension compared to non-disabled men in South Africa. This finding highlight that even though public health research speculates that people living with disabilities suffer worse health conditions related to non-communicable diseases. They have a better chance of being detectable to health professionals in South Africa.

In terms of other controlled variables in our study, we found that men in the youngest age groups (15-24, 25-34 and 35-44) were statistically associated with higher chances of living with undiagnosed hypertension. This indicates that the majority of young men in our country suffer from high blood pressure without being on treatment and this will compromise their healthy transition into adulthood. Consequently, decreasing a healthy population of youths who can work and improve the economy of South Africa.

Another important finding from this study is that education plays a protective role in undiagnosed hypertension. Our study indicates that men with as little as primary education are

significantly less likely to experience undetected hypertension in their lives. Proving synonymous with past public health research that educated people are conscious of health information. The multivariate analysis further indicates all the provinces except for KwaZulu-Natal increased chances of living with undetected hypertension, with only the Free State and Mpumalanga province presenting odds attested by 5% level of statistical significance. This might be due to hindered access to health services due as majority of the population relays on public health care services. This finding shows us that there is need to strengthen hypertension detection nationwide in South Africa.

Our study attested to the perspective that poverty is notorious for hampering health and access to healthcare by highlighting reduced probabilities for rich and middle-income men for presenting undiagnosed hypertension compared to poor men even though the relationship was significant in adjusted model. At the same time being employed was shown as a hindrance to being officially diagnosed with hypertension by a health professional and this relationship was statistically significant. Additionally, within our sample, men with overweight and underweight BMI showed significantly reduced probabilities of having undiagnosed hypertension, indicating that efforts should be more directed towards men of normal weight.

The lifestyle covariates such as frequency of alcohol use, consumption of processed meats and smoking included in this study did not produce a statistically significant association with undiagnosed hypertension. Even though, our study echoed previous research that using tobacco and not limiting high salt content food in the form of processed meats exposed individuals to living with undiagnosed hypertension. This could mean that men who use tobacco and eat high salt-content food might not know about hypertension and its established risk factors. However, our study deviated concerning alcohol consumption showing that consuming alcohol regularly decreased the odds of undiagnosed hypertension.

This study has shown that there is high prevalence of undiagnosed hypertension in South Africa particularly among young men and this condition is less associated with the disabled people but the majority who are non-disabled. Therefore, government of South Africa should act swiftly to counter this growing numbers of undiagnosed hypertension as it poses a threat to the wellbeing of the country's future working age group as well as threating more mortalities due to cardiovascular diseases.

5.5 Recommendations

This study showed that the prevalence of undetected hypertension outweighs detected hypertension in both disabled (52% v/s 48, respectively) and non-disabled (70% v/s 30%, respectively) male populations in South Africa. However, undetected hypertension disproportionately affected the non-disabled population (70%). These findings highlight the need programme interventions to reduce the burden of undiagnosed hypertension in non-disabled South African men. Based on our findings, the programme should target the youthful population as they showed the highest prevalence of undiagnosed hypertension and demonstrated extreme probabilities of living with undiagnosed hypertension. The youthful males rarely utilise health facilities therefore interventions should aim at bridging the gap between young men and healthcare facilities.

Suggestable interventions could include intensifying existing programmes by taking blood pressure screenings to places of learning such as schools and universities to detect blood pressure earlier in young males. The government can increase the capacity of health personnel to screen blood pressure by shifting this task to lower health care workers such as community health workers instead of nurses and doctors. This will allow more people to be screened for high blood pressure as nurses and doctors will be relieved of overwhelming patient queues. Additionally, these lower-level health workers can be utilised to conduct screening in places of learning and work to target young males.

5.6 Future research

Future research should focus on collecting data on a representative scale for different types of functional impairment to allow an investigation of hypertension unawareness in each different functional impairment. This will contribute to the research knowledge on access to blood pressure screening by individuals of different functional impairments. Ultimately providing an opportunity to ascertain whether there are limitations in detecting hypertension with reference to different functional impairments. Including a qualitative research approach will add more context on factors hindering going for blood pressure screening. This can be achieved by conducting interviews to understand knowledge, attitudes, and beliefs about the severity of hypertension and the importance of starting early treatment. Additionally, a stratified analysis of the disabled and non-disabled population investigating undiagnosed hypertension could provide more insights than the present study.

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Appendixes

Appendix A

```
. linktest
(running logit on estimation sample)

Survey: Logistic regression

Number of strata   =        26                  Number of obs      =      1,480
Number of PSUs     =       580                  Population size    = 1,014.3433
                                                Design df          =        554
                                                F(   2,     553)   =      45.05
                                                Prob > F           =     0.0000
```

hypertensive_outcome	Coef.	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
_hat	1.038161	.1674735	6.20	0.000	.7092007	1.367122
_hatsq	-.0338884	.0983066	-0.34	0.730	-.2269876	.1592109
_cons	.008588	.1234808	0.07	0.945	-.2339597	.2511358

Appendix B

```
. . pwcorr hypertensive_outcome disability_status highest_education marrital_status age_group ethnicity la
> nguage household_income health_insurance employment_status type_of_residence province bmi_regression use
> s_tobacco processed_meat freq_alcohol_use, obs star (0.05) sig
```

	hypert~e	disabi~s	highes~n	marrit~s	age_gr~p	ethnic~y	language
hypertensi~e	1.0000						
	1480						
disability~s	-0.1843*	1.0000					
	0.0000						
	1480	1480					
highest_ed~n	0.0726*	-0.2108*	1.0000				
	0.0052	0.0000					
	1480	1480	1480				
marrital_s~s	-0.2098*	0.1972*	-0.1593*	1.0000			
	0.0000	0.0000	0.0000				
	1480	1480	1480	1480			
age_group	0.2659*	-0.3567*	0.2941*	-0.5939*	1.0000		
	0.0000	0.0000	0.0000	0.0000			
	1480	1480	1480	1480	1480		
ethnicity	-0.1486*	0.0607*	0.2261*	0.1208*	-0.1523*	1.0000	
	0.0000	0.0195	0.0000	0.0000	0.0000		
	1480	1480	1480	1480	1480	1480	
language	0.0960*	-0.0303	-0.1587*	-0.0358	0.0677*	-0.6557*	1.0000
	0.0002	0.2440	0.0000	0.1688	0.0091	0.0000	
	1480	1480	1480	1480	1480	1480	1480
household_~e	-0.1414*	-0.0293	0.3501*	0.1172*	-0.1061*	0.4293*	-0.2703*
	0.0000	0.2606	0.0000	0.0000	0.0000	0.0000	0.0000
	1480	1480	1480	1480	1480	1480	1480

health_ins~e	-0.1105*	-0.0148	0.3089*	0.1577*	-0.1047*	0.4325*	-0.2920*
	0.0000	0.5697	0.0000	0.0000	0.0001	0.0000	0.0000
	1480	1480	1480	1480	1480	1480	1480
employment~s	0.1089*	-0.1858*	0.2168*	0.0434	0.0681*	0.0257	-0.0558*
	0.0000	0.0000	0.0000	0.0949	0.0088	0.3238	0.0319
	1480	1480	1480	1480	1480	1480	1480
type_of_re~e	0.0387	0.0668*	-0.2255*	0.0034	-0.0223	-0.2809*	0.1665*
	0.1368	0.0101	0.0000	0.8956	0.3913	0.0000	0.0000
	1480	1480	1480	1480	1480	1480	1480
province	0.1321*	-0.0852*	0.0119	0.0541*	-0.0125	-0.2241*	0.2713*
	0.0000	0.0010	0.6464	0.0376	0.6313	0.0000	0.0000
	1480	1480	1480	1480	1480	1480	1480
bmi_regres~n	-0.1424*	0.0511*	0.0058	0.1655*	-0.1705*	0.1322*	-0.0491
	0.0000	0.0492	0.8238	0.0000	0.0000	0.0000	0.0591
	1480	1480	1480	1480	1480	1480	1480
uses_tobacco	0.0795*	-0.0014	-0.0672*	-0.1125*	-0.0103	-0.0015	-0.0110
	0.0022	0.9583	0.0097	0.0000	0.6925	0.9527	0.6722
	1480	1480	1480	1480	1480	1480	1480
processed_~t	-0.0084	0.0129	-0.1163*	-0.0116	-0.0103	-0.0434	-0.0036
	0.7480	0.6209	0.0000	0.6550	0.6913	0.0949	0.8897
	1480	1480	1480	1480	1480	1480	1480
freq_alcoh~e	0.0975*	-0.0700*	0.0968*	-0.0833*	0.0956*	-0.0114	0.0457
	0.0002	0.0070	0.0002	0.0013	0.0002	0.6616	0.0789
	1480	1480	1480	1480	1480	1480	1480

	household_~e	health_ins~e	employment~s	type_of_re~e	province	bmi_regres~n	uses_tobacco
household_~e	1.0000						
	1480						
health_ins~e	0.3901*	1.0000					
	0.0000						
	1480	1480					
employment~s	0.0362	0.1954*	1.0000				
	0.1634	0.0000					
	1480	1480	1480				
type_of_re~e	-0.5018*	-0.1955*	-0.0348	1.0000			
	0.0000	0.0000	0.1807				
	1480	1480	1480	1480			
province	-0.1552*	-0.0565*	0.0144	0.1777*	1.0000		
	0.0000	0.0298	0.5798	0.0000			
	1480	1480	1480	1480	1480		
bmi_regres~n	0.1802*	0.1416*	-0.0344	-0.0838*	-0.0524*	1.0000	
	0.0000	0.0000	0.1862	0.0013	0.0439		
	1480	1480	1480	1480	1480	1480	
uses_tobacco	-0.0468	-0.1113*	-0.0156	-0.0573*	-0.0361	-0.1077*	1.0000
	0.0719	0.0000	0.5494	0.0274	0.1650	0.0000	
	1480	1480	1480	1480	1480	1480	1480
processed_~t	-0.0509	-0.0675*	-0.0216	0.0515*	-0.0488	0.0035	0.0176
	0.0502	0.0094	0.4064	0.0478	0.0606	0.8930	0.4987
	1480	1480	1480	1480	1480	1480	1480
freq_alcoh~e	-0.0135	0.0162	0.0165	0.0278	0.0867*	-0.0552*	0.2822*
	0.6029	0.5330	0.5257	0.2857	0.0008	0.0338	0.0000
	1480	1480	1480	1480	1480	1480	1480

	processed_~t	freq_alcoh~e
processed_~t	1.0000	
	1480	
freq_alcoh~e	0.0174	1.0000
	0.5046	
	1480	1480

Appendix C

```
. lfit, group (10) table
```

Logistic model for hypertensive_outcome, goodness-of-fit test

(Table collapsed on quantiles of estimated probabilities)
(There are only 9 distinct quantiles because of ties)

Group	Prob	Obs_1	Exp_1	Obs_0	Exp_0	Total
1	0.4243	33.18464	36.5	77.71774	74.4	110.9024
2	0.5268	53.8575	52.9	56.67971	57.6	110.5372
3	0.5996	62.64205	62.9	47.63045	47.4	110.2725
4	0.6602	77.50288	69.7	33.0345	40.8	110.5374
5	0.7029	75.51205	75.6	35.04556	34.9	110.5576
6	0.7544	75.3838	82.1	37.48101	30.8	112.8648
7	0.8025	84.17816	84.2	23.77984	23.8	107.958
8	0.8461	92.32106	91.0	18.13215	19.5	110.4532
9	0.9147	98.17371	97.0	12.50525	13.7	110.679

```
      number of observations =      1105
            number of groups =         9
Hosmer-Lemeshow chi2(7) =         5.09
                  Prob > chi2 =         0.6490
```

.

Appendix D


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ORIGINALITY REPORT

3%	4%	2%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	wiredspace.wits.ac.za Internet Source	3%