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Multimorbidity in sub Saharan Africa: Focusing on the National Prevalence and the Response of Primary Care in Botswana

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Declaration

I declare that this thesis has been composed by myself. No part of this work has been submitted for another degree or qualification. All the sources I have used or quoted have been indicated and acknowledged.

Mpho Refilwe Disang

Abstract

Introduction

Multimorbidity, defined as the coexistence of two or more chronic conditions in an individual, poses a profound global public health challenge, with far reaching implications for affected individuals, their families and healthcare systems. Although research on multimorbidity has gained momentum in recent years, most of the existing evidence originates from High Income Countries (HICs), where disease patterns and healthcare systems substantially differ from those in Low- and-Middle-Income Countries (LMICs). Within the context of sub Saharan Africa (SSA), Botswana, like many other countries in the region, is experiencing a dramatic increase in the burden of noncommunicable diseases (NCDs), coinciding with one of the world's highest incidence of HIV/AIDS. This rising burden of NCDs is primarily attributed to demographic shifts, adoption of westernised and urban lifestyles, and cumulative exposure to other NCD risk factors within the general population. Additionally, Botswana has achieved remarkable success in implementing antiretroviral therapy (ART) programs, leading to prolonged life expectancy for people living with HIV (PLWHIV). Consequently, this achievement significantly contributes to the escalating burden of NCDs within the population, creating a dual burden of these conditions.

As the epidemiological landscape evolves, there is a compelling call for action, urging the government to adopt and strengthen primary health care (PHC) in response to this dual burden of disease. At the heart of this call is the pressing need for service integration, a strategy designed to optimise resource allocation and empower healthcare providers to deliver comprehensive care and support to individuals grappling with multimorbidity. Recent observations pertaining to the COVID-19 pandemic further underscored the heightened vulnerability of individuals with underlying chronic conditions to severe complications and mortality. This emerging evidence emphasised the

predicament faced by healthcare systems, particularly in LMICs, as they grappled with the dual challenge of containing the virus's spread and managing chronic conditions. Therefore, gaining a comprehensive understanding of multimorbidity patterns and its management becomes of paramount importance.

My thesis thus aims to investigate the epidemiology of chronic disease multimorbidity in Botswana, with a specific focus on the intersection of chronic communicable diseases such as HIV/AIDS and tuberculosis (TB) with NCDs, and to understand the strategies that can be adopted to improve care for people with multiple chronic conditions.

The following specific objectives were formulated to achieve the aim of my thesis.

1. To assess and summarise the evidence on the epidemiology of chronic disease multimorbidity in SSA
2. To determine the prevalence and patterns of chronic disease multimorbidity among the adult population in Botswana.
3. To examine socio-demographic and lifestyle factors associated with chronic disease multimorbidity among the adult population in Botswana.
4. To explore perceptions and experiences of health care providers and policymakers on care and management of patients with multimorbidity in Botswana.
5. To provide a deeper understanding of what is understood by multimorbidity in the local context and recommendations to inform provision of care for patients with multimorbidity in primary care settings in Botswana.

Methods

Using a convergent mixed methods approach, my study was divided into three components. In the first study, I performed a systematic literature review following the PRISMA guidelines, to assess and synthesise the evidence on

the prevalence and patterns of chronic disease multimorbidity among adults in the SSA region. I conducted an extensive literature search across multiple databases and sources including grey literature for observational studies reporting on the prevalence, patterns, and epidemiology of multimorbidity in SSA, published between January 2000 and December 2020. Given the heterogeneity in multimorbidity definitions and populations, a narrative synthesis of the findings was adopted.

In the quantitative phase of this study, I conducted secondary analysis of cross-sectional data from the 2017 Botswana Demographic Survey (BDS). The BDS is a nationally representative survey commissioned and administered by the government of Botswana through Statistics Botswana, the country's official statistics authority. The survey encompassed a wide range of socio-demographic information and collected self-reported data on the presence of various health conditions. For the purposes of this study, I focused my analysis on participants aged 18 year and above and assessed multimorbidity using 16 self-reported chronic conditions including communicable diseases, and various NCDs. Multiple logistic regression models were used to investigate the association of multimorbidity with demographic, socioeconomic, and lifestyle factors.

The third study involved qualitative interviews that aimed to explore the experiences and perceptions of healthcare workers and policymakers regarding the care and management of patients with multimorbidity, barriers and enablers, and their views on how primary care can be strengthened to best deal with multimorbidity in Botswana. Participants were recruited using purposive and snowball sampling techniques in 4 health districts. 27 semi-structured telephone interviews were conducted, transcribed verbatim, and analysed using thematic analysis with the aid of Nvivo 12.

Results

The systematic review identified 37 studies reporting multimorbidity prevalence and patterns among adults in SSA, conducted across twelve

countries. These studies predominantly employed cross-sectional designs, with only a few utilizing cohort data. Sample sizes varied considerably, ranging from 142 to 47,334 participants. Prevalence estimates exhibited remarkable heterogeneity, largely due to methodological variations in the number and types of conditions considered, study settings, and participant demographics. Conditions varied in number, with studies incorporating as few as 3 to as many as 30 chronic conditions. Notably, the prevalence of multimorbidity ranged from 1.4% to 69.4%. Additionally, the review revealed diverse patterns of multimorbidity, with HIV and TB frequently co-occurring with conditions like hypertension, diabetes, anaemia, and depression.

For the prevalence study 15,512 adults aged 18 years and older were included in the analysis. Multimorbidity was defined as the presence of two or more of the 16 self-reported conditions. The most prevalent conditions were hypertension (14.3%), HIV/AIDS (13.9%), asthma (3.4%), tuberculosis (2.2%) and gastric ulcers (2.1%). The findings revealed that 4410 (25.3%) of participants had at least one chronic condition. Multimorbidity was present in 1558 (9%) of the population and was independently associated with factors such as age, female gender, marital status, education level, residence, and BMI. The findings further revealed that among individuals with multimorbidity, hypertension (65%) and HIV/AIDS (43.4%) were the most prevalent chronic conditions, significantly shaping the multimorbidity patterns. A descriptive analysis of disease pairs identified the top five dyads, including hypertension and HIV (24.1%), hypertension and diabetes (18.8%), HIV and tuberculosis (9.9%), hypertension and rheumatism (9.1%), and hypertension and cardiovascular disease (8.2%), underscoring the prominence of hypertension in co-occurring conditions, with HIV/AIDS as the second most prevalent comorbidity.

I interviewed 14 primary care workers from different facilities in the 4 health districts, and 13 policymakers with diverse professional roles within the healthcare system of Botswana, both at national and regional level. The findings were explored under six thematic areas, which described how

healthcare professionals conceptualised multimorbidity, how care for chronic diseases and multimorbidity is organised, the barriers, and challenges they face in providing care. While there were subtle variations in the terminology used, the core understanding of multimorbidity as the presence of multiple health conditions was shared by both healthcare workers and policymakers. The significance and complexity of multimorbidity were acknowledged, particularly in relation to the interplay between HIV/AIDS and NCDs. The findings revealed that the current healthcare system is characterised by vertical disease programs, limited funding for NCDs and lack of integration, often leading to fragmented services for patients with multiple chronic conditions. Additionally, the absence of comprehensive multimorbidity care guidelines, poor communication among professionals, extended waiting times, and persistent shortages of personnel and essential medications, were highlighted as some of the barriers in provision of multimorbidity care. Respondents articulated several recommendations aimed at enhancing multimorbidity care in Botswana. These encompassed multi-sectoral collaboration, integration of health services, increased staffing, health education, community engagement, policy changes, and the promotion of preventive care, among many other factors. Finally, the role of research in guiding evidence-based decision-making to improve multimorbidity care in Botswana was emphasised throughout the interviews.

Conclusion

This study examined the epidemiology and complexities of chronic disease multimorbidity in in the SSA context, considering the coexistence of chronic communicable and noncommunicable diseases. The limited evidence from SSA region, as highlighted by the systematic review, underscores a significant research gap in the region. The reliance on limited data sources, such as the WHO SAGE dataset, also highlights the need for comprehensive and context-specific data. The prevalence study was the first to explore multimorbidity with HIV and TB included in the list of conditions. The study revealed the substantial burden of chronic conditions and their intersections. This was further

emphasised by the healthcare professionals as they provided valuable insights into the observed multimorbidity patterns in their daily work. Effective multimorbidity management strategies should consider the coexistence of NCDs and communicable diseases, socioeconomic disparities, patient-related obstacles, and healthcare system challenges. Collaboration between stakeholders, policy changes, and research-based decision-making can contribute to improved patient care and better outcomes in Botswana's healthcare system.

Lay Summary

The number of people living with multiple long-term health conditions (a problem commonly referred to as multimorbidity, is rising globally. This is a complex issue which is not only a challenge to the patients, but also to those who are involved in their care. Most of the research on multimorbidity comes from wealthy countries where the healthcare systems are different from those in developing countries. In Botswana, like other countries in the sub Saharan Africa (SSA), there is a growing problem of diseases such as diabetes and high blood pressure, referred to as noncommunicable diseases (NCDs). Due to better healthcare and improving living conditions, more people in the region are living longer, and as they age, they are more likely to develop multiple health problems. Adoption of unhealthy lifestyles and other risk factors are on the rise in SSA, and all these factors combined can increase the likelihood of developing long-term/ chronic conditions. In addition, infectious diseases or 'communicable') such as HIV/AIDS and tuberculosis are also present in many African countries. With the availability of better treatments for HIV/AIDS, many people with HIV are living longer and developing other long –term conditions alongside HIV. The COVID-19 pandemic has also added another layer of challenge, putting a lot of pressure on the already under-resourced healthcare system. Addressing multimorbidity requires approaches that take into account the unique challenges in each setting, hence the need to understand better what is happening in African countries.

My PhD therefore sought to understand this problem better from the situation in Botswana. In the first study, I looked at the existing research from across sub Saharan Africa to see what is already known about multimorbidity. In the second study I used data from the Botswana Demographic Survey of 2017 to find out how common multimorbidity is among adults, and what kinds of diseases people have at the same time. In the third study I talked to healthcare workers and policymakers in Botswana to understand their experiences in taking care of people with multiple health problems. My overall aim was to shed

light on the complex problem of multimorbidity in Botswana, to provide a clearer picture of its nature, how it affects the population and the healthcare system, and to find better ways to make healthcare better for everyone, especially those dealing with multiple health conditions.

My review found that multimorbidity is common in SSA, but there hasn't been enough research carried out in Africa do understand the topic in depth. The identified studies showed that rates of multimorbidity vary a great deal; in one country it was reported that 1.4% of the population had multiple conditions, while in another country the reported rate was 69.4% This shows that countries measure multimorbidity differently hence the results are usually different and hard to compare. Some studies tried to determine which health problems tend to occur together. The common combinations included hypertension and diabetes. Others showed that HIV and TB often occurred with hypertension, diabetes and other chronic conditions, illustrating the importance of communicable diseases in multimorbidity burden in SSA. The second study included 15, 512 adults aged 18 years and older. I looked at 16 different heath conditions that people reported having, and the most common health problems were hypertension, HIV/AIDS, asthma, TB and stomach ulcers. I also found out that being older, being female, having lower education and being obese were linked to having multiple health conditions. When I looked at pairs of health problems that often occurred together, the most common combinations were hypertension and HIV, hypertension and diabetes, HIV and TB, hypertension, and rheumatism and hypertension and cardiovascular disease. This shows that hypertension and HIV were the most common health problems that people had alongside other conditions.

In the third study, I spoke with 14 healthcare workers and 13 policymakers in Botswana. I found a common awareness that having multiple health problems is a growing problem in Botswana, especially when it comes to dealing with both HIV/AIDS and NCDs. The participants shared that the healthcare system of Botswana is set up to handle specific diseases separately. This can make it hard for people with multiple health problems because they have to go to

different places for care. Some of the problems highlighted in the interviews were related to funding, with concerns that there is not enough money for long-term health issues which translates to lack of equipment for diagnosing these conditions on time, shortage of skilled workers, and shortage of medications and other essentials. I also found that there were no clear guidelines which helped healthcare workers in taking care of people living with multiple health problems. Patients also have to wait longer to be seen by doctors and other specialists. The participants shared their suggestions to improve care, including working with communities, especially community health workers, integration of healthcare services, teaching people about staying healthy and more focus on preventing common health conditions.

My PhD has shown that there is not enough research on multimorbidity in Botswana, and more widely in African countries. This is the first study to look at the combination of multimorbidity in both NCDs and infectious/ communicable diseases, and it is clear that these health problems occur together in many individuals. My study has revealed the challenges faced by healthcare workers in caring for people with multimorbidity. The problems of treating conditions in isolation, and not having enough evidence to support decision in providing care, were also highlighted. My PhD recommends that to improve multimorbidity care in primary care settings in Botswana, there is a need to integrate services and develop more evidence to help people know how to do this well.

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This thesis is dedicated to my late matriarchs: my mother, who instilled in me the love for books; my grandmother, who had this dream for me; and to my great-grandmother, who taught me the power of prayer.

List of Abbreviations

ADL	Activities of Daily Living
ART	Anti-Retroviral Therapy
AIDS	Acquired Immuno Deficiency Syndrome
BAIS IV	Botswana AIDS Impact Survey IV
BDS	Botswana Demographic Survey
BONELA	Botswana Network on Ethics, Law and HIV/AIDS
BMI	Body Mass Index
CAPI	Computer Assisted Personal Interview
CI	Confidence Interval
COCOPOP	Condition-Context-Population
COHSASA	Council for Health Services Accreditation of Southern Africa
COPD	Chronic Pulmonary Disease
CMD	Cardio Metabolic Disease
CSO	Civil Society Organisation
DEBSWANA	De Beers Botswana Mining Company
FBO	Faith Based Organisation
FHI360	Family Health International
HAALSI	Health and Aging in Africa Longitudinal Study
HCW	Health Care Worker
HICs	High Income Countries

HIV	Human Immuno Deficiency Virus
IDCC	Infectious Disease Control Centre
LGBTQI	Lesbian, Gay, Bisexual, Transgender, and Queer Identities
LMICs	Low- and Middle-Income Countries
NACA	National AIDS Coordinating Agency
NAHPA	National AIDS and Health Promotion Agency
NCDs	Noncommunicable Diseases
NGO	Non-Governmental Organisation
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
PHC	Primary Health Care
PLWHIV	People Living with HIV
PM	Policymaker
PPE	Personal Protective Clothing
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
PROSPERO	Prospective Register for Systematic Reviews
SD	Standard Deviation
SPSS	Statistical Package for Social Scientists
SSA	Sub Saharan Africa
SANIDS	South African National Income Dynamics Study
TB	Tuberculosis

UB	University of Botswana
UN	United Nations
UNAIDS	United Nations Programme on HIV/AIDS
UNICEF	United Nations Children's Fund
WHO	World Health Organisation
WHO SAGE	World Health Organisation Study on Global Ageing and Adult Health
WHS	World Health Survey

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Chapter 1 Overview of thesis

1.1 Overview

This chapter is an introduction to the structure of the thesis. It begins by providing a brief background on the research context, followed by a clear outline of the study aim and specific objectives. Additionally, it details the thesis structure to guide the reader through the forthcoming chapters. This thesis centres its inquiry on the epidemiology of multimorbidity in Botswana and the organisation of care for individuals grappling with this complex health challenge within primary care settings. Multimorbidity, characterised by the coexistence of multiple chronic health conditions within an individual, is an emerging public health concern worldwide. It presents unique challenges in healthcare delivery and demands a comprehensive understanding of its prevalence, patterns, and the existing healthcare landscape.

1.2 Background

Botswana's disease profile reflects that of other SSA countries, with a high prevalence of both communicable and noncommunicable diseases. There has been a rapid increase in the prevalence of NCDs in the recent past, a problem that is exacerbated by rapid urbanisation, adoption of risky lifestyles and population ageing among other factors (Botswana Government, 2019a). In 2016, the World Health Organisation estimated that NCDs were responsible for 46% of all deaths in the country (World Health, 2018). A study that analysed data from the fourth national Botswana AIDS Impact survey conducted in 2013 reported a prevalence of 17% for three NCDs, i.e., hypertension, asthma, and diabetes. The same study indicated that 2.6% of the respondents had more than one chronic condition (Letamo et al., 2017). There is a possibility that this study underestimated the prevalence of NCDs and multimorbidity as it only studied three NCDs.

A nationally representative study carried out in 2014, the Botswana STEPS survey, provided evidence that there is a high prevalence of NCDs risk factors; 30% of adults were overweight or obese, 18.5% were smokers, and 95% did

not eat enough vegetable and fruits (Botswana Government, 2015). Another recent cross-sectional study with a sample of 1178 participants showed similar patterns of high prevalence of NCDs risk factors and further established that prevalence for different risk factors varied by socio-economic status (Keetile et al., 2019). This demonstrates the growing prevalence of NCDs and their risk factors in a setting that already has challenges with timely diagnoses of NCDs and access to treatment which could translate into an underestimation of the true burden of NCDs.

Botswana also has one of the highest HIV prevalences in the world. In 2017 it was estimated that the prevalence of HIV among people aged 15 years and over was 23.7%, and over 300 000 individuals were receiving ART (Botswana Government, 2019b). The interaction of NCDs, such as hypertension, diabetes and cardiovascular disease, with HIV, TB and other infectious diseases has been explored in some regional and national studies (Haacker et al., 2019; Masupe et al., 2019; Mosepele & Botsile, 2018; Reid et al., 2016), but there are still gaps in the literature in establishing the magnitude of their coexistence. Botswana was one of the first countries in SSA to provide free HIV lifesaving drugs, anti-retroviral therapies (ART), to its citizens. There is growing evidence in the literature that with the success of the ART program in the country, many people living with HIV are surviving into their middle and older ages (Masupe et al., 2019; Matlho et al., 2019), and that there is a significant burden of NCDs among these people (Haacker et al., 2019; Reid et al., 2016).

The government of Botswana recently adopted a multisectoral NCD strategy which seeks to address the four major NCDs, i.e. cardiovascular diseases, diabetes, cancers, and chronic respiratory diseases (Botswana Government, 2019a). The country is also in its early stages of integrating NCDs in primary healthcare by implementing the 2016 Botswana primary healthcare guidelines for adults (Tapela et al., 2019). Although the interaction of NCDs and major chronic infectious disease in Botswana have been established, and the presence of multimorbidity has been recognised, the magnitude of the problem, as well as the common combinations of these conditions in the

general population has not been extensively studied, and like other LMICs there is still limited scientific evidence on this issue (Arokiasamy, Uttamacharya, Jain, Biritwum, Yawson, Wu, Guo, Maximova, Espinoza, Rodríguez, et al., 2015). Understanding the true burden of multimorbidity and its patterns is important in the context of Botswana as the country moves towards promoting integrated care at primary care level. My research therefore aims to address this gap in the literature by studying the prevalence, patterns and determinants of multimorbidity in Botswana taking into account the coexistence of NCDs and chronic communicable diseases such as HIV.

1.3 Research Aim and Objectives

The primary aim of this thesis is to investigate the epidemiology of chronic disease multimorbidity in Botswana and to understand how care is structured and delivered to individuals facing this health issue. This overarching aim, is addressed through specific objectives:

- To assess and summarise epidemiological evidence on chronic disease multimorbidity among adults in SSA.
- To determine the prevalence and patterns of chronic disease multimorbidity among the adult population in Botswana.
- To examine socio-demographic and lifestyle factors associated with chronic disease multimorbidity among the adult population in Botswana.
- To explore perceptions and experiences of health care providers and policymakers on care and management of patients with multimorbidity in Botswana.
- To provide a deeper understanding of what is understood by multimorbidity in the local context and recommendations to inform provision of care for patients with multimorbidity in primary care settings in Botswana.

1.4 Research questions

- What is the available evidence on the epidemiology of chronic disease multimorbidity among adults in sub Saharan Africa?

- What is the prevalence, patterns, and determinants of multimorbidity in the adult population of Botswana?
- What are the experiences and perceptions of healthcare professional and policymakers in providing care for people living with multimorbidity?

1.5 Structure of the thesis

To address the specific objectives of the study, the thesis is structures into distinct chapters as follows:

Chapter 1 is an overview of this thesis, stating a brief background and the study objectives.

Chapter 2 reviews the literature by looking at the definition and operationalisation of multimorbidity, its prevalence and patterns globally and regionally. It will then address the intersection of HIV/AIDS and NCDs and how that contributes to multimorbidity in SSA and Botswana. I will conclude by focusing on impact of multimorbidity on the healthcare system.

Chapter 3 describes the methodology used in this study. It explains the philosophical worldviews in research, the mixed methods study and justification for adopting this approach.

Chapter 4 reports the systematic review of multimorbidity prevalence and patterns in SSA. It outlines the methods used, the results of this review, and discussion of the findings from this review.

Chapter 5 presents the quantitative component of this study. It describes the methods used in analysing the BDS dataset, the results and the discussion of the findings from this study.

Chapter 6 reports the methods, findings and discussion of the qualitative study. This is based on qualitative interviews conducted with healthcare workers and policymakers in Botswana.

Chapter 7 discusses the results from the three components of the thesis, the implications for research, policy, practice and the strengths and limitations of the study.

Chapter 8 provides a conclusion.

Chapter 2 Introduction

2.1 Overview

This chapter introduces the literature on multimorbidity. It will start with the definition and operationalisation of multimorbidity, and its global and regional prevalence. It will go on to explore the intersection of HIV/AIDS and NCDs and their contribution to the multimorbidity burden in SSA and Botswana. The chapter concludes by assessing the impact of multimorbidity on healthcare systems.

2.2 Background

Since the onset of industrialisation in the 18th century, global populations have experienced significant demographic shifts, including improved survival rates and a subsequent dramatic increase in the world's population (Ezeh, Bongaarts, & Mberu, 2012). According to United Nations estimates, the global population has surged from 2.6 billion in 1950 to the current 7.7 billion, projected to reach 9.7 billion by 2050. Average global life expectancy at birth has risen from 47 to 72 years over the past seven decades (United Nations, 2019). Furthermore, the proportion of individuals aged 65 and older is anticipated to double from 2019 to 2050, with the most substantial growth occurring in LMICs. SSA alone is expected to contribute 101 million elderly individuals, a notable increase from the current 32 million (United Nations, 2020).

As demographic structures evolve, morbidity patterns are also shifting. There has been a transition from health profiles dominated by communicable diseases to an upsurge in chronic NCDs such as cardiovascular diseases, diabetes, mental disorders, chronic respiratory diseases, and cancer (Wahdan, 1996). This shift was initially elucidated by Omran's epidemiological transition theory, which sought to explain changing disease and health patterns (Omran, 2001). Advances in medical care and living standards have considerably extended life expectancy, and fuelled population aging (Kuate Defo, 2014). These two factors are believed to underpin the increase in

individuals living with multiple long-term conditions, commonly known as multimorbidity (Academy of Medical Sciences, 2018). It is noteworthy, however, that different countries are experiencing these transitions disparately; for instance, LMICs continue to combat communicable diseases while simultaneously grappling with a rising prevalence of NCDs (Global Burden of Disease, 2017).

2.2.1 Defining and measuring multimorbidity

The terms "comorbidity" and "multimorbidity" are often used interchangeably in the literature to describe the concurrent presence of multiple health conditions (Valderas, Starfield, Sibbald, Salisbury, & Roland, 2009; van den Akker, Buntinx, & Knottnerus, 1996). While comorbidity typically refers to the co-occurrence of multiple chronic conditions in relation to a specific index condition, multimorbidity takes a more holistic view, encompassing the presence of multiple conditions without singling out any as primary (Almirall & Fortin, 2013; Boyd & Fortin, 2010; Johnston, Crilly, Black, Prescott, & Mercer, 2019). Despite a growing body of scientific research in this area, ongoing debate surrounds the precise definition of multimorbidity, with no universally accepted standard among practitioners and researchers (Catalá-López et al., 2018), This lack of international consensus regarding the operational definition of multimorbidity, as well as the selection of conditions to include in prevalence studies, has been identified as a major reason for the variability in results across different settings (Diederichs, Berger, & Bartels, 2011; Fortin, Stewart, Poitras, Almirall, & Maddocks, 2012; Violan et al., 2014).

A systematic review aimed at synthesising evidence on the definition and measurement of multimorbidity from other systematic reviews found that, while definitions vary, most studies adopt a straightforward definition: "the occurrence of multiple conditions," often defined as the presence of two or more chronic conditions (Johnston et al., 2019). Another critical consideration in measuring multimorbidity is the choice of chronic diseases to include in the study (Xu, Mishra, & Jones, 2017). A study conducted in Canada demonstrated that different multimorbidity measures, including cut-off points

or the number of conditions considered, significantly influence the final prevalence estimates (Ramond-Roquin, Haggerty, Lambert, Almirall, & Fortin, 2016).

Beyond the simple count of long-term conditions from a list of individual conditions, alternative methods for measuring multimorbidity include grouping individual conditions or using indices such as the Charlson Index, the Chronic Disease Score, and the Adjusted Clinical Groups (ACG) system (Huntley, Johnson, Purdy, Valderas, & Salisbury, 2012; Lefèvre et al., 2014). A recent systematic review identified and elaborated on thirty-five indices used to measure multimorbidity, highlighting that mental health conditions are often overlooked in these studies (Stirland et al., 2020). These measures are typically employed when assessing outcomes such as healthcare utilisation, mortality, and quality of life. (Griffith et al., 2018).

Moreover, the source of data for measuring multimorbidity is a crucial consideration (Fortin et al., 2012), encompassing medical records, patients' self-reports, clinical tests, routine data, and population/community surveys (Johnston et al., 2019). LMICs face challenges in generating clinical data or retrieving medical records due to inadequate record-keeping systems. The ongoing debate centres on standardising the definition of multimorbidity and the inclusion of specific conditions in measurement indices to ensure comparable results across diverse settings (The Academy of Medical Sciences, 2018).

Ho and colleagues' recent systematic review (Ho et al., 2021) sheds light on the pervasive ambiguity surrounding the conceptualization and operationalization of multimorbidity. This review of 566 studies reveals that there is no consensus regarding the definition of this complex phenomenon. Notably, many studies define multimorbidity as the concurrent presence of two or more medical conditions. However, this definition is confounded by a strikingly heterogeneous array of conditions, ranging from two to 285 in number. This extensive analysis underscores the inherent uncertainty and

variation in how researchers approach and measure multimorbidity, highlighting the need for standardised definitions and criteria in this area of study.

2.2.2 Prevalence of multimorbidity

Evidence on the epidemiology of multimorbidity is growing, although most of it comes from HICs. Several studies conducted across various countries, employing diverse methodological approaches have yielded disparate results, partly attributable to the absence of a standardised operational definition, as previously discussed (Xu et al., 2017). One of the largest and most representative prevalence studies took place in Scotland in 2007. Analysing data from medical practices covering 1,751,841 individuals, it estimated a prevalence of approximately 23% (Barnett et al., 2012). Additional studies from HICs include a cohort study in Canada, which utilised national longitudinal data for primary care patients, estimating that 53% of patients had two or more chronic conditions (Nicholson et al., 2019). Similarly, a study in England, relying on medical records, reported a prevalence of 27% (Cassell et al., 2018).

Comparable high prevalence patterns are also observed in LMICs. For instance, a study in Iran, based on pharmacy claim data, estimated a prevalence of 21% (Ebrahimoghli et al., 2019), while in Burkina Faso, a population-based survey reported a prevalence of 22.8% (Odland et al., 2020). Another prevalence study in South Africa, which included mental disorders and HIV, estimated a prevalence of 54% (Chang et al., 2019). A systematic review synthesising the global literature on multimorbidity prevalence, comprising seventy community-based studies, with thirty-five originating from LMICs and ten from Sub Saharan Africa. The estimated pooled prevalence was 37.9% for HICs and 29.7% for LMICs (Eyowas et al., 2019).

2.2.3 Patterns of Multimorbidity

Understanding the interactions among chronic conditions and how they co-occur is essential for tailoring patient care effectively. Some conditions tend to coexist because they share a similar underlying cause and can be managed with a unified treatment approach, referred to as concordant multimorbidity. Conversely, certain co-occurring conditions may have unrelated origins, necessitating distinct treatment strategies, known as discordant multimorbidity (Academy of Medical Sciences, 2018). Common disease combinations identified in various studies encompass cardiovascular and metabolic conditions, mental health issues, and musculoskeletal disorders (Garin et al., 2015; Violan et al., 2014; Wang et al., 2015). It's worth noting that patterns of disease combinations can vary significantly by age, gender, and socioeconomic status (Nicholson et al., 2019; Barnett et al., 2012).

In the context of SSA, distinct patterns may emerge compared to HICs due to the region's high prevalence of HIV and TB. Evidence already suggests that these communicable diseases are associated with an elevated risk of NCDs such as diabetes and cardiovascular conditions (Mudie et al., 2019). Numerous studies in the region have highlighted these combinations of communicable and noncommunicable diseases (Wong et al., 2021)(Ataguba, 2013; Chang et al., 2019; Kansiime, Mwesigire, & Mugerwa, 2019).

2.2.4 Determinants of multimorbidity

Epidemiological evidence consistently reveals significant associations between multimorbidity prevalence and age, gender, and socio-economic status. A systematic review of 39 observational studies across 12 countries (Violan et al., 2014) highlighted a substantial increase in multimorbidity prevalence with age, with notably higher rates among females. Similarly, a UK-based primary care study found a prevalence of 30% among females compared to 24% among males, and it emphasized the common occurrence of multimorbidity among socially disadvantaged individuals (Cassell et al., 2018). This socio-economic association was also seen in the seminal Scottish cross-sectional study, where individuals from deprived backgrounds were

shown to experience the onset of multimorbidity 10-15 years earlier than their wealthier counterparts (Barnett et al., 2012). While most multimorbidity research has concentrated on older populations, it's crucial to recognize that younger populations are also at risk of developing multimorbidity, and their inclusion in research and healthcare considerations is paramount.

2.2.5 Impacts of multimorbidity

Individuals with multiple chronic conditions face complex healthcare needs and are prone to negative health outcomes, which may vary based on the number and severity of their conditions (Arokiasamy et al., 2015; Calderón-Larrañaga et al., 2019). Multimorbidity also leads to complex treatment regimens, polypharmacy, and adherence challenges (Nguyen, Ngangue, Haggerty, Bouhali, & Fortin, 2019; World Health, 2016). Numerous studies have highlighted the association between multimorbidity and reduced quality of life (Boyd & Fortin, 2010; Fortin, Soubhi, Hudon, Bayliss, & van den Akker, 2007; Pati, Swain, Knottnerus, Metsemakers, & van den Akker, 2019). Moreover, evidence consistently shows that individuals with multimorbidity frequently utilize healthcare services, necessitating interactions with various healthcare professionals and resulting in higher healthcare costs (Navickas, Petric, Feigl, & Seychell, 2016). In England, for instance, patients with multimorbidity accounted for the majority of general practitioner consultations, medication prescriptions, and hospital admissions (Cassell et al., 2018). A systematic review of multimorbidity prevalence and outcomes in South Asia also identified increased healthcare utilization as a significant consequence of multimorbidity in the region (Pati et al., 2015). These challenges may be exacerbated in LMICs where chronic conditions are often diagnosed late, and healthcare facilities are resource-constrained (Basto-Abreu et al., 2022).

2.2.6 Multimorbidity care

Multimorbidity poses substantial challenges not only to individuals experiencing it but also to their caregivers and healthcare systems, which often struggle to organize care to meet the complex needs of these patients. In addition to the high utilization of healthcare services, including frequent consultations and extended hospitalizations, the care demands of individuals with multimorbidity strain the limited resources available in many health care settings (Moffat & Mercer, 2015; Smith et al., 2012). Research highlights key barriers in multimorbidity care, such as single-disease-oriented treatment guidelines, fragmented and duplicative care, over-specialization, and challenges in delivering person-centered care (Bower et al., 2011; O'Brien et al., 2011; Søndergaard et al., 2015).

Recognising primary care as pivotal in managing patients with chronic conditions (Barbara et al., 2005; Starfield, 2011), several studies in various contexts have explored healthcare professionals' perspectives on multimorbidity. These studies aim to understand how healthcare providers perceive multimorbidity, make decisions regarding patients with multimorbidity, navigate daily practice challenges, and offer insights into healthcare improvements (Prazeres & Santiago, 2016; Sinnott et al., 2013; Stokes et al., 2017). However, there is limited evidence from Botswana and other SSA countries regarding the primary care response to multimorbidity, necessitating further exploration and research in this region.

2.3 Multimorbidity in the context of SSA and COVID-19

SSA is grappling with a double burden of diseases; with a growing incidence of NCDs while at the same time the burden of communicable diseases remains high (Mensah, 2016; Nyirenda, 2016). Furthermore, SSA has one of the fastest growing populations in the world, and it is projected that between 2019 and 2050 the region will contribute more than 50% to the global population (United Nations, 2019). Additionally, the population is rapidly ageing as survivorship has significantly improved due to enhanced life expectancy and the success

of anti-retroviral treatment (ART) (Mudie et al., 2019). All these factors together with rapid urbanization, adoption of risky behaviours like unhealthy eating habits, sedentary lifestyles, are expected to worsen the NCD problem and it is projected that by 2030, NCDs morbidity and mortality would have surpassed that of communicable diseases. This important observation demonstrates that SSA is experiencing a rapid change in its health and demographic profiles relative to other regions, especially HICs. The interaction of communicable diseases and NCDs presents a complex form of multimorbidity that is different from those observed in HICs. For example, SSA is likely to have a larger proportion of an ageing population on ART in the coming decades (Angela Y. Chang et al., 2019). This highlights the importance of generating context specific evidence for SSA as a region that is hardest hit by HIV and at the same time experiencing a rapid increase in the burden of NCDs.

The recent outbreak of the new coronavirus commonly known as COVID-19, which was declared an international public health emergency by WHO in 2020 (World Health Organization, 2020), has also brought to the global debate a new perspective in the interaction of communicable diseases and NCDs. Epidemiological evidence gathered so far show that individuals with underlying chronic conditions (such as chronic obstructive pulmonary disease (COPD), diabetes, hypertension and cardiovascular diseases) have an increased mortality risk and worse health outcomes compared to patients with no underlying chronic condition (Katulanda et al., 2020; Wang et al., 2015; Zheng et al., 2020). Scientific evidence is being generated to provide a better understanding of the association of COVID-19 and chronic conditions (Zheng et al., 2020). It is worth noting that health systems around the world struggled to allocate resources between pandemic-associated costs and the already existing health care needs (both chronic conditions, as well as the emerging health problems, including conditions such as depression and anxiety (Chatterjee et al., 2020; Rajkumar, 2020).

2.4 Study setting and context

Botswana is an upper middle-income, landlocked, country in Southern Africa. It shares its borders with South Africa, Namibia, Zimbabwe and Zambia. According to the national population and housing census of 2011, the population is estimated to be over 2 million with a life expectancy at birth around 68 years (Statistics Botswana, 2015). The regional population distribution indicates that a majority of the population stays in urban areas, reporting an urban population of 64 percent (Botswana Government, 2018). The economy is largely driven by diamond mining, while rural communities depend of subsistence farming for their livelihoods (Botswana Government, 2016).

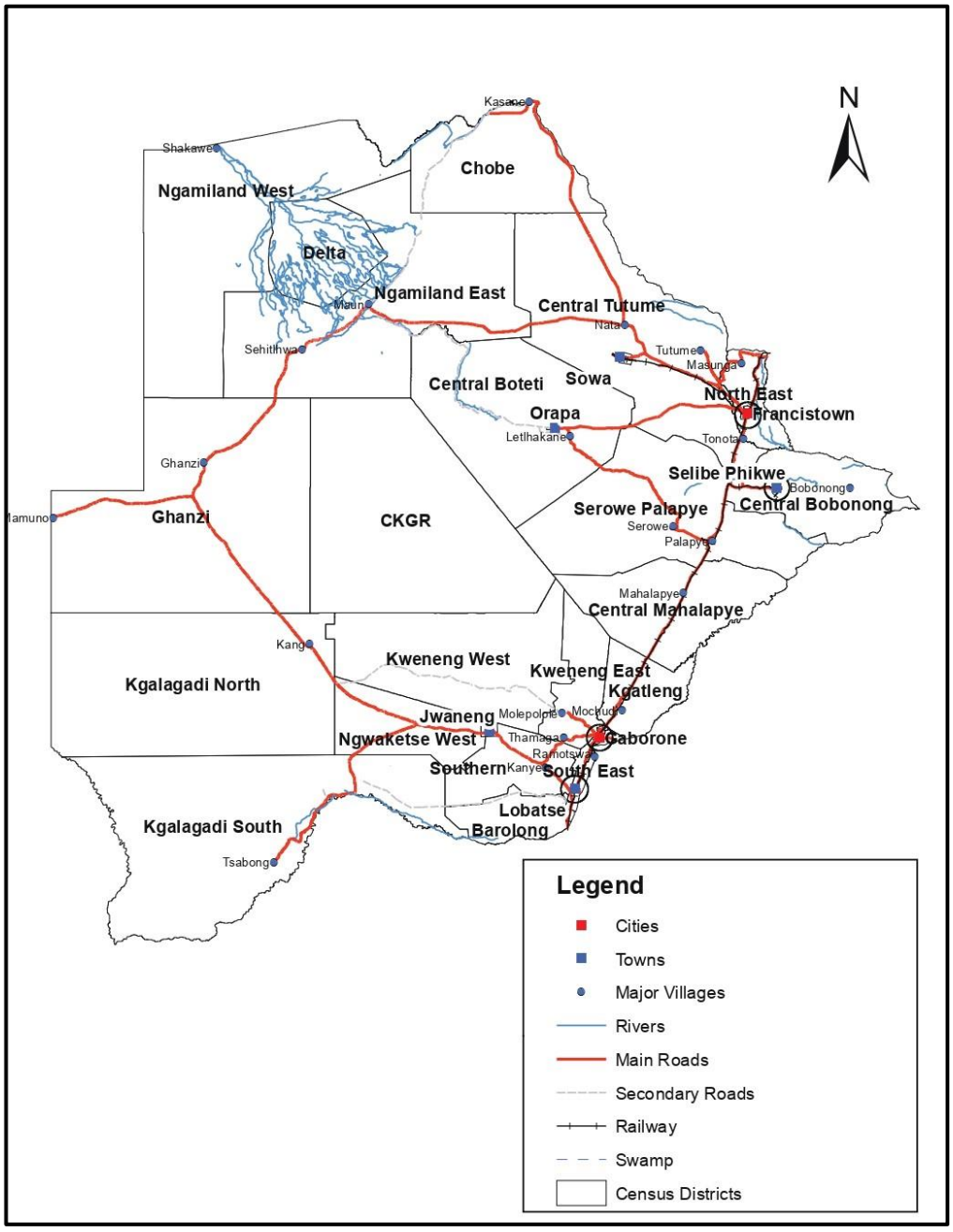
2.4.1 Botswana's Healthcare System

The Ministry of Health (MoH) in Botswana holds the mandate for healthcare coordination, regulation, and provision across the nation's 27 health districts. Figure 1 shows the map of Botswana and the health districts. This responsibility is executed through the District Health Management Teams (DHMTs), each overseeing healthcare within its defined geographic boundaries. Botswana's healthcare system, similar to other regional counterparts, follows a primary care model. Approximately 80% of the population accesses healthcare services through the public health facilities, with a smaller segment seeking care from private providers and non-governmental/faith-based organizations (Seitio-Kgokgwe et al., 2014).

Healthcare is delivered through a network of three (3) referral hospitals, seven (7) district hospitals, fourteen (14) primary hospitals, two hundred and sixty-five (265) primary care clinics, a number of health posts and mobile clinic stops and private outpatient clinics. National referral hospitals are the highest level, responsible for providing tertiary care; mobile clinic stops are the lowest level, providing limited services such as immunisations, childcare services, minor curative treatment and care services, basic NCDs screening as well as health education/advise. (Nkomazana et al., 2014). It is estimated that nationally, 95 percent of the total population live within 8 kilometres of a health facility, and

84 percent within a 5 kilometres radius (Seitio-Kgokgwe et al., 2014; Tapela et al., 2019). The health system in Botswana is predominantly nurse-led with a limited number of doctors, specialists and other health professionals, unequal distribution of health services, poor infrastructure, and resources among other challenges. Chronic care in Botswana is still at a developmental stage; the country's first national primary healthcare guidelines for adults were adopted in November 2016. Before then, NCD care and management was random and depended largely on the individual healthcare provider's understanding of NCDs (Tapela et al., 2019; Tsima et al., 2016).

Figure 1: Map of Botswana

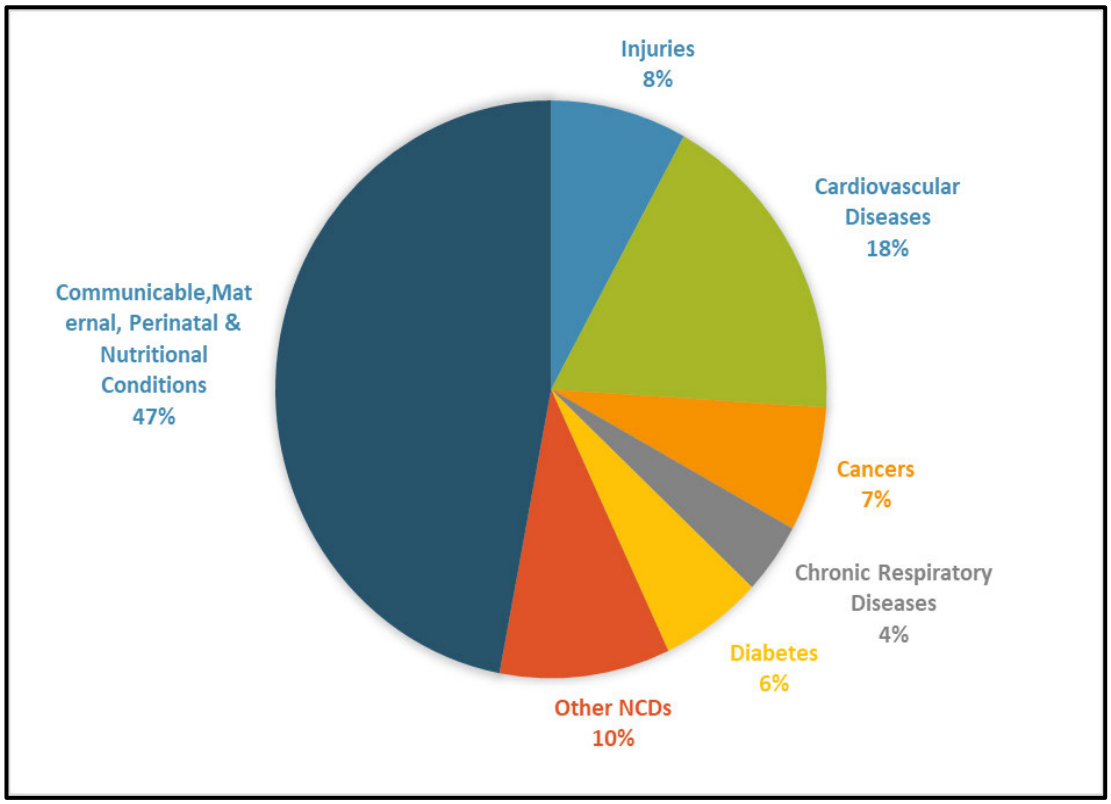


2.4.2 Noncommunicable diseases in Botswana

Botswana like other countries in SSA has over the years been battling with high mortality and morbidity primarily from infectious disease. The disease profile has however changed as the country is experiencing a rapid increase in the prevalence of NCDs. In 2016 the World Health Organisation estimated that NCDs were responsible for 46% of all deaths in the country, the most

common being cardiovascular diseases accounting for 18% of total mortality, followed by cancers (7%), diabetes (6%) and chronic respiratory diseases (4%).. Together these four conditions are responsible for 82% of NCD related deaths. (World Health Organisation, 2018). Premature mortality was estimated to be around 20%, (23% for males and 18% for females. Figure 2 below summarises causes of deaths in Botswana.

Figure 2: Causes of Death in Botswana



2.4.3 NCDs risk factors

Evidence indicates that Botswana shares similar risk factors with the rest of the world, and these risk factors are exacerbated by rapid urbanisation, population ageing and adoption of sedentary lifestyle due to economic development, environmental changes as well as childhood exposures. The prevalence of NCDs risk factors is on the rise (Botswana STEPS survey, 2007 & 2014, Letamo et al, 2016).

2.4.3.1 Overweight/obesity, physical activity and unhealthy eating

Botswana like many countries is experiencing a nutritional transition which is characterised by a shift from traditional and plant-based diets to diets high in saturated fats, energy and sugars, a change that is largely due to industrialisation and rapid urbanisation (Nyepi et al, 2014). According to the Botswana STEPS survey of 2014, about 95% of the participants ate less than 5 servings of fruit and vegetables on average per day. It is also evident that overweight and obesity are becoming a major public health concern in Botswana. The prevalence has increased from 18.7% in 2007 to 30.6% as indicated in the STEPS surveys. (Botswana STEPS Survey, 2007 & 2014).

Furthermore, several studies indicate that overweight/obesity tend to be more prevalent among females compared to their male counterparts, and that prevalence increases with age and level of education; that is people with a higher socioeconomic status tend to be more obese (Keetile, 2019, Letamo 2011. Poor physical activity has been cited as another important risk factor associated with NCDs in Botswana (World Health Organisation, 2016, Keetile et al., 2019, Republic of Botswana, 2014, 2018). The World Health Organisation estimates that the prevalence of physical inactivity was around 20% in 2016. There is strong evidence that physical inactivity, unhealthy eating habits and obesity/overweight are major modifiable risk factors associated with most NCDs and that inequalities by gender, level of education and socio economic status are observed in the country (Keetile et al 2019, Letamo et al 2016).

2.4.3.2 Hypertension/raised blood pressure

There has been significant increase in the prevalence of hypertension/ raised blood pressure in the last two decades as indicated by the national noncommunicable diseases risk factors survey (STEPS, 2014). The prevalence among young adults aged 15-69 was estimated to be around 29.4%. Age, gender, level of education and insufficient physical activity have been found to be associated with raised blood pressure (Keetile, Navaneethan & Letamo, 2015). According to the Botswana Demographic survey which was

conducted in 2017, the prevalence of high blood pressure for people aged 12 years and above was estimated to be 34.9% There is clear evidence that the prevalence of high blood pressure is increasing, and that there is an association with poor diet, insufficient physical activity, alcohol and tobacco use.

2.4.3.3 Harmful use of alcohol

Several studies show that Botswana is battling with a problem of harmful alcohol consumption (Riva et al. 2018, Sinkamba 2015, Pitso & Obot 2011, Weiser, 2006). The national NCD risk factors survey (STEPS) also indicates that the proportion of respondents who consume alcohol increased from 18.7% in 2007 to 26.4% in 2014. According to the 2018 WHO Global Status Report on Alcohol and Health, Botswana has a total adult per capita consumption of 8.4 litres of pure alcohol per annum, well above the regional average of 6.3 litres. Alcohol use has been linked to various health issues like HIV/AIDS, noncommunicable diseases such as cardiovascular diseases, tuberculosis, as well as social ills like road traffic accidents, risky sexual behaviours, gender-based violence and other crimes (Weiser,2006, Pitso & Obot, 2011, Republic of Botswana, 2018).

2.4.3.4 Tobacco Use

Although there is limited comprehensive data on the prevalence of tobacco use in Botswana, the available evidence suggests that there has been an increase in the use of tobacco in the country over the years even among adolescents (Republic of Botswana 2014, Mbongwe 2004). The National STEPS survey estimates a prevalence of 18.3%, higher among males (31.4%) than females (4.9%). There are also studies that indicate that despite efforts to regulate tobacco smoking in the country, the problem is increasing among adolescents, a trend that could suggest that the current smoking cessation policies are barely working (Mbongwe et al., 2017, Letamo, Bowelo & Majelantle, 2016).

2.5 Chapter Summary

This chapter puts into perspective the concept of multimorbidity, starting with an exploration of its definition, prevalence, and the changing landscape of diseases due to global population shifts. It also touches upon the determinants and impacts of multimorbidity. Additionally, it provides an overview of Botswana's healthcare system and the rising burden of noncommunicable diseases (NCDs) in the country, along with their risk factors. While multimorbidity research is advancing in HICs, there is a need for more context-specific research in LMICs, including Sub Saharan Africa, to understand the unique challenges and patterns of multimorbidity in these regions. The interaction between communicable and NCDs, especially in regions heavily affected by diseases like HIV/AIDS, remains an area requiring in-depth investigation to develop appropriate healthcare strategies. Understanding and addressing multimorbidity is crucial for improving healthcare outcomes and resource allocation, particularly in regions facing complex health challenges like Sub Saharan Africa.

Chapter 3 General Methodology

3.1 Overview

This chapter describes the methodological approach adopted in this thesis. I begin by exploring the philosophical underpinnings and systematic procedures that shape the entire research, the rationale for the choice of the study paradigm, discuss the mixed methods design chosen for this study, and the rationale for using this approach, and elaborate on each of its individual components: systematic literature review, the prevalence study, and the qualitative interviews.

To put this chapter into perspective, it is important to distinguish between research methodology and research methods. Research methodology refers to the overarching approach and framework that guide a research study, including the selected paradigm or theoretical foundation (Mackenzie & Knipe, 2006). The primary focus is placed on the procedural aspects, including the logical steps and the necessary tools involved in data collection and analysis. Methodology is therefore not just a set of methods; it also includes the philosophical assumptions that underpin the study within a specific discipline or field of inquiry (Jackson, 2013). Research methods, on the other hand, refer to the systematic modes, procedures, or tools used specifically for data collection and analysis in a research study. Methods are the practical techniques and steps employed to gather and analyse data (McGregor & Murnane, 2010). While methods are a vital component of research, they are a subset of the broader research methodology, which provides the overall framework and rationale for the study.

3.2 Philosophical Worldview

This study is based on mixed-methods methodology, which involves the integration of both quantitative and qualitative data to address its specific research objectives. However, before delving into the details of the methodology used in this study, it is essential to explain first the underlying philosophical stances. Saunders defines philosophy as *“a system of beliefs*

and assumptions about development of knowledge." (Saunders et al., 2007). It is widely accepted that these beliefs, assumptions, and principles, strongly influence the selection of a research strategy (Jackson, 2013; Saunders et al., 2007). Creswell (Creswell, 2017a) has identified four prominent philosophical worldviews that researchers often draw upon when designing their studies; post-positivism, constructivism, transformative and pragmatism.

1. Post-positivism is a research approach that aims to study and understand the world through systematic observation, measurement, and the testing of theories. It is rooted in determinism and emphasises the establishment of causal relationships, often through experimental methods, to simplify complex ideas into testable variables. Post-positivism is primarily associated with quantitative research methods, which rely on numerical data and statistical analyses (Creswell, 2017b).

2. Constructivism represents research paradigms that highlight the subjective nature of reality, as perceived and constructed by individuals within their unique contexts. This worldview is closely tied to qualitative research, operating on the premise that truth is not absolute but rather relative and shaped by how individuals interpret the world. Constructivist researchers delve into the complexities of human experiences and perspectives (Creswell, 2017a).

3. Transformative worldview asserts that research should be intimately connected to politics and should have a clear reform agenda that can potentially bring about change in the lives of participants and society at large. Researchers within this worldview prioritise social justice and often focus on marginalised populations. Their work is driven by the aim of effecting positive social and political transformations (Mertens, 2009).

4. Pragmatism is an approach that revolves around the idea of embracing multiple realities and prioritising practicality in research. Instead of adhering rigidly to specific methodologies, this worldview emphasises understanding the

research issue at hand and employing a diverse range of available approaches to gain comprehensive insights into that issue. Pragmatism serves as a philosophical underpinning for mixed methods research, allowing researchers the flexibility and discretion in selecting methodologies based on the specific requirements and objectives of the study (McGregor & Murnane, 2010).

3.2.1 Justification of the pragmatic worldview

This thesis is firmly situated within the pragmatic approach mixed methods research. The pragmatic worldview, as articulated by Creswell, acknowledges that the combination and integration of different data types-quantitative and qualitative-can yield a more comprehensive understanding of a phenomenon (Creswell, 2017a). As outlined in Chapter 1, multimorbidity research in the SSA region is still in its infancy, and numerous fundamental aspects of this research area remain poorly understood and understudied. The pragmatic approach provides a valuable framework for this context because it allows for flexibility and adaptability in research design (Creswell, 2017a). This is especially pertinent when dealing with a multifaceted and underexplored issue like multimorbidity in SSA. By leveraging the strengths of both quantitative and qualitative data, the chosen mixed methods approach enables the exploration of research questions from multiple angles, thereby giving a holistic and comprehensive understanding of multimorbidity in the context of SSA and Botswana

3.3 Mixed Methods Approach

Health issues are often complex and investigating them with one approach sometimes doesn’t address all the questions. Mixed method approach is increasingly becoming common to understand public health problems beyond the counting of diseases but also to understanding the context within which these health problems occur (Kaur, 2016). Mixed methods research is described as a design whereby combining and integrating qualitative and quantitative methods is used in a single study to gain understanding of a complex phenomenon, through multiple research phases and/ or

complementary data sources (Creswell, 2015; Johnson et al., 2007). This methodology has evolved over the years, moving beyond early debates on its compatibility to become a prominent and valuable research method (Clark et al., 2008).

There are various classifications of research designs in mixed methods research, offering the researcher flexibility in their approach to data collection and analysis (Halcomb & Hickman, 2015). The three main mixed methods designs widely used in social and healthcare research are convergent parallel, explanatory sequential and exploratory sequential mixed methods research (Creswell, 2017a). The convergent parallel mixed methods design involves collecting both qualitative and quantitative data simultaneously or in parallel. Researchers place equal emphasis on both approaches and analyse them separately. The results are then compared to identify convergence or discrepancies, providing a comprehensive view of the research problem. This design is particularly useful when the researcher aims to obtain different but complementary data on the same topic (Creswell et al., 2003).

Explanatory sequential mixed methods design begins with the collection and analysis of quantitative data, followed by the collection of qualitative data. The quantitative results inform the subsequent qualitative phase, allowing the researcher to delve deeper into the findings from the quantitative phase. This design is beneficial when the researcher wants to use qualitative data to explain or elaborate upon quantitative results. In contrast to the explanatory sequential design, the exploratory sequential mixed methods design initiates with qualitative data collection and analysis. Here the researcher aims to explore a phenomenon through qualitative means, identifying patterns and relationships. Subsequently, the findings from the qualitative phase guide the development of quantitative instruments for data collection. This design is useful when researchers seek to tailor quantitative data collection to the insights gained from qualitative exploration. These three cores mixed methods design differ in the order of data collection and the relationship between qualitative and quantitative components.

Combining the findings from qualitative and quantitative data is the distinguishing factor between multi-method approaches and mixed methods research. It can be challenging exercise because qualitative and quantitative data come in different forms and bringing them together requires time and effort (Anguera et al., 2018). Integration can be accomplished through various techniques such as triangulation, “following a thread”, and the use of mixed methods matrices (O’Cathain et al., 2010). Triangulation entails determining whether the results of each method confirm, complement, or contradict one another. To facilitate interpretation, “following a thread” entails tracing themes or questions from one data type to another. In addition, the use of mixed methods matrices enables direct comparisons of quantitative and qualitative data collected from the same cases, thereby facilitating a thorough integration process. Ultimately, the integration of findings from both quantitative and qualitative sources is essential to derive meaningful conclusions within mixed methods research (Plano Clark, 2019).

3.4 Components of my PhD study

The overarching aim of my study was to investigate the epidemiology of chronic disease multimorbidity in Botswana and to understand the strategies that can be utilised to improve primary care for individuals with multiple chronic conditions. I employed a convergent mixed methods research design. This approach is characterised by the simultaneous collection and analysis of both qualitative and quantitative data components, with the ultimate intention of integrating these in the final stage of the study (Creswell, 2017b), which is the Discussion chapter. In this research design, the individual components of the study were conducted concurrently, allowing for the comprehensive exploration the research questions from multiple perspectives and data sources. The details of the individual components are outlined below.

3.4.1 Systematic Literature Review

The first component of my study involved carrying out a systematic literature review, which aimed to identify and synthesise the evidence on the prevalence

and patterns of chronic disease multimorbidity among adults in SSA region. This review laid the essential groundwork for my PhD study. Despite compelling global evidence indicating an increasing occurrence of multiple chronic conditions, including within SSA, there remains a scarcity of evidence specific from this region that provides a comprehensive understanding of the current status or magnitude of multimorbidity (Sciences, 2019). Most existing systematic reviews examining the prevalence and patterns of multimorbidity have primarily concentrated on HICs (Nguyen et al., 2019). In cases where SSA countries were included, they were often grouped together with other LMICs (Asogwa et al., 2022; Ho et al., 2021; Nguyen et al., 2019). Yet, SSA exhibits a distinct disease profile, characterised by the coexistence of communicable diseases and NCDs. Given the ongoing shifts in disease patterns and population dynamic in the region, there is a growing need for SSA-specific evidence. This systematic review bridges this gap by offering region-specific insights into the prevalence and patterns of multimorbidity. These findings are directly applicable and comparable to the context of Botswana, which is the focal point of my study.

3.4.2 Prevalence Study

Epidemiological studies are essential in understanding the health dynamics of populations, by providing valuable insights into the frequency of disease across different populations and the underlying reasons for these variations (Frérot et al., 2018). The second component of my PhD research is a quantitative study focused on estimating the prevalence of multimorbidity, investigating its patterns, and identifying the socio-demographic factors that contribute to its occurrence. This study aims to generate evidence-based information that can inform healthcare policies, resource allocation, and shape interventions tailored to address the specific needs of individuals facing multiple chronic health conditions (Nguyen et al., 2019; Sciences, 2018). In the context of Botswana, where empirical evidence on multimorbidity is still limited, understanding the true extent of multimorbidity and its determinants and patterns becomes pivotal. Such knowledge is essential for policymakers and

healthcare providers, as it equips them with reliable data necessary to advocate for and implement meaningful changes in the organisation and delivery of healthcare, particularly for individuals dealing with multimorbidity.

To address objectives number 2 and 3 in this PhD study, I relied on data from the fourth Botswana Demographic Survey (BDS), conducted between August-October 2017. The BDS is a comprehensive cross-sectional national survey administered by Statistics Botswana, the official government agency responsible for collecting and managing all official statistics in the country. This extensive nationwide survey is conducted every five years, serving as an essential update to the national population and housing census. The choice of utilising an existing dataset aligns with the recommendations outlined in the report by the Academy of Medical Sciences. This report outlines research priorities for addressing multimorbidity in SSA, emphasising the importance of leveraging existing data resources to advance our understanding of this complex health issue in the region (Sciences, 2019).

To access and use the data for this study, formal permission was sought and granted by Statistics Botswana on the 26th of April 2021. This collaboration was facilitated by my affiliation with the University of Botswana (UB), where I am employed in the Department of Population Studies. UB has established a longstanding partnership with Statistics Botswana, formalised through a Memorandum of Understanding signed in 2018. This partnership has fostered various collaborative efforts over the years, encompassing joint surveys and research projects, capacity building and training initiatives, as well as the analysis of census data, among other areas of cooperation. Thanks to this robust partnership, Statistics Botswana regularly extends invitations to utilise their newly acquired data resources. Consequently, obtaining the necessary data for conducting the prevalence study proved to be a seamless process. In Chapter 5 I give a detailed description of this dataset and the analyses conducted to address objectives 2 and 3.

3.4.3 Qualitative Study

Qualitative research allows for a deeper exploration and understanding of a health issue from the perspectives, and experiences of the participants (Isaacs, 2014; Pope & Mays, 1995). This qualitative component sets out to explore and describe perceptions and experiences of primary healthcare workers and policymakers in Botswana about multimorbidity, addressing objective 4 of my study. This enquiry aimed to obtain a comprehensive understanding of how multimorbidity is perceived in the Botswana context, how care and services for individuals with multimorbidity are organised, the challenges they face in providing care and their views on how primary care can be strengthened to respond to this complex issue.

To allow for a thorough understanding of multimorbidity from healthcare professionals' perspective, a phenomenological qualitative approach was adopted (Starks & Brown Trinidad, 2007; VanManen, 1990). Healthcare providers at different levels of the primary health sector are responsible for the provision and coordination of routine care for patients living with multiple chronic conditions. Policymakers on the other hand are responsible for the formulation of effective and efficient healthcare policies. It is against this background that their views are important in providing a complete picture and deeper understanding about the burden and care of multimorbidity in Botswana where the evidence base is still limited. For the scope of this study, the term "healthcare worker" pertains to healthcare professionals and personnel operating at the primary healthcare level. These individuals are responsible for delivering a range of healthcare services to individuals with multiple chronic conditions in public health facilities. This category encompasses various roles, including but not limited to nurses, doctors, pharmacists, social workers, healthcare educators, and others. On the other hand, the term "policymaker" encompasses any professional holding a position of authority at both national and district levels within Botswana's healthcare system. These individuals are actively engaged in decision-making processes concerning healthcare matters in the country.

3.5 Integration

The convergent parallel mixed methods design employed in this study holds a unique strength: the ability to integrate diverse data types for a more comprehensive understanding of the research topic (O'Cathain et al., 2010). In the Discussion chapter, I utilised triangulation to systematically compare and contrast findings from the individual components (Fetters et al., 2013). This approach facilitated a holistic examination, allowing for the exploration of any discrepancies or contradictions and seeking convergence or divergence in the results. Through this process, I ensured robust conclusions were drawn, addressing the multifaceted aspects of multimorbidity as outlined in the specific objectives of this study, including its prevalence, patterns, correlates, healthcare system organisation, challenges, and barriers and recommendations to strengthen primary care.

3.6 Chapter Summary

This chapter outlines the research methodology employed in this thesis, which adopted a convergent mixed methods approach. The research commenced with a systematic literature review focused on multimorbidity prevalence and patterns in Sub Saharan Africa, providing an overview of the existing research landscape on this subject in the wider geographical region. Subsequently, the quantitative study examined the prevalence and patterns of multimorbidity among adults in Botswana, utilising secondary data sourced from the BDS. In the qualitative component, healthcare professionals working across 14 primary healthcare facilities in Botswana were interviewed. This study aimed to obtain an in-depth understanding of the organisation of care for individuals with multimorbidity and the challenges faced by healthcare providers in delivering such care. The objective of conducting a convergent mixed methods study is to offer a more comprehensive and robust understanding of the research problem by triangulating findings from both qualitative and quantitative data. In my study, I followed this approach by simultaneously conducting the study components and later integrating the findings in the Discussion chapter. The

next chapters (4, 5 and 6) provide detailed information on the methods and findings from each of the three study components.

Chapter 4 Epidemiology of multimorbidity in sub Saharan Africa: Systematic literature review

4.1 Overview

This chapter describes the methods and results of a systematic review of the epidemiology of multimorbidity among adults in SSA. Although other reviews have investigated multimorbidity prevalence and patterns globally, most included studies from HICs (Ng et al., 2018; Nguyen et al., 2019; Prados-Torres et al., 2014; Xu et al., 2017a). Disease patterns in LMICs are different from HICs – accordingly, the evidence from these reviews might have limited applicability to SSA. Other reviews have also explored multimorbidity in LMICs; they have mostly focused on NCDs only, excluding communicable diseases (Abebe et al., 2020; Asogwa et al., 2022). Given the overlap between NCDs and chronic communicable diseases, combined with the rapidly ageing population in the region, understanding patterns of multimorbidity in SSA is critical for policy response and the development of interventions that could assist healthcare providers in providing quality care to patients with multiple chronic conditions.

4.2 Aims and Objectives

In this systematic review, I aimed to systematically review and synthesise evidence on the epidemiology of multimorbidity among adults in SSA region, primarily focusing on the prevalence and patterns of chronic communicable and noncommunicable diseases.

4.2.1 Specific Objectives

1. To explore how multimorbidity has been defined and measured in sub Saharan Africa (SSA) and how the differences in measurement might influence reported patterns of multimorbidity.
2. To identify and summarise evidence on the estimates of prevalence and patterns of chronic disease multimorbidity among adults in SSA.

3. To examine the interaction of chronic communicable diseases such as HIV and tuberculosis (TB) with the most prevalent chronic NCDs in SSA.
4. To incorporate emerging literature on the impact of COVID-19 on chronic conditions in SSA.

4.3 Methods

4.3.1 Protocol and Registration

This systematic review was developed and reported according to the Preferred Reporting Items for Systematic reviews and Meta- Analyses (PRISMA) guidelines (Moher et al., 2009). The protocol for this review has been registered with the International Prospective Register for Systematic Reviews (PROSPERO, https://www.crd.york.ac.uk/prospero), registration number CRD42020183539, and was also published in the Journal of Global Health Reports (Disang et al., 2021)-Appendix 1. A second reviewer Rebecca Howett (RH) was involved in the screening and data extraction, and her input is described below.

4.3.2 Eligibility Criteria

The inclusion and exclusion criteria for this review were developed based on the Condition-Context-Population (CoCoPop) Framework for reviews of prevalence studies recommended by the Joanna Briggs Institute (Munn et al., 2018).

Condition: I adopted the Academy of Medical Sciences definition of multimorbidity (Sciences, 2018) which defines multimorbidity as "the coexistence of two or more chronic conditions, each one of which is either; a physical noncommunicable disease of long duration, such as a cardiovascular disease or cancer, a mental health condition of long duration, such as a mood disorder or dementia, or an infectious disease of long duration, such as HIV or hepatitis C".

Context: I focused my review on studies from the sub Saharan Africa region, conducted in any setting. Sub Saharan Africa was defined according to the World Bank Country and Lending Groups (World Bank, 2020). Studies

including both SSA countries and other regions (multinational studies), were only included if I could extract data for SSA countries.

Population: The population was adults aged 18 years and older residing in sub Saharan Africa.

I therefore excluded studies reporting comorbidities (where participants were selected based on an index / primary condition of interest), those conducted outside the SSA region, qualitative studies, systematic reviews, editorial letters, and studies conducted among children.

4.3.3 Information Sources

This review's major aim was to locate observational studies that investigated and reported quantitative data on the prevalence, patterns, or epidemiology of multimorbidity and comorbidities in SSA, published from 2000 to 2020 with no language restrictions. A detailed search strategy was developed with the assistance of a medical librarian from the University of Edinburgh. A systematic literature search was conducted in the following electronic databases; Medline, EMBASE, CINAHL, Global Health, PsycINFO, African Index Medicus, African Journals Online, ProQuest Dissertations & Theses, Web of Science and Google Scholar.

To supplement the database results, I conducted an additional search on Google to identify grey literature such as government and institutional reports, theses and dissertations. To further optimise the identification of more eligible studies and also compare search strategies, we contacted an expert in the field who had recently published a scoping review on multimorbidity of chronic noncommunicable diseases in LMICs (Abebe et al., 2020). Finally, I manually screened/searched reference lists of relevant studies for additional studies which might have been missed by the database search. The final search was undertaken on 30/09/2021.

I used keywords and Medical Subject Heading (MeSH) search terms adopted from previous systematic reviews on multimorbidity (Nguyen et al., 2019;

Stirland et al., 2020; Violan et al., 2014). These include “multimorbidity”, “comorbidity”, “multiple chronic conditions”, “polymorbidity”, “pluripathology”. Another set of search terms used were “prevalence”, “patterns”, “epidemiology” and the third set of terms was “sub Saharan Africa”, as well as a list of individual sub Saharan countries. I used Boolean operators “OR” to combine search terms within a category or set, and I used “AND” to combine search terms across the categories. This search strategy was fully developed on Medline (Ovid) interface, tested, refined, and adapted to the other databases accordingly (Disang et al., 2021).

4.3.4 Data Screening, Selection and Extraction

All identified records from electronic searches were exported to Endnote version X9 library software to manage the screening process. Duplicates were identified and removed using the deduplication function of Endnote, and for those that were not detected by the function, they were manually removed. The initial screening of titles and abstracts was done by myself (MRD), and studies which clearly did not meet the inclusion criteria were removed. A consensus discussion of a random sample of 20% titles and abstracts was undertaken with the second reviewer (RH). In the second phase of the screening, remaining titles and abstracts were divided into two groups: multimorbidity studies, and comorbidity studies. Studies were categorised as comorbidity studies when participants were selected based on an index condition, and as multimorbidity studies when there was no reference to any primary condition. If the abstracts lacked adequate information to determine the study category, MRD & RH independently assessed the full text of the study and categorised it accordingly.

In the third stage, full texts for studies which were in the multimorbidity category were all assessed, and data were extracted from the 64 studies. Data extraction was done independently by MRD and RH, using a pre-tested data extraction form to collect key information variables from each of the studies. The data extraction form collected the following items; author(s), year of publication, study country, sample size, sample characteristics, data source,

definition of multimorbidity, number of conditions assessed, list of conditions assessed, prevalence of multimorbidity, and disease combinations observed. The form is shown in Appendix 2. Previous multimorbidity reviews were consulted to develop this comprehensive data extraction form (Nguyen et al., 2019; Pati et al., 2015; Violan et al., 2014). Disagreements during the screening and data extraction processes were resolved through discussion and with PhD supervisors (CC & DW).

4.3.5 Quality Assessment

The methodological quality of individual studies was independently evaluated by MRD and RH using the JBI Critical Appraisal checklist for studies reporting prevalence data (Munn et al., 2015). The tool has ten items with three possible responses; yes, no and unclear. The appraisal tool is shown in Appendix 3. Studies were classified to have a “high risk of bias” if the “yes” scores were less than 5, “moderate risk of bias” if the “yes” scores were between 5 to 7, and “low risk of bias” if the “yes” scores were between 8 to 10. Disagreements between reviewers were discussed until a resolution was reached. The review included all studies, regardless of the outcome of the methodological assessment.

4.3.6 Data Analysis

Due to the lack of uniformity in how multimorbidity is defined and measured, as well as disparities in the features of the study populations and the various contexts in which the studies were conducted, I anticipated that identified studies were going to be too heterogeneous to allow for a meta-analysis. Thus, I decided that a statistical synthesis of the results would not be appropriate and therefore adopted a narrative approach. A narrative synthesis is generally defined as “an approach to the systematic review and synthesis of findings from multiple studies that relies primarily on the use of words and text to summarise and explain the findings of the synthesis (Popay et al., 2006).

I used my study aims to guide the synthesis process. To address the main review objective, which seeks to synthesise evidence on the prevalence and

patterns of multimorbidity, we provided a descriptive overview of the characteristics of the included studies. I also report the prevalence of multimorbidity from individual studies, and their 95% CI, where provided. Where the prevalence was not provided, I calculated the prevalence using the available information. Prevalence estimates were also assessed in relation to age, sex, and urban/rural residence. Furthermore, I assessed the variation in prevalence according to study setting, for example, population surveys versus health facility-based studies. I used tables and graphs to demonstrate the groupings clearly.

In relation to patterns of multimorbidity, I identified studies that investigated the most frequent combinations of conditions or the commonly co-occurring chronic conditions, then summarised and reported the most prevalent conditions and observed patterns, paying particular attention to the overlap of NCD and HIV/TB. Within the narrative synthesis, I have interpreted and described the relationships, similarities, and differences we observed by further subgrouping studies based on sex, residence and age, because these factors have a strong influence on multimorbidity prevalence and patterns.

Additionally, I descriptively analysed how multimorbidity is defined and measured in SSA. This was done by describing and tabulating the definitions of multimorbidity, the number and types of conditions included in the studies and how the presence of conditions was determined.

I also aimed to synthesise any emerging evidence on the link between COVID-19 and multimorbidity/ chronic conditions in the region. However, no relevant studies on COVID-19 and multimorbidity were identified during the searches.

4.3.7 Ethical Consideration

Ethical approval was not required as this systematic literature review synthesised data from already published primary literature.

4.4 Results

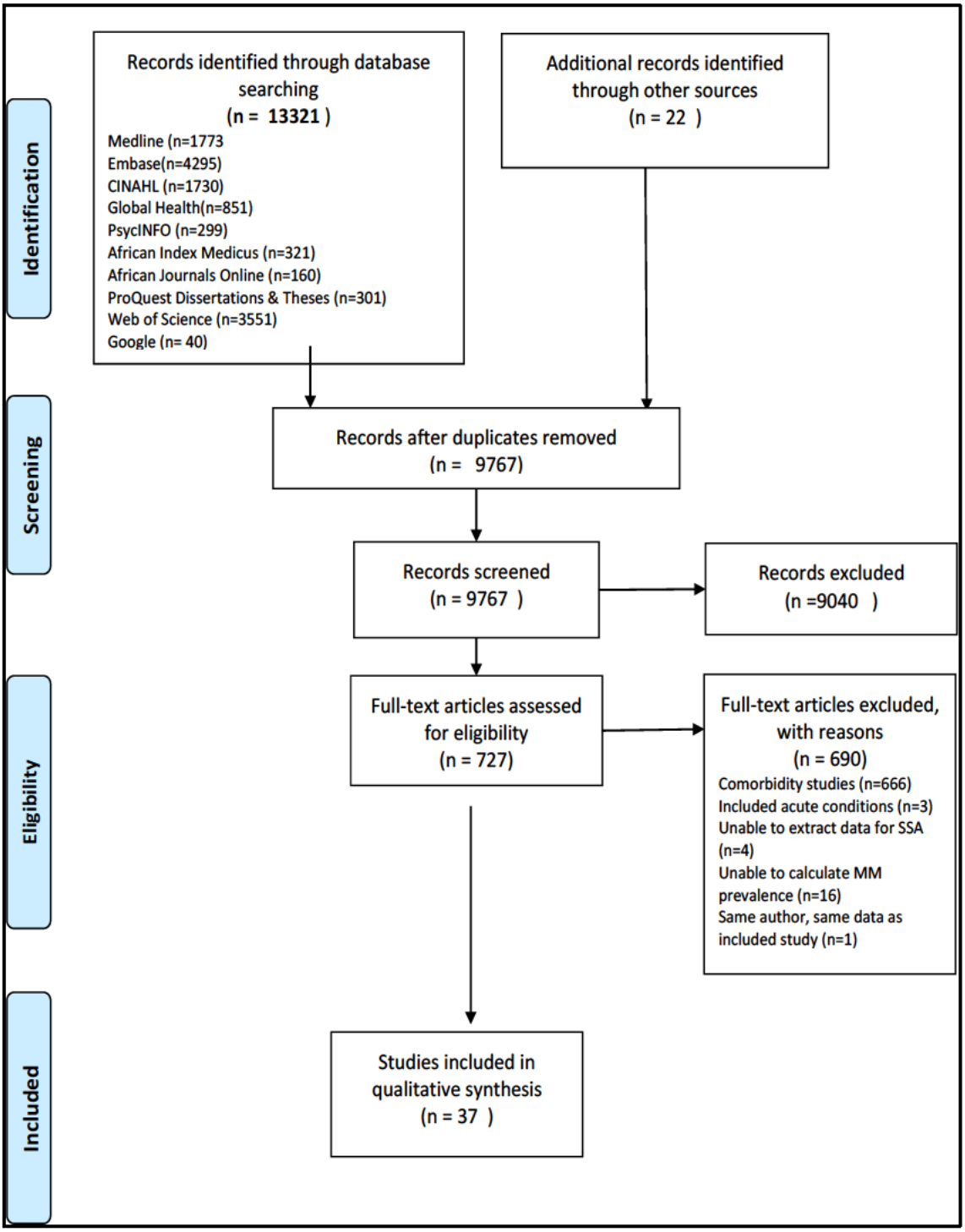
4.4.1 Study Selection

The search identified 13,321 studies through electronic database searches, and 22 through other sources. The combined 13,343 articles were screened for duplicates. After removing duplicates, using the EndNote deduplication function, 9767 articles remained. The initial screening of titles and abstracts was undertaken MRD and a consensus discussion of 20% of studies was carried out with RH, who checked if the studies met the eligibility criteria. 9040 studies which were not related to multimorbidity or comorbidity, commentaries, reviews, animal studies, studies conducted out of the SSA region and those involving children under the age of 18 were excluded. Studies which met the eligibility criteria after the title and abstract screening were further assessed (727) and categorised into two groups;

i. Multimorbidity Group; studies focused on multiple chronic conditions holistically without reference to a specific index condition or without focusing on any particular condition as the main one.
ii. Comorbidity Group; studies describing the co-occurrence of multiple chronic conditions in reference to an index condition.

Of these, 666 studies were identified as comorbidity studies and 64 as multimorbidity studies. This approach was adopted to ensure that we did not exclude multimorbidity studies whose authors had originally identified them as comorbidity studies due to the interchangeable use of these two concepts. Full text review of the 64 multimorbidity studies was then carried out independently by MRD and RH, and 27 studies were subsequently removed, leaving 37 which were included in this review. Figure 3 outlines the study selection process.

Figure 3: PRISMA Flow Diagram for Study Selection Process



4.4.2 Study Characteristics

Of the thirty-seven (n=37) studies that met my inclusion and exclusion criteria, the data collection period ranged from 2001 to 2018, and the first article was published in 2012 (Oduro & Tawiah, 2012). Twenty-eight studies (n=28) were single country studies, while the remaining nine (n=9) were multi country studies reporting results from several countries, and we were able to extract data for the relevant SSA countries. For example, using data from the World Health Survey, a study estimated the prevalence of multimorbidity for twenty-eight (28) countries, and we were able to extract data for five (5) SSA countries (Afshar et al., 2015).

Of the 28 single country studies, the majority were conducted in South Africa (n=14), three (n=3) in Nigeria (Cadmus et al., 2017; Fakoya et al., 2018; Nwani & Isah, 2016), two (n=2) in Burkina Faso (Hien et al., 2014; Odland et al., 2020), two (n=2) in Botswana (Keetile et al., 2020; Letamo et al., 2017), two (n=2) in Ghana (Nimako et al., 2013; Oduro & Tawiah, 2012), and one each in Ethiopia (Woldesemayat et al., 2018), Malawi (Price et al., 2018), Uganda (Mugisha et al., 2016) and Togo (Gbeasor-Komlanvi et al., 2020). On the other hand, of the nine multi country studies, seven (n=7) were based on the World Health Organisation Study on Global Ageing and Adult Health (WHO SAGE) dataset, reporting findings for Ghana and South Africa, while one analysed data from the World Health Survey (WHS) reporting findings for Burkina Faso, Ghana, Kenya, Namibia and South Africa. There was one study; a PhD thesis, that analysed both the WHO SAGE and WHS datasets (Morgan, 2017). The WHS is a cross-sectional survey conducted by WHO, collecting data on various aspects of health across all age groups in different populations, providing a comprehensive overview of health status. In contrast, the WHO SAGE specifically focuses on the health, social, and economic determinants of aging in individuals aged 50 and above, aiming to inform policies for healthy ageing.

The studies were conducted across a range of settings; sixteen (n=16) were national surveys with nationally representative data, eleven (n=11) were

community surveys focusing on specified geographical areas/ communities and ten (n=10) obtained data from health care facilities. Seven (n=7) of the facility-based studies were carried out in hospitals, two (n=2) in primary healthcare facilities and one (n=1) in community pharmacies. Most studies (n=24) included participants from both rural and urban areas, while nine were focused on urban areas and four specifically in rural areas. The samples ranged from 142 (Emeh et al., 2020) to 47 334 (Sharman & Bachmann, 2019). All studies included both males and females in their samples, except for only one study which specifically investigated health seeking behaviours of women living with NCDs (Aboyade et al., 2016). Table 1 provides a detailed summary of the characteristics of the reviewed articles.

Table 1: Characteristics of Included Studies

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
Community Based Studies									
1	Aboyade (2016)	South Africa	Urban	To explore the health-seeking behaviour, healthcare practices and prevalence of traditional herbal medicine use among older women self-reporting noncommunicable diseases.	Cross-sectional. A sub-sample of participants from the South African arm of a large prospective study-the PURE study	2016	250	≥50	100.0
2	Chang (2019)	South Africa	Rural	To enhance the evidence base on multimorbidity by developing a comprehensive portrait of the epidemiology of multimorbidity in a rural South	Cross-sectional analysis of survey data from Health and Ageing in Africa: A longitudinal study of an INDEPTH Community in South Africa Programme (HAALSI)	2014-2015	3889	≥40	54.8
3	Emeh (2020)	Cameroon	rural & urban	To identify the major health problems affecting elderly people, determine the morbidity pattern and to identify the impact of age on	Cross-sectional community study among adults aged 60 years and above	2012	142	≥60	57.7

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
				functional habits among the elderly people in the Buea Health District	in the Buea Health District				
4	Gaziano (2017)	South Africa	Rural	To assess the prevalence of Cardio Metabolic Disease (CMD) risk factors and symptomatic CMDs and to measure the 10-year CMD risk in a large rural South African population.	Cross-sectional nested within a cohort study of Health and Ageing in Africa: A longitudinal study of an INDEPTH Community in South Africa Programme (HAALSI)	2015	5059	≥40	53.6
5	Hien (2014)	Burkina Faso	Urban	To assess the prevalence and distribution patterns of multimorbidity among urban older adults in Burkina Faso	Cross sectional study among community dwelling adults in the city of Bobo-Dioulasso.	2012	389	≥60	44.7
6	Mugisha (2016)	Uganda	rural & urban	To describe the prevalence of chronic diseases, including angina, arthritis, chronic obstructive pulmonary disease, depression, diabetes mellitus, and hypertension, stroke and vision problems in older people living with and without HIV.	Cross sectional analysis of data from the second wave of the Longitudinal World Health Organisation Study on Global AGEing and Adult Health (SAGE) - Wellbeing of Older People Study (WOPS).	2012-2013	471	≥50	62.6

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
7	Odland (2020)	Burkina Faso	rural & urban	To investigate the prevalence and associations (including important down-stream consequences of multimorbidity including frailty, disability, quality of life and other measures of physical performance) among middle-aged and older individuals in a rural, very low income setting in Burkina Faso.	Cross-sectional analysis of data from the baseline wave of the CRSN Heidelberg Aging Study (CHAS) in the Nouna HDSS area.	2018	2604	≥40	50.1
8	Pengpid (2020)	South Africa	rural	To investigate the relationship between poor mental health and socio-demographic factors, health variables, and chronic conditions among rural middle-older persons in South Africa	Cross-sectional analysis of baseline data from the Health and Ageing in Africa: Longitudinal Study of an INDEPTH community in South Africa Programme (HAALSI).	2015	5059	≥40	53.6
9	Price (2018)	Malawi	rural & urban	To investigate the burden of diabetes, overweight and obesity, hypertension and multimorbidity, their treatment, and their associations with	Cross-sectional survey conducted in two sites; rural survey nested in the Karonga Health and Demographic Surveillance Site, urban survey	2013-2016	28891	≥18	62.0

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
				lifestyle and other factors in Malawi	conducted in Lilongwe.				
10	Sharman (2019)	South Africa	Rural	To describe changes in prevalence of hypertension, diabetes, HIV and TB, and prevalence of comorbidity, and to investigate associations between each condition, and combination of conditions, with self-reported general health and hospital admission	Cohort study using data from a longitudinal population based HIV and health surveillance study conducted by the Africa Health Institute (AHRI) based in Umkhanyakude district of rural KwaZulu Natal, South Africa.	2009-2015	47334	≥15	53.0
11	van Heerden (2017)	South Africa	rural & urban	To characterise the prevalence of NCD risk factors and depression, stratified by HIV status, in a high HIV prevalence setting.	Cross-sectional single site study, conducted in rural and peri-urban South Africa following a prospective multicounty cohort study for HIV testing and care.	2011-2012	570	≥18	69.0
Facility Based Studies									
12	Cadmus (2017)	Nigeria	Urban	To describe the morbidity profile and its determinants among older persons who	Cross-sectional descriptive study. Data obtained from hospital records in a	2013-2014	4886	≥60	60.0

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
				presented at an established geriatric centre in southwestern Nigeria.	Geriatric Centre in south-western Nigeria.				
13	Fakoya (2018)	Nigeria	rural & urban	To assess the quality of life (QoL) and its determinants in elderly patients attending a general practice clinic in Southwest Nigeria	Cross-sectional descriptive study conducted among elderly patients attending a general practice clinic of Wesley Guild Hospital	2013	216	≥60	72.2
14	Gbeasor-Komlanvi (2020)	Togo	urban	To assess the prevalence of polypharmacy and its associated factors among community-dwelling elderly in Lome, Togo in 2017.	Cross sectional study among community dwelling elderly persons who visited 53 of the 117 registered community pharmacies in Lome, Togo.	2017	370	≥60	54.9
15	Isaacs (2014)	South Africa	Urban	To determine the disease profile and cost of treating patients at 10 facilities in the western half of the Cape Town Metropole	Cross-sectional study. Data collected from patients 18 years and older, attending 10 community health centres in the western half of Cape Town metropole	2011	4184	≥18	64.7

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
16	Lalkhen (2015)	South Africa	rural & urban	To measure the current degree of multimorbidity among patients diagnosed with NCDs in South Africa	Cross-sectional. Analysed data from South African Primary Healthcare Morbidity Survey, a survey of consultations in primary care in four provinces; Western Cape, Northwest, Northern Cape and Limpopo.	2010	5793	Unclear	66.6
17	Nimako (2013)	Ghana	urban	To determine the prevalence of multimorbidity and its associated risk factors among adult patients presenting to an inner city clinic in Ghana	Cross-sectional survey undertaken among patients presenting to Tema General Hospital in the Accra Region, Ghana.	2012	1399	≥18	69.5
18	Nwani (2016)	Nigeria	Urban	To determine the frequency of occurrence and the patterns of chronic diseases and multimorbidity among elderly inpatients.	Longitudinal prospective study, focused on elderly patients who were admitted to the medical wards of the Nnamdi Azikiwe University Teaching Hospital in Nigeria over a period of 12 months.	2009	345	≥65	35.9

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
19	Oduro (2012)	Ghana	Urban	To statistically identify significantly occurring clusters of chronic diseases (i.e. multimorbidity patterns) among elderly patients and determine their impact on the length of hospitalisation until death and on mortality among elderly patients.	Cross-sectional analyses based on data from patients aged 50 years and older seen in general clinic consultation at Kwadaso S.D.A Hospital from October 2011 to July 2012.	2011-2012	984	≥50	57.7
20	Petersen (2019)	South Africa	Urban	To identify the risk correlates for coexisting common mental disorders in the chronic care population in South Africa, with the view to identifying particularly vulnerable patient populations	Cross-sectional facility detection survey conducted by the Programme for Improving Mental Health Care, among patients 18 years and older, attending the clinic for treatment for a chronic illness in three large facilities in the Dr Kenneth Kaunda District in the Northwest Province, South Africa.	2014-2015	2549	≥18	76.0

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
21	Woldesemayat (2018)	Ethiopia	rural & urban	To describe the prevalence of noncommunicable chronic diseases and multimorbidity among patients who attended the outpatient department of Hawassa University Comprehensive Specialized Hospital (HUCSH).	Cross-sectional study conducted among adult patients attending outpatient department at Hawassa University Comprehensive Specialised Hospital	2016	411	≥18	43.1
National Surveys									
22	Afshar (2015)	Multi country Burkina Faso Ghana Kenya Namibia South Africa	rural & urban	To compare the prevalence of MM across (LMICs), and to investigate patterns by age and education, as a proxy for socio-economic status (SES).	Cross-sectional. Analysed data from World Health Survey, a multinational study of 28 countries, of which five are in SSA.	2001-2004	 4948 4165 4640 4379 2629	≥18	 52.8 50.9 51.2 53 52

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
23	Agrawal (2016)	Multi country Ghana South Africa	rural & urban	To evaluate the prevalence of NCD multimorbidity by overweight/ obesity status, based on a list of nine chronic conditions and investigate the association between body mass index and prevalence of multimorbidity in six LMICs.	Cross-sectional analysis of data from the WHO Study on Global Ageing and Adult Health (SAGE) Wave 1 (2007-2010). SAGE is a longitudinal study with nationally representative samples of adults in six LMICs, of which 2 are in SSA.	2007-2010	 5571 4227	≥18	 48.8 57
24	Alaba (2013)	South Africa	rural & urban	To determine the prevalence of MM and examine its association with various social determinants of health in South Africa.	Cross-sectional. Analysed data from the first wave of the South African National Income Dynamics Study (SA-NIDS), a nationally representative panel survey conducted by the South African Labour and Development Research Unit.	2008	11638	≥18	61

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
25	Arokiasamy (2015)	Multi-country Ghana South Africa	rural & urban	Examines the prevalence and correlates of multimorbidity as well as the associations between multimorbidity and self-rated health, activities of daily living (ADLs), quality of life, and depression across six LMICs.	Cross-sectional analysis of data from the WHO Study on Global Ageing and Adult Health (SAGE) Wave 1 (2007-2010). SAGE is a longitudinal study with nationally representative samples of adults from six LMICs, of which 2 are in SSA.	2007-2010	 5108 4221	≥18	 50 52.8
26	Garin (2016)	Multi-country Ghana South Africa	rural & urban	To identify and describe multimorbidity patterns in low, middle, and high income countries	Cross Sectional. Analysed nationally representative data from the Collaborative Research on Ageing in Europe project - Finland, Poland, and Spain (COURAGE) and the World Health Organization's Study on Global Ageing and Adult Health -China, Ghana, India, Mexico, Russia, and South Africa (WHO SAGE).	2007-2010	 4305 3836	≥50	 47.55 55.95

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
27	Keetile (2020)	Botswana	rural & urban	To assess prevalence and correlates of multimorbidity among the adult population in Botswana	Cross sectional. Analysed data from Botswana Chronic Noncommunicable diseases Study of 2016.	2016	1178	≥15	69.1
28	Kunna (2017)	Ghana	rural & urban	To examine inequalities in the socioeconomic distribution of single and multiple NCDs in adults aged 50 and over in China and Ghana.	Cross sectional. Analysed data from nationally representative data from the World Health Organisation Study on Global AGEing and Adult Health (SAGE) Wave 1, focusing on adults aged 50 and over in China and Ghana	2007-2010	4050	≥50	47.2
29	Lee (2015)	Multi country Ghana South Africa	rural & urban	To look at the socio-demographic correlates of NCD multimorbidity, and examine the impact of NCD multimorbidity on healthcare utilisation and out-of-pocket expenditure	Cross sectional. Analysed data from nationally representative data from the World Health Organisation Study on Global AGEing and Adult Health (SAGE) Wave 1.	2007-2010	 4873 3243	≥18	 49.9 54.1

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
30	Letamo (2017)	Botswana	rural & urban	To estimate the prevalence of self-reported chronic noncommunicable diseases and their correlates in Botswana	Cross sectional. Analysed data from the Botswana AIDS impact Survey (BAIS IV), a nationally representative survey that provides information on current HIV prevalence and incidence.	2013	2153	10-64	57.4
31	Mall (2014	South Africa	rural & urban	To obtain estimates of the relationship between days out of role and comorbid physical and mental health conditions in the South African context, and offer directions for policymakers in designing interventions that address comorbid physical and mental conditions	Cross sectional. Secondary analysis of data from the South African Stress and Health Study (SASH), a nationally representative survey of individuals aged 18 years and above.	2002-2004	4351	≥18	n/a
32	Morgan (2017)	Multi country Burkina Faso	rural & urban	To examine the distribution of multimorbidity (by age) in LMICs and compare this to HICs and to	Cross-sectional. Analysed data from World Health Survey, a multinational study	2002-2004	4948 4165	≥18	52.8 50.9

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
	Study 1	Ghana Kenya Namibia South Africa Ghana		examine the sociodemographic determinants of multimorbidity, and how this varies by age in LMICs	of 28 countries, of which five are in SSA.		4640 4379 2629		51.2 53 52
	Study 2	Multi country Ghana South Africa	rural & urban	To examine how multimorbidity, defined as two or more chronic conditions varies by urban living across SAGE countries.	Cross-sectional analysis of data from the WHO Study on Global Ageing and Adult Health (SAGE) Wave 1 (2007-2010). SAGE is a longitudinal study with nationally representative samples of adults from six LMICs, of which 2 are in SSA.	2007-2010	5573 4227	≥18	50.4 52.8
33	Phaswana-Mafuya (2013)	South Africa	rural & urban	To investigate the self-reported prevalences of major chronic NCDs and predictors among older South Africans.	Cross sectional. Secondary analysis of data from the World Health Organization (WHO) Study on Global Ageing and Adult	2008	3836	≥50	58

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
					Health (SAGE Wave 1) in 2008.				
34	Stubbs (2018)	Multi country Ghana South Africa	rural & urban	To assess whether a variety of chronic conditions and multimorbidity are associated with higher perceived stress levels among community dwelling older adults using nationally representative data from six LMICs	Cross sectional. Secondary analysis of data from the World Health Organization (WHO) Study on Global Ageing and Adult Health (SAGE Wave 1) from six LMICS of which 2 are from SSA.	2007-2010	4305 3838	≥50	47.6 55.9
35	Sum (2019)	Multicountry Ghana South Africa	rural & urban	To investigate the prevalence of NCD dyad and triad combinations, and the implications of different NCD dyad combinations on healthcare utilisation and quality of life.	Cross sectional. Used data from the World Health Organization (WHO) Study on Global Ageing and Adult Health (SAGE Wave 1).	2007-2010	5067 3477	≥18	 47.35 60.28
36	Waterhouse (2017)	South Africa	rural & urban	To examine the relationship between multi-morbidity and disability in older adults, and whether hypertension (diagnosed or undiagnosed)	Cross sectional. Analysed data from the South African Study on Global Ageing and Adult Health (SAGE Wave 1) in 2008, which is a	2007-2008	3055	≥50	60.4

No	Author (Year)	Country	Rural/Urban	Primary Study purpose	Study Design & Data Source	Data Collection Period	Sample Size	Age	Gender (%) Female
				mediates this relationship. Finally, it examines whether socio-demographic factors affect multi-morbidity's disability impact.	part of a Longitudinal Survey Programme in WHO's multicountry survey of six LMICs.				
37	Weimann (2016)	South Africa	rural & urban	To study the epidemiology of selected chronic infectious and noncommunicable diseases and multimorbidity, and the association with socioeconomic disadvantage in South Africa.	Cross-sectional. Analysed data from Wave 1 (2008) and Wave 3 (2012) of the South African National Income Dynamics Study (SA-NIDS), a nationally representative panel survey conducted by the South African Labour and Development Research Unit.	2008 & 2012 Wave 1 Wave 3	 18526 20015	≥15	 55.31 55.72

4.4.3 Quality Assessment

The Joanna Briggs Institute Critical Appraisal Checklist for Studies reporting Prevalence Data (Munn et al., 2015) was used to evaluate the methodological quality of the 37 included studies.

- 23 studies attained a score between 8-10 and were ranked as good quality studies (Agrawal & Agrawal, 2016; Arokiasamy, Uttamacharya, Jain, Biritwum, Yawson, Wu, Guo, Maximova, Espinoza, Rodriguez, et al., 2015; Cadmus et al., 2017; A. Y. Chang et al., 2019; Fakoya et al., 2018; Garin et al., 2016; Gbeasor-Komlanvi et al., 2020; Hien et al., 2014; Kunna et al., 2017; Lee et al., 2015; Morgan, 2017; Mugisha et al., 2016; Negin et al., 2012; Nimako et al., 2013; Odland et al., 2020; Pengpid & Peltzer, 2020; Petersen et al., 2019; Phaswana-Mafuya et al., 2013; Price et al., 2018; Stubbs et al., 2018; Sum et al., 2019; van Heerden et al., 2017; Waterhouse et al., 2017; Woldesemayat et al., 2018)

- 12 studies scored between 5-7, and were classified as moderate quality studies (Aboyade et al., 2016; Afshar et al., 2015; Alaba & Chola, 2013a; Emeh et al., 2020; Gaziano et al., 2017; Isaacs et al., 2014; Keetile et al., 2020; Letamo et al., 2017; Mall et al., 2014; Nwani & Isah, 2016; Oduro & Tawiah, 2012; Weimann et al., 2016)

- 2 studies scored below 5 and were classified as poor quality studies (Lalkhen & Mash, 2015; Sharman & Bachmann, 2019)

Studies which were categorised as ‘good quality’ provided details on characteristics of their target populations and clearly described their sampling methods. The majority of these studies analysed secondary data from representative samples. For example, studies which utilised datasets from national surveys had nationally representative samples. These studies also used objective, standard criteria for measuring chronic conditions. This includes a combination of medical records reviews, physical assessments/examinations, laboratory tests, medication/ prescription records reviews and the use of symptom algorithms. It was reported in these studies that standardised data collection tools were used, some translated to local languages with transparent protocols and that data collectors were trained on the instruments and data collection procedures prior to data collection. Additionally, the studies described their statistical analysis approach, and described how multimorbidity prevalence was measured.

In the moderate and poor quality studies I identified, participants were not selected randomly, or researchers used convenience samples. Some studies did not give sufficient details on their recruitment strategies, and these were given an ‘unclear’ score. Many studies did not give sufficient information on coverage bias. More than half of these studies did not give details on non-responses, how they differed or were similar to those who responded and whether that could have had an impact on the study results. For example, studies that scored “yes” in this item showed that there were no dropouts, refusal or missing data. For those that showed missing data they elaborated on the characteristics of the missing data or gave a reference for further details. Moreover, the majority of these studies either solely depended on self-reported data or it was unclear how conditions were ascertained and did not provide sufficient details on who the data collectors were, and if they were trained on the data collection instruments. Table 2 provides a summary of the rankings of the included studies.

Table 2: Summary of Quality Assessment of Included Studies

Author (Year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total		
											Y	N	U
1. Aboyade (2016)	Y	U	N	Y	Y	N	Y	Y	U	Y	6	2	2
2. Afshar (2015)	Y	U	Y	U	U	N	U	Y	Y	Y	5	1	4
3. Agrawal (2016)	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	9	0	1
4. Alaba (2013)	Y	Y	Y	Y	N	N	U	Y	Y	Y	7	2	1
5. Arokiasamy (2015)	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	9	0	1
6. Cadmus (2017)	Y	Y	Y	Y	Y	Y	Y	N	N	Y	8	2	0
7. Chang (2019)	Y	Y	Y	Y	Y	Y	U	Y	Y	Y	9	0	1
8. Emeh (2020)	Y	Y	Y	Y	Y	Y	U	U	N	Y	7	1	2
9. Fakoya (2018)	Y	Y	Y	Y	Y	U	U	Y	Y	Y	8	0	2
10. Garin (2016)	Y	Y	Y	N	U	Y	Y	Y	Y	Y	8	1	1
11. Gaziano (2017)	Y	Y	Y	Y	U	Y	Y	N	U	Y	7	1	2
12. Gbeasor-Komlanvi (2020)	Y	N	Y	Y	Y	N	Y	Y	Y	Y	8	2	0
13. Hein (2014)	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	9	0	1
14. Isaacs (2014)	Y	N	Y	Y	U	Y	Y	U	N	N	5	3	2

Author (Year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total		
											Y	N	U
15. Keetile (2020)	N	Y	Y	Y	U	N	Y	Y	Y	Y	7	2	1
16. Kunna (2017)	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	9	0	1
17. Lalkhen (2015)	N	N	U	N	U	Y	Y	Y	N	N	3	5	2
18. Lee (2015)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	9	1	0
19. Letamo (2017)	Y	Y	Y	Y	U	N	U	Y	Y	Y	7	1	2
20. Mall (2014)	Y	Y	Y	N	U	N	Y	Y	Y	Y	7	2	1
21. Morgan (2017)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10	0	0
22. Mugisha (2015)	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	9	0	1
23. Nimako (2013)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	9	1	0
24. Nwani (2015)	Y	Y	U	Y	Y	Y	U	Y	N	Y	7	1	2
25. Odland (2020)	Y	Y	Y	Y	N	N	Y	Y	Y	Y	8	2	0
26. Oduru (2012)	U	U	Y	N	Y	U	U	Y	Y	Y	5	1	4
27. Pengpid (2020)	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	9	0	1
28. Petersen (2017)	N	Y	Y	Y	Y	N	Y	Y	Y	Y	8	2	0
29. Phaswana- Mafuya (2013)	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	9	0	1
30. Price (2018)	N	Y	Y	Y	Y	Y	U	Y	Y	Y	8	1	1

Author (Year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total		
											Y	N	U
31. Sharman (2019)	U	U	Y	N	U	N	U	Y	Y	Y	4	4	2
32. Stubbs (2017)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10	0	0
33. Sum (2019)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10	0	0
34. Van Heerden (2017)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10	0	0
35. Waterhouse (2017)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	9	1	0
36. Weimann (2016)	Y	U	Y	Y	Y	N	U	Y	Y	Y	7	1	2
37. Woldesemayat (2018)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10	0	0

Legend:

Abbreviations: Y= Yes; N= No; U= Unclear; Q= Questions

Low risk of bias= 8-10

Moderate risk of bias= 5-7

High risk of bias =0-4

4.4.4 Definition and Measurement of Multimorbidity in SSA

The majority of the studies (n=27), defined multimorbidity as the coexistence of two or more conditions, with two other studies having another definition where multimorbidity was defined as the presence of chronic conditions from one or two categories or domains (A. Y. Chang et al., 2019) (Odland et al., 2020). Although the remaining ten studies did not explicitly state the concept of multimorbidity, they reported the proportion of participants with two or more chronic conditions, or we were able to estimate the prevalence of multimorbidity based on the information provided. For example, a study conducted in a peri-urban South African community, was primarily interested in investigating the health-seeking behaviour and healthcare practices of elderly women living with noncommunicable diseases (Aboyade et al., 2016). Women who reported two or more of the listed NCDs, were considered to have a comorbid NCD.

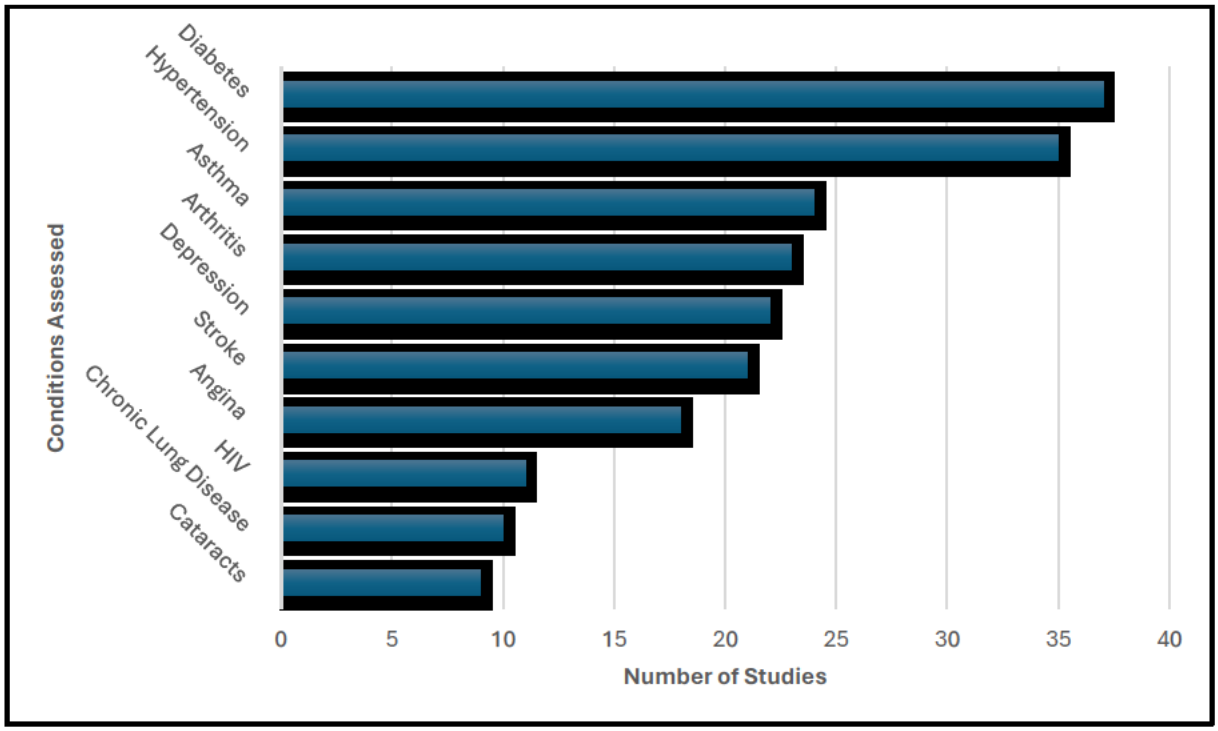
Over half of the studies that provided a definition of multimorbidity, referenced sources such as van den Akker (van den Akker et al., 1996), Fortin (Fortin et al., 2012), Marengoni (Marengoni et al., 2011), WHO Report on Multimorbidity (World Health Organization, 2016) and Academy of medical Sciences (Sciences, 2018). The Academy of Medical Sciences definition was used in two studies that included HIV and categorised all the assessed conditions into three domains; noncommunicable diseases, communicable diseases and mental health/ disorders (A. Y. Chang et al., 2019; Odland et al., 2020).

The number of conditions included in the count varied considerably, ranging from a minimum of three (3) conditions to a maximum of thirty (30) conditions, with only one study giving an inconclusive number of conditions assessed (Emeh et al., 2020). The study with the least number of conditions was a secondary analysis of national survey data from the Botswana AIDS Impact Survey IV of 2013 (Letamo et al., 2017), while the study with the highest number of conditions was a hospital-based study conducted in Nigeria (Nwani & Isah, 2016). Studies conducted in health care facilities included a higher number of conditions compared with national and community surveys. The median number of conditions included in facility-based studies was 13 (IQR 11.5-16.5), followed by community surveys with a median of 9 (IQR 5.0-10.3) and national surveys 8 (IQR 6.0-9.0).

Multimorbidity measures are not only influenced by the number of conditions included in the measure, but also in large part by the type of conditions included in the measure. While the majority of the studies had a pre-defined list of conditions to assess, only a handful provided a justification for why specific conditions were selected. The reasons provided included availability of data, more especially for studies that utilised population survey datasets (Afshar et al., 2015; Stubbs et al., 2018), based on prior multimorbidity studies (A. Y. Chang et al., 2019; Hien et al., 2014; Sum et al., 2019) and lastly other studies reported that they selected the most prevalent conditions in the study area (A. Y. Chang et al., 2019; Garin et al., 2016; Nimako et al., 2013; Weimann et al., 2016).

The included studies considered a wide range of chronic conditions in the measurement of multimorbidity. Just over half of the studies (n=19) included both physical and mental conditions in their measure, while five studies (n=5) assessed only physical conditions. The most frequently included mental health conditions were depression (n=9), anxiety (n=5), and dementia (n=4). With respect to communicable diseases, around a third of the studies (n=13) included HIV and tuberculosis in their measure. Furthermore, while some studies gave a clear diagnosis such as heart failure (Pengpid & Peltzer, 2020), other studies presented a broader category of conditions like cardiovascular disease (Mall et al., 2014) or heart disease (Odland et al., 2020). The most common conditions that were included in the assessment of multimorbidity were diabetes, hypertension, arthritis, asthma, depression, stroke, COPD and HIV. Figure 4 provides the top 10 assessed conditions in the included studies.

Figure 4: Top 10 Conditions Included in Multimorbidity Studies in SSA



Chronic conditions were ascertained in various ways across the different studies. The majority of studies (n=23) relied on self-reported information combined with review of medical records and/ or prescription information, and clinical assessments. Seven studies (n=7) exclusively relied on self-reported information, five (n=5) reviewed medical records alone, and only one study established the presence of chronic conditions through clinical assessment alone (van Heerden et al., 2017). All studies except for one (Oduro & Tawiah, 2012) used a simple count of conditions to estimate the prevalence of multimorbidity from a pre-determined list of conditions.

4.4.5 Prevalence of chronic disease multimorbidity among adults in SSA.

The reported prevalence of multimorbidity in the included studies varied considerably, and are reported in Table 3a-c. The overall prevalence across the 37 included studies ranged from 1.4% in a PhD study that examined how multimorbidity varied by urban settings in six LMICs (Morgan, 2017), to 69.4% in a rural South African community among adults aged 40 years and older (A. Y. Chang et al., 2019). To allow for comparability of results among the six countries in the study by Morgan, the prevalence rates were age-standardized to the WHO Standard Population; this led to a reported prevalence of 1.4% for Ghana and 4.7% for South Africa.

Two studies both conducted in South Africa in different populations, reported multimorbidity prevalence for two different time points. These studies included similar conditions in their multimorbidity measure, focusing on participants aged 15 years and over. Using nationally representative data from the South African National Income Dynamics Panel, one study reported that the prevalence of multimorbidity in 2008 was 2.7% and 2.8% in 2012, showing an increase of only 0.4% over 4 years. (Weimann et al., 2016). In contrast, another study which evaluated multimorbidity in a rural community of a sample of 47,337 individuals, reported a prevalence of 8.4% in 2009 and 13.2% in 2015, showing an increase of around 4.8% in this community over a period of 6 years.

Among the sixteen national surveys, the prevalence ranged from 1.4% to 64.9% with a median prevalence of 9.2% (IQR 4.2-22.5). As previously stated, the WHO SAGE and WHS datasets were utilised across multiple studies. Interestingly, the prevalence estimates reported in the two studies that analysed WHS data were similar (Afshar et al., 2015; Morgan, 2017). These studies included persons aged 18 years and older and assessed similar six conditions. In contrast, studies which used the WHO SAGE dataset reported varying results across the studies. For example, one study included participants aged 18 years and older, assessed 9 chronic conditions among 5571 participants in Ghana and 4227 in South Africa, and reported a prevalence of 23% and 32% respectively (Agrawal & Agrawal, 2016). Another study, using similar data and including 13 conditions, explored multimorbidity prevalence among participants aged 50 years and older; 4305 participants in Ghana and 3838 in South Africa. The estimated prevalence was 47.6% in Ghana and 64.9% in South Africa (Stubbs et al., 2018). Table 3 shows prevalence of multimorbidity for national studies.

Prevalence by Study Setting

Majority of the studies, as indicated earlier, were predominantly conducted in South Africa, with only a few others coming from 11 other countries in the region. As shown in Table 4, the prevalence for community-based studies ranged from 3.4% [28] and 69.4% [37]. The lower prevalence was reported in a study conducted in Malawi, which explored the burden of multimorbidity of three conditions (overweight/obesity, hypertension, and diabetes), and its association with lifestyle factors among adults

aged 18 years and over in two sites; one urban and one rural. In contrast, a study carried out in a rural community in South Africa among adults aged 40 years and older, and included ten chronic conditions, and used the same data as two previous studies [42, 50]. Although they estimated prevalence in the same age range of 40 years and over, Chang and colleagues included different conditions in their measurements, in terms of number and type. As indicated earlier, Chang included ten conditions and the reported prevalence was 69.4%, Gaziano assessed nine conditions and reported a prevalence of 55.7%, while Pengpid evaluated a higher number of thirteen conditions, and the prevalence was 56%. While Chang included mental health conditions such as depression, PSTD and alcohol dependence, the other two studies did not. Conditions which were included across all the three studies were hypertension, dyslipidaemia, HIV, diabetes and angina. The median prevalence in this group of studies was 38.3% (IQR 20.4-56.0). Community surveys predominantly featured smaller sample sizes, adults aged 40 and above and multimorbidity assessment included between 3 and 15 conditions.

Conversely, facility-based studies generally had smaller sample sizes primarily falling below 1000 or between 1000 and 10000.These studies reported a higher prevalence compared to the other two settings (national and community surveys), ranging from 17.8% [27] to 57.6% [30] with a median of 48.7% (IQR 36.0-51.8). Methodologically, all the studies used a combination of self-reported information, medical records and/ or prescription reviews, as well as clinical evaluation, and around 40% investigated multimorbidity in older adults aged 60 years and over [19-21, 30]. A summary of prevalence estimates in facility-based studies included in this review is presented in Table 5.

Prevalence by Rural Urban Residence

Of the 24 studies conducted in both rural and urban areas across the three settings, only a third reported prevalence estimates by residence, and they were all national surveys (n=8). The median prevalence was higher in urban residence at 8.3% (IQR 4.9-19.8), while in rural residence it was 4.4% (IQR 2.9-11.6). Appendix 4 shows the prevalence of multimorbidity by residence.

Table 3: Prevalence of Multimorbidity in National Surveys

No	Author (Year)	Country	Sample Size	Age	Definition of Multimorbidity	Type of Multimorbidity Measure	Number of Conditions	Proportion with multimorbidity (n/N)	Prevalence of multimorbidity % (95% CI)
1	Afshar (2015)	Burkina Faso Ghana Kenya Namibia South Africa	4948 4165 4640 4379 2629	≥18	The presence of two or more chronic diseases.	Self-reported, Simple count	6	n/a n/a n/a n/a n/a	6.3 (5.6-7.0) 3.6 (3.0-4.2) 4.2 (3.6-4.8) 7.9 (7.0-8.8) 11.2 (9.8-12.5)
2	Agrawal (2016)	Ghana South Africa	5571 4227	≥18	Concurrent occurrence of two or more of the nine chronic health conditions in the same individual	Self-reported diagnoses, symptom-based assessment, treatment & medication in the last 12 months, physical examination Simple count	9	1156/5529* 878/4148*	23 32
3	Alaba (2013)	South Africa	11638	≥18	Two or more chronic diseases in an individual.	Self-reported Simple count	6	463/11638	4
4	Arokiasamy (2015)	Ghana South Africa	5108 4221	≥18	The simultaneous presence of two or more chronic physical health conditions.	Self-reported diagnoses, symptom-based assessment, treatment & medication in the last 12 months, physical examination. Simple count	8	n/a	22.0 (19.3-25.1) 22.5 (18.2-27.4)

No	Author (Year)	Country	Sample Size	Age	Definition of Multimorbidity	Type of Multimorbidity Measure	Number of Conditions	Proportion with multimorbidity (n/N)	Prevalence of multimorbidity % (95% CI)
5	Garin (2016)	Ghana South Africa	4305 3836	≥50	Having at least two of the twelve chronic conditions.	Self-reported diagnoses, symptom-based assessment, treatment & medication in the last 12 months, physical exam. Simple count & factor analysis to investigate multimorbidity patterns.	12	2050/4305* 2376/3836*	48.3 63.44
6	Keetile (2020)	Botswana	1178	≥15	The presence of two or more chronic NCD conditions in an individual.	Self-reported Simple count	10	63/1178	5.4
7	Kunna (2017)	Ghana	4050	≥50	Two or more of the eight specified chronic conditions.	Self-report symptoms-based algorithms treatment & medication in the last 12 months, physical exam Simple count	8	1222/4050	30.2
8	Lee (2015)	Ghana South Africa	4873 3243	≥18	The presence of two or more of the listed conditions without a specific reference condition.	Self-report symptoms-based algorithms treatment & medication in the last 12 months, physical exam Simple count	9	n/a	3.9 (3.0-4.9) 9.2 (6.7-11.7)
9	Letamo (2017)	Botswana	2153	10-64	Two or more conditions.	Self-reported Simple count	3	57/2153	2.6

No	Author (Year)	Country	Sample Size	Age	Definition of Multimorbidity	Type of Multimorbidity Measure	Number of Conditions	Proportion with multimorbidity (n/N)	Prevalence of multimorbidity % (95% CI)
10	Mall (2014)	South Africa	4351	≥18	Reported comorbidity of mental and physical conditions	Mental disorders: diagnosed by interviewer (using the SASH measuring instrument during 3-4-hour interview) Physical disorders: self-reported Simple count	10	n/a	42.1
11	Morgan (2017) Study 1	Burkina Faso	4948	≥18	The co-occurrence of two or more chronic conditions within an individual.	Self-reported, Simple count	6	n/a	6.3 (5.6-7.0)
		Ghana	4165					n/a	3.6 (3.0-4.2)
		Kenya	4640					n/a	4.2 (3.6-4.8)
		Namibia	4379					n/a	7.9 (7.0-8.8)
		South Africa	2629					n/a	11.2 (9.8-12.5)
	Study 2	Ghana	5573	≥18	The co-occurrence of two or more chronic conditions within an individual.	Self-reported diagnoses, symptom-based assessment, treatment & medication in the last 12 months, physical exam	7	n/a	1.4 (1.1-1.7)
		South Africa	4227					n/a	4.7 (4.0-5.4)

No	Author (Year)	Country	Sample Size	Age	Definition of Multimorbidity	Type of Multimorbidity Measure	Number of Conditions	Proportion with multimorbidity (n/N)	Prevalence of multimorbidity % (95% CI)
12	Phaswana-Mafuya (2013)	South Africa	3836	≥50	Two or more chronic conditions.	Self-reported diagnoses, symptom-based assessment, treatment & medication in the last 12 months, physical exam. Simple count	8	829/3638	22.5
13	Stubbs (2018)	Ghana South Africa	4305 3838	≥50	Two or more chronic conditions.	Self-report symptom-based algorithms, treatment & medication in the last 12 months, physical exam Simple count	13	n/a n/a	47.6 64.9
14	Sum (2019)	Ghana South Africa	5067 3477	≥18	Two or more NCDs.	Self-report symptoms-based algorithms treatment & medication in the last 12 months, physical exam Simple count	9	n/a n/a	17.18 17.72
15	Waterhouse (2017)	South Africa	3055	≥50	The coexistence of two or more diseases.	Self-report symptoms-based algorithms, physical measurement of BP Simple count	9	394/3055	12.9
16	Weimann (2016)	South Africa Wave 1	18526	≥15	The presence of two or more chronic health conditions existing	Self-reported diagnosis Measurements of blood pressure height	4	n/a	2.73 (2.50-2.98)

No	Author (Year)	Country	Sample Size	Age	Definition of Multimorbidity	Type of Multimorbidity Measure	Number of Conditions	Proportion with multimorbidity (n/N)	Prevalence of multimorbidity % (95% CI)
					simultaneously in an individual.	and weight Simple count			
		Wave 3	20015					n/a	2.84 (2.61-3.08)

Table 4: Prevalence of Multimorbidity in Community Surveys

No	Author	Country	Sample Size	Age	Definition of Multimorbidity	Type of Multimorbidity Measure	Number of Conditions	Proportion with multimorbidity (n/N)	Prevalence of multimorbidity % (95% CI)
1	Aboyade (2019)	South Africa	250	≥50	Women were considered to have a comorbid NCD if they reported two or more diagnoses of the mentioned NCDs.	Self-reported. Simple count.	9	98/250	39.2
2	Chang (2019)	South Africa	3889	≥40	(i) The presence of more than one condition (ii) The presence of more than one category of conditions.	Self-reported, clinical evaluation. Simple count.	10	2700/3889	69.4 (68.0-70.9)
3	Emeh (2020)	Cameroon	142	≥60	Not explicitly defined, reports on the proportion of participants with two or more conditions	Self-reported, clinical evaluation, medical records. Simple count.	7 (and others not stated)	51/142	35.9
4	Gaziano (2017)	South Africa	5059	≥40	Not explicitly defined, reports on the proportion of participants with two or more conditions	Self-reported, clinical evaluation. Simple count.	9	2820/5059	55.7
5	Hien (2014)	Burkina Faso	389	≥60	The co-occurrence of ≥2 chronic diseases in the same older adult	Self-reported, medical records review, clinical evaluation. Simple count.	15	252/389	65

No	Author	Country	Sample Size	Age	Definition of Multimorbidity	Type of Multimorbidity Measure	Number of Conditions	Proportion with multimorbidity (n/N)	Prevalence of multimorbidity % (95% CI)
6	Mugisha (2016)	Uganda	471	≥50	Not explicitly defined, reports on the proportion of participants with two or more conditions	Self-reported, clinical evaluation, laboratory tests. Simple count.	9	176/471	37.4
8	Odland (2020)	Burkina Faso	2604	≥40	The presence of two or more conditions (regardless of domain); two or more conditions, with atleast one in a different domain (discordant multimorbidity); or two or more conditions that are all in the same domain (concordant multimorbidity)	Self –reported, symptom-based assessment, blood tests. Simple count	11	n/a	22.8 (21.4-24.2)
9	Pengpid (2020)	South Africa	5059	≥40	Having 2 to 13 of the included conditions.	Self –reported, clinical evaluation. Simple count.	13	2267/5059**	56
10	Price (2018)	Malawi	28891	≥18	Two or more of the studied conditions.	Self-report, medical records review, clinical evaluation. Simple count	3	988/28891	3.4
11	Sharman (2019)	South Africa 2009 2015	47334	≥15	Not explicitly defined, reports on the proportion of participants with two or more conditions	Self-reported, current ongoing treatment within the last 12 months. Simple count.	4	n/a	 8.4 13.2

No	Author	Country	Sample Size	Age	Definition of Multimorbidity	Type of Multimorbidity Measure	Number of Conditions	Proportion with multimorbidity (n/N)	Prevalence of multimorbidity % (95% CI)
12	van Heerden (2017)	South Africa	570	≥18	Two or more of included conditions	Clinical evaluation, laboratory tests. Simple count.	5	n/a	56

Table 5: Prevalence of Multimorbidity in Facility-Based Studies

No	Author	Country	Sample Size	Age	Definition of Multimorbidity	Type of Multimorbidity Measure	Number of Conditions	Proportion with multimorbidity (n/N)	Prevalence of multimorbidity % (95% CI)
1	Cadmus (2017)	Nigeria	4886	≥60	Not explicitly defined, reports on the proportion of participants with two or more conditions	Medical records, laboratory test. Simple count	17	1517/4886	31
2	Fakoya (2018)	Nigeria	216	≥60	Not explicitly defined, reports on the proportion of participants with more than one condition.	Self-reported, physical assessment, medical records (prescription information). Simple count.	11	109/216	50.5
3	Gbeasor-Komlanvi (2020)	Togo	370	≥60	Two or more chronic diseases.	Self-reported/ caregiver reported. Medication information. Simple count.	15	213/370	57.6 (52.4-62.7)
4	Isaacs 2014)	South Africa	4184	≥18	"Comorbid script of conditions: Two or more chronic conditions".	Medical records, prescription records. Simple count.	13	2256/4184	53.9
5	Lalkhen (2015)	South Africa	5793	Unclear	The presence of two or more chronic conditions.	Medical records, clinical evaluation. Simple count.	6	2806/5793	48.4
6	Nimako (2013)	Ghana	1399	≥18	The co-existence of atleast two of the 13 pre-selected chronic conditions within the same individual.	Medical records, self-reported. Simple count.	13	n/a	38.8 (36.3-41.4)

No	Author	Country	Sample Size	Age	Definition of Multimorbidity	Type of Multimorbidity Measure	Number of Conditions	Proportion with multimorbidity (n/N)	Prevalence of multimorbidity % (95% CI)
7	Nwani (2015)	Nigeria	345	≥65	The co-occurrence of two or more chronic disease conditions in the same person at a specified time.	Medical records. Simple count.	30	169/345	49
8	Oduro (2012)	Ghana	984	≥50	Co-existence of two or more chronic diseases in the same individual	Medical records. Weighted Index (Factor Analysis)	13	n/a	52.2
9	Petersen (2017)	South Africa	2549	≥18	The presence of two or more disorders (physical and/or mental)	Self-reported, clinical evaluation (questionnaire). Simple count.	5	893/2549	35
10	Woldesemayat (2018)	Ethiopia	411	≥18	The presence of two or more of the noncommunicable chronic conditions.	Self-reported, medical records, clinical evaluation. Simple count.	18	73/411	17.8

4.4.6 Prevalence of multimorbidity by sample size

There was significant variation in the number of participants included in each of the prevalence studies in this review. The national surveys had sample sizes ranging from 1178 to 11638, while the community surveys had number of participants ranging from 142 to 47334. Facility-based studies had the most limited sample sizes, ranging from 216 to 5793. We divided the sample sizes into three categories; less than 1000, 1000-10 000 and over 10 000. Ten studies had sample sizes less than 1000, only 4 studies had sample sizes over 10000 participants while the remaining studies (24) fell in the 1000-10000 category, majority of which were national surveys.

For studies with sample sizes of less than 1000, both community surveys and facility-based studies reported a wide range of prevalence estimates, with community surveys reporting higher prevalence rates (35.9% to 65%) compared to facility-based studies (17.8% to 57.6%). The majority of these studies looked at older individuals aged 50 years and above and included a varying number of conditions in multimorbidity measurement (5 to 30). Within the 1000-10000 sample size range, prevalence estimates ranged from 1.4% to 69.4%, with national surveys accounting for the vast majority of the studies. Studies with sample sizes greater than 10,000 often indicated lower prevalence estimates (varying from 2.73% to 13.2%). These studies generally included all participants aged 18years and older.

This sub-analysis revealed a significant pattern where the age distribution of the study participants differed among these sample size categories, with smaller studies commonly focusing on older persons. Furthermore, these studies tend to report higher prevalence estimates of multimorbidity. Another noteworthy finding is the variation in the number of conditions assessed in the studies across different sample size categories, which has the potential to impact the reported prevalence estimates. Larger studies commonly included a lesser number of conditions in contrast to smaller studies, either as a result of logistical constraints or the need to prioritize certain health outcomes.

4.4.7 Prevalence of multimorbidity by sex and age

Out of the 37 studies, 43% (n=16) reported sex-specific prevalence estimates, of which three (n=3) were community-based studies, five (n=5) facility-based and eight (n=8) were national surveys. Four (n=4) of the eight national surveys analysed the WHO study of ageing and adult health (Agrawal & Agrawal, 2016; Kunna et al., 2017; Morgan, 2017; Phaswana-Mafuya et al., 2013). In contrast to two studies that found a higher prevalence of multimorbidity among males (Nwani & Isah, 2016; Petersen et al., 2019), the majority of the studies (n=14) reported a higher prevalence among females. The two studies which reported a lower prevalence in females than males were conducted in health facilities. One study reported the prevalence of multimorbidity among older patients aged 65 years and older who were admitted to medical wards in a hospital in Nigeria; females comprised 36% of the sample population (Nwani & Isah, 2016). The prevalence of multimorbidity among males was 33.3% and 15.7% among females. In another study, multimorbidity was investigated in patients attending three healthcare facilities in South Africa, among adults aged 18 years and over: 76% of the sample were females, and the reported prevalence was 36% among males and 35% in females.

In community surveys studies the median prevalence was higher among females at 55.6% (IQR 31.4-71.4) compared to males 43.7% (IQR 21.8-61.1). Similarly, the same pattern was observed in facility-based studies and national surveys; with median prevalence for females 35.0% (IQR 33.0-41.3) and for males 33.3% (IQR 33.3-36.0), in facility-based studies and 9.7% (IQR 4.9-23.7) and 2.6% (IQR 2.4-14.5) in national surveys. Appendix 5 shows the sex prevalence of multimorbidity.

Age-specific estimates of multimorbidity prevalence were reported by seventeen studies), of which four were community-based, four facility-based and nine were national surveys. As reported previously, the majority of the national surveys analysed the WHO SAGE data, and among these nine studies, six studies used the WHO SAGE, while two used the WHS data. In overall, prevalence varied between 31.0% (Cadmus et al., 2017) and 65.0%

(Hien et al., 2014) in studies that focused on persons 60 years of age and older. Among studies which included younger participants, the prevalence tended to be lower. For example, a study by Letamo and colleagues analysed nationally representative data from the Botswana AIDS Impact Survey, focusing on participants aged between 10-64 years, and they reported a prevalence of 2.6% (Letamo et al., 2017). Similarly, studies that included participants 18 years and older reported a prevalence ranging from 1.4% to 56%. Appendix 6 shows the prevalence of multimorbidity by age.

4.4.8 Patterns of Multimorbidity

Some studies went beyond just estimating and reporting on the prevalence of multimorbidity, and explored patterns of multimorbidity, i.e., clustering of chronic conditions. Table 6 shows a summary of disease combinations in the included studies. Different methodological approaches were utilised to determine multimorbidity patterns, leading to different results which were difficult to compare. Nine studies (n=9) identified the most prevalent multimorbidity combinations or clusters. Four (4) of these studies were from South Africa (A. Y. Chang et al., 2019; Lalkhen & Mash, 2015; Sharman & Bachmann, 2019; Weimann et al., 2016), two (2) were conducted in Ghana (Nimako et al., 2013; Oduro & Tawiah, 2012), one from Ethiopia (Woldesemayat et al., 2018), one from Malawi (Price et al., 2018) while the last one was a multi-country study representing Ghana and South Africa (Garin et al., 2016).

Among the nine studies, seven (n=7) used a descriptive approach, including Venn diagrams, bubble charts, and frequencies to identify the most common double, triple and quadruple comorbidities (A. Y. Chang et al., 2019; Lalkhen & Mash, 2015; Nimako et al., 2013; Price et al., 2018; Sharman & Bachmann, 2019; Weimann et al., 2016). One study used a descriptive approach to identify commonly co-occurring disease categories (Woldesemayat et al., 2018). Factor analyses, which a statistical approach that identifies statistically significant associations between conditions was utilised in two (2) studies [41, 61].

Although the quantity and types of patterns found in the research varied significantly, the majority of chronic condition combinations contained hypertension. The most prevalent pairs were hypertension and diabetes, hypertension and HIV, diabetes and HIV and HIV and TB. Hypertension also commonly clustered with cardiovascular and metabolic conditions. Studies that investigated the most common triads featured hypertension, diabetes and HIV, hypertension, HIV and anaemia as well as diabetes, tuberculosis and hypertension (A. Y. Chang et al., 2019; Sharman & Bachmann, 2019).

Two studies used a factor analysis methodology, and also reported diverse results, although they identified somewhat similar patterns of cardio metabolic and cardiorespiratory clusters. Three mental health related clusters were reported in the two studies. Garin et al (Garin et al., 2016) reported mental articular including arthritis and depression in Ghana and a cardiorespiratory cluster including angina, asthma, COPD, stroke, depression, and arthritis was identified in South Africa. Oduro and colleagues (Oduro & Tawiah, 2012) identified a cluster consisting of gastritis, peptic ulcer disease, anxiety, and low back pain among elderly patients in a general clinic in urban Ghana.

Table 6: Patterns of Multimorbidity in SSA

Author	Multimorbidity patterns	Prevalence (%)
Descriptive Analysis		
Chang (2019)	Hypertension + Dyslipidaemia	9.4
	Hypertension + Anaemia	6.4
	Hypertension + Dyslipidaemia +Anaemia	4.7
	Anaemia + HIV	2.6
	Hypertension + Anaemia + HIV	2.6
	Dyslipidaemia + Anaemia	2.1
	Dyslipidaemia + Anaemia + HIV	2.0
	Hypertension + HIV	1.9
	Hypertension + Dyslipidaemia+ Diabetes	1.8
	Hypertension +Depression	1.7
	Dyslipidaemia + HIV	1.6
	Hypertension + Dyslipidaemia + HIV	1.6
	Hypertension + Dyslipidaemia + Anaemia + HIV	1.3
	Hypertension + Dyslipidaemia + Depression	1.3
	Hypertension + Angina	1.2
	Hypertension + Dyslipidaemia =Anaemia + Diabetes	1.2
	Hypertension + Dyslipidaemia + Anaemia + Depression	1.1
	Hypertension + Dyslipidaemia + Angina	1.0
Lalkhen (2015)	Hypertension + Diabetes	n/a
	Hypertension + Osteoarthritis	n/a
	Asthma + Hypertension	n/a
	Hypertension + COPD	n/a
	Hypertension + Ischaemic Heart Disease	n/a
	Hypertension + Epilepsy	n/a

Author	Multimorbidity patterns	Prevalence (%)
Nimako (2013)	Hypertension + Diabetes	36.6
	Hypertension + Musculoskeletal Conditions	19.9
	Hypertension + other Cardiovascular conditions	11.4
Price (2018)	Hypertension + Obesity	n/a
	Hypertension + Diabetes	n/a
Sharman (2019)	Hypertension + Diabetes	9.8
	Hypertension + HIV	6.5
	HIV + Diabetes	1.7
	HIV + Diabetes + Hypertension	0.4
Weimann (2016)	Diabetes + Hypertension	70.8
	Tuberculosis + Hypertension	13.3
	HIV + Hypertension	10.8
	HIV + Tuberculosis	4.0
	Tuberculosis + Diabetes	0.8
	HIV + Diabetes	0.3
	Tuberculosis + Diabetes + Hypertension	64.0
	Hypertension + HIV + Tuberculosis	36.0
	Diabetes + Hypertension	71.22
	Tuberculosis + Hypertension	5.19
	HIV + Hypertension	23.08
	HIV + Tuberculosis	0.16
	Tuberculosis + Diabetes	0.12
	HIV + Diabetes	0.24
	Tuberculosis + Diabetes + Hypertension	22.02

Author	Multimorbidity patterns	Prevalence (%)
	Hypertension + HIV + Tuberculosis Diabetes + Hypertension + HIV	7.89 n/a
Woldesemayat (2018)	Cardiovascular + Endocrine System Diseases Cardiovascular + Musculoskeletal Diseases	2.4 1.2
Factor Analysis		
Garin (2017)	Cardio-respiratory: Angina + Asthma + COPD + Stroke Metabolic: Diabetes + Obesity + Hypertension + Stroke Mental Articular: Arthritis + Depression Cardio-respiratory: Angina + Asthma + COPD + Stroke + Depression + Arthritis Metabolic: Diabetes + Obesity + Hypertension + Stroke + Cataract + Arthritis + Endetulism	n/a n/a n/a n/a
Oduro (2012)	Cardio metabolic & Pain Disorders: Diabetes + Hypertension + Arthritis +Migraine Cardio-Pulmonary Disorders: Asthma + Congestive Heart Failure + Stroke Gastrointestinal, Low Back Pain & Anxiety Disorders: Gastritis + Peptic Ulcer Disease + Anxiety + Low Back Pain	28.2 13.9 10.1

4.4.9 Multimorbidity of communicable and noncommunicable diseases

Of the 37 included studies, only thirteen (n=13) reported multimorbidity from a combination of communicable and noncommunicable diseases. These studies were published between 2016 and 2020. The majority of the studies were conducted in South Africa (n=8), of which three (n=3) were based on data from

HAALSI (A. Y. Chang et al., 2019; Gaziano et al., 2017; Pengpid & Peltzer, 2020), and two utilized data from a national survey, SANIDS (Alaba & Chola, 2013a; Weimann et al., 2016). The remaining studies were undertaken in Nigeria (n=2), Burkina Faso (n=1), Cameroon (n=1) and Uganda (n=1). HAALSI is an interdisciplinary study in Agincourt, South Africa, tracking social, economic, and biological risks for chronic health conditions, including cardiovascular disease, HIV, cognitive functioning, and dementia. It aims to monitor these issues longitudinally amid significant epidemiological and demographic changes in the region.

Multimorbidity of communicable and noncommunicable diseases was most often (seven studies) examined in community based surveys (A. Y. Chang et al., 2019; Emeh et al., 2020; Gaziano et al., 2017; Mugisha et al., 2016; Odland et al., 2020; Pengpid & Peltzer, 2020; Sharman & Bachmann, 2019), while three were facility based (Cadmus et al., 2017; Nwani & Isah, 2016; Petersen et al., 2019), and two studies analysed South African national survey data (Alaba & Chola, 2013a; Weimann et al., 2016). Sample sizes for these studies ranged from 142 (Emeh et al., 2020) to 47 334 (Sharman & Bachmann, 2019), with only three studies (n=3), having sample sizes >10 000 (Alaba & Chola, 2013a; Sharman & Bachmann, 2019; Weimann et al., 2016). In terms of age, the studies included participants across different age ranges, and only three studies focused on adults aged 60 years and older (Cadmus et al., 2017; Emeh et al., 2020; Nwani & Isah, 2016).

The prevalence of multimorbidity of communicable and noncommunicable diseases ranged from 2.73% in a national survey conducted in South Africa (SANIDS) (Weimann et al., 2016) to 69.4% in a community-based survey also conducted in South Africa (A. Y. Chang et al., 2019). All the studies reported a prevalence above 20%, except for three studies (n=3) which were conducted in South Africa, two of which used same dataset (Alaba & Chola, 2013a; Weimann et al., 2016). Alaba et al (Alaba & Chola, 2013a; Weimann et al., 2016) reported a prevalence of 4.0% while in the Weimann study it was 2.73% in wave 1 and 2.84% in wave 3. Alaba utilised wave 1, while Weimann

analysed data from wave 1 and 3. Similarly, Sharman et al (Sharman & Bachmann, 2019) also reported a lower prevalence of 8.4% in 2009 and 13.2% in 2015 after assessing four conditions; HIV, TB, diabetes and hypertension. Although Alaba and Weimann utilised the same dataset, the number of conditions in the count were different; six and four respectively. Conditions were self-reported in all these studies, and they reported a similar limitation that there might be under-reporting of HIV information, due to stigma associated with the condition. The reported prevalence of HIV in these two studies was 0.6%, 1.1% and 2.13%, far below the national HIV prevalence of South Africa.

Some of the studies discovered a highly prevalent combination of HIV and/or TB with hypertension (A. Y. Chang et al., 2019; Sharman & Bachmann, 2019; Weimann et al., 2016). Additionally, recognised as frequent dyads were HIV and anaemia, HIV and depression, HIV and alcohol use disorder, and HIV and COPD. In their studies Chang et al (A. Y. Chang et al., 2019) and Mugisha et al (Mugisha et al., 2016) reported a higher prevalence of multimorbidity among people who were HIV-positive. Contrarily, two other studies on communicable diseases reported the higher prevalence of some NCDs among non-HIV participants, a finding that they associated with improved management of NCDs in HIV-positive individuals (Gaziano et al., 2017; van Heerden et al., 2017). A summary of these studies is in Appendix 7.

4.5 Discussion

4.5.1 Overview of results

This systematic review provides an up-to-date overview of multimorbidity prevalence and patterns in the SSA region. The review included 37 studies published between 2000 and 2020, undertaken in 12 countries. The majority of the single country studies were confined to South Africa. In total, ten studies analysed data from the World Health Organisation Study of Adult Health and Ageing (WHO SAGE). Prevalence estimates were highly heterogeneous due to methodological differences in terms of number and type of conditions included in the multimorbidity count, study settings, and participants' age.

The relatively limited number of included studies, as well as the over-dependence on the WHO SAGE dataset, shows that multimorbidity is still under-researched in the region. Xu and colleagues conducted a study in 2016 to map the global research output on multimorbidity, and they found that only 5% of research on this topic was carried out in LMICs (Xu et al., 2017b). Another group of researchers (themselves from LMICs) made the same observations, and recently made an urgent call for the generation of multimorbidity evidence which can inform policy formulation around strengthening primary healthcare and integrated care in LMICs (Basto-Abreu et al., 2022).

One of the key findings in this review was the variation in prevalence estimates across the included studies, ranging from 1.4% in a study conducted in Ghana (Morgan, 2017), to 69.4% (A. Y. Chang et al., 2019) in South Africa. Prior reviews that assessed the prevalence of multimorbidity in different settings have also reported this variation (Asogwa et al., 2022; Fortin et al., 2012; Nguyen et al., 2019). For example, a recent systematic review conducted in China and India reported a prevalence ranging from 1.5% to 90.5% in community based studies (Zhang et al., 2022). Similarly, another review conducted in different high income settings also reported varying multimorbidity prevalence of 3.5% to 98.5% (Fortin et al., 2012).

4.5.2 Variability in the Included Studies

The current study's most notable finding, in my opinion, is the level of methodological heterogeneity in the included studies, rather than the prevalence of multimorbidity in the region. This conclusion should not come as a surprise given the differences in sample size, setting, diagnostic criteria, data collection method, and overall research methodology. Heterogeneity is an important concept when it comes to interpreting and comprehending the results of systematic reviews of prevalence data. Conducting reviews of prevalence studies entails aggregating and synthesising data from several sources to obtain a dependable estimate of prevalence. Nevertheless, these studies are never similar, exhibiting variations in several respects, including

the characteristics of the participants, the recruitment methods employed, the research settings, the methodological approaches, and the analytical approaches used. Heterogeneity refers to any variability among studies included in a systematic review.

The wide variation in the included studies is attributed to the use of different methodologies to define and measure multimorbidity, making it difficult to compare the results and pool an overall prevalence through a meta-analysis (Calderón-Larrañaga et al., 2017; Griffith et al., 2018). The included studies varied in terms of the study settings, data sources, age of participants and the types and number of chronic conditions considered in the measurement of multimorbidity.

Majority of the studies utilised cross-sectional study design, allowing for the assessment of multimorbidity prevalence at a single point in time. Majority of these cross-sectional studies analysed secondary data from national health surveys and other large surveys such as WHO SAGE, WHS and other sources. While longitudinal studies allow for the exploration of multimorbidity trajectories over a period of time, only a few studies utilised this design. These studies included longitudinal community health studies and HIV surveillance studies.

The geographic allocation of the included studies also varied significantly with the majority of the studies conducted in South Africa. This therefore means the findings derived from these studies might not truly reflect the burden of multimorbidity in SSA. Although these countries are in the same region they still differ in various critical aspects such as socioeconomic status, cultural practices, disease burden, as well as dynamics of their healthcare systems and research capacities.

These studies were categorised into three settings as previously indicated; facility based, community and national surveys. Facility based studies involved collecting data from medical records or from patients visiting different healthcare facilities. Notably, these studies predominantly focused on older

adults in terms of age, had smaller sample size and assessed more conditions. Facility-based studies objective measures to determine the existence of specific conditions. These approaches included detailed medical record reviews, clinical assessments by healthcare professionals, and systematic screening for diseases in clinic settings.

Community based studies on the other hand focused on specific community subsets or targeted certain age groups or geographic areas, unlike national surveys which utilised data from big studies such as WHO SAGE, WHS, BAIS, SA-NIDS or nationally representative surveys. National surveys generally include bigger sample sizes, which allow for the inclusion of diverse populations and provide greater statistical power to find relationships and estimate prevalence with precision. The inclusion of bigger samples in national surveys improves the ability to generalise prevalence figures to wider populations. In contrast, community and facility-based research typically utilised smaller sample sizes due to their focus on specific demographics.

Another important aspect to consider is the operational definition of multimorbidity across the 37 included studies. There is no universally agreed upon definition of multimorbidity. This leads to variability in how multimorbidity is operationalised across different studies. As indicated in the description of the characteristics of the included studies, the number of conditions included in the studies varied considerably across from 3 to 30. National surveys assessed a lesser number of conditions compared to facility-based studies and community surveys. The variation in the number of conditions evaluated among national surveys, facility-based studies, and community surveys is apparent due to the different objectives, methodology, and sample sizes associated with each research undertaking.

Multimorbidity assessment in reviewed studies covered a broad range of chronic illnesses, including NCDs, communicable diseases, and mental health conditions. The debate on which conditions to consider when measuring multimorbidity is ongoing. An expert panel in Canada concluded that there is no single measure of multimorbidity that is perfect, however, researchers

should consider the following factors when measuring multimorbidity: the key purpose of the study, outcomes, preference of involved stakeholders and data availability [63]. A previous systematic review from HICs also observed wide heterogeneity and recommended that multimorbidity studies should include at least 12 recognised chronic conditions in their measures [56]. A recent Delphi study which involved panellists from both HICs and LMICs recommended a list of conditions to include in multimorbidity measures, a reporting format for multimorbidity studies and most importantly the need for researchers to explicitly state their justification for the choice of conditions and measurement [64]. Appendix 8 shows the different conditions which were included in the studies and their prevalence.

4.5.3 Comparison with the literature

Consistent with previous epidemiological studies (Agur et al., 2016; Barnett et al., 2012) and other reviews (Violan et al., 2014), my review also observed that multimorbidity was more prevalent among females and older adults. In a global review of seventy community based studies, Nguyen and colleagues reported that out of the twenty-five studies that explored the gender differences in multimorbidity prevalence, twenty-one studies reported a higher prevalence in females, and multimorbidity appeared higher in older adults (Nguyen et al., 2019). Similarly, in the present analysis, a majority of the studies that have reported prevalence estimates based on sex have consistently observed higher rates of multimorbidity in females compared to males. This observed gender disparity could potentially be attributed to the methodology, as many of the studies relied on self-reported data, and women are possibly more likely to disclose their health conditions. The tendency of women to be more open in sharing information about their health conditions corresponds with the observed trends in healthcare-seeking behaviour. Baker (2014) and Dryden (2012) reveal that men are less likely to visit healthcare facilities, report symptoms, or discuss illnesses. This trend is global and can be linked to women's higher healthcare utilisation, especially during their reproductive years. Notably, similar patterns exist in Sub Saharan Africa, where traditional

notions of masculinity deter men from seeking testing and adopting health-promoting behaviours (Baker et al., 2014; Dryden et al., 2012).

Another possible explanation is that life expectancy among women is higher compared to men; while men can die prematurely from chronic conditions, women are more likely to survive with these conditions into their older ages (Kudesia et al., 2021).

Prevalence also differed by rural/urban residence, with a higher prevalence observed among urban residents. Other studies that have made the same observation argue that this could be due to lifestyle differences between urban and rural residents. Rural residents are likely to engage in labour intensive work, and as a result may have better fitness, compared to their urban counterparts who are likely to live sedentary lifestyles (Balakrishnan et al., 2022; Zhang et al., 2022). Price et al (Price et al., 2018) conducted a study in an urban and rural setting, and reported that prevalence of obesity, hypertension and diabetes were higher among urban dwellers than rural dwellers due to the fact that risk factors for these conditions are more prevalent in urban areas. Additionally, urban residents typically have better access to healthcare facilities, which might translate into better preventive screening services. They are more likely to be aware of their chronic disease diagnoses; hence, there is a possibility of under reporting of multimorbidity among rural residents (Asogwa et al., 2022; Beran, 2015).

The emergence and rapid increase of NCDs in SSA has not replaced communicable diseases. The region still bears the bulk of morbidity and mortality burden from HIV, TB, malaria, diarrhoeal diseases and other infectious diseases (Dalal et al., 2011; Oni et al., 2014), hence the recognition that SSA and many LMICs are experiencing a dual burden of disease (Basto-Abreu et al., 2022). I anticipated that chronic communicable conditions would be widely included in identified multimorbidity studies, in reality only a handful of the identified studies included HIV and TB; the majority of these were community based surveys in South Africa that were primarily HIV surveillance surveys (A. Y. Chang et al., 2019; Gaziano et al., 2017; Pengpid & Peltzer,

2020; Sharman & Bachmann, 2019; van Heerden et al., 2017). The review further highlights the contribution of HIV and TB to multimorbidity patterns observed in the studied populations, as they frequently co-occurred with hypertension, diabetes, anaemia, and depression. Evidence from the region clearly demonstrates that people living with HIV are more likely to suffer from NCDs such as diabetes, kidney diseases and cancer (Coetzee et al., 2019; McCombe et al., 2021; Mudie et al., 2019). It is therefore imperative that multimorbidity measures in the region takes into account the most important conditions in the region, and that could be in terms of their prevalence, their impact on patients, or their burden on the healthcare system (Basto-Abreu et al., 2022; Griffith et al., 2018; Oni & Unwin, 2015). Surprisingly, the majority of national surveys and demographic health surveys did not include HIV and TB. These surveys have been instrumental in generating epidemiological data for the region, and it might be important for them to review their research instruments to include the impact of communicable diseases on multimorbidity in the region.

Finally, identifying common combinations of chronic diseases is important for the formulation of treatment guidelines and interventions for the prevention or management of multimorbidity. My review has found only limited evidence on multimorbidity patterns, with only two studies adopting factor analysis to establish non-random associations of chronic conditions in the included studies (Garin et al., 2016; Oduro & Tawiah, 2012). Although the results were hard to compare, their findings suggest that the cardiovascular conditions commonly co-occur with metabolic conditions, and this is consistent with findings reported in other reviews (Prados-Torres et al., 2014; Violan et al., 2014). The combination of hypertension with other cardio metabolic conditions, and with HIV, was also observed. This was not surprising as the conditions that frequently co-occurred were also the most prevalent in the studied populations. This highlights the importance of investigating the non-random clusters of chronic conditions across the lifespan to establish the common risk factors that facilitates this clustering, and to help explore better clinical management of individuals with multimorbidity.

4.5.4 Strengths and Limitations

This is the one of the first systematic reviews to explore the epidemiology of multimorbidity in the SSA region, paying attention to the intersection of NCDs and communicable diseases. Prior reviews either included all countries in the LMIC category or focused on NCD multimorbidity. Taking into account the importance of communicable diseases in this sub Saharan Africa provides a truer picture of the burden of multimorbidity in this region and may be a starting point for conversations around a standard operational definition of multimorbidity for the region. It also offers evidence that could inform discussions around integrated healthcare provision.

My review was comprehensive and involved a rigorous search, which covered a good number of years, with no language restrictions and included grey literature. The search strategy was developed with a medical librarian, leading to a comprehensive and effective search strategy. Additionally, the screening process, data extraction and quality assessment exercise were carried out independently by two reviewers. The minor disagreements that arose during the review were discussed and resolved with the assistance of the third reviewer. This systematic and rigorous approach used in this review limited selection and extraction bias. Therefore, this thesis reports credible results on the prevalence and patterns of multimorbidity in SSA.

Although the inclusion and exclusion criteria specifically stated that studies poor quality would not be excluded, the majority of the studies were of good quality and only two studies scored below 50%. Additionally, a number of included papers used the WHO study of Global Ageing and Adult Health: this study used standard tools that are internationally acceptable and deemed rigorous, hence the findings from these studies could be considered valid and reliable.

One of the limitations of my study is that the majority of the included multimorbidity studies relied on self-reports of the absence or presence of chronic conditions. While there has been some assurance that there is not any

great disparity in prevalence estimates between data from administrative records and self-reported data from the SSA context it is possible that the reliance on self-reported data could result in an under estimation of multimorbidity. One reason for this is that noncommunicable diseases screening and diagnosis is still very low, which could potentially mean some people who have these conditions may not be aware of it.

Moreover, mental health conditions, and HIV/AIDS are highly stigmatised in SSA (Aguwa et al., 2022; Apanga, 2014), and relying on self-reports could potentially lead to under reporting of these conditions. Furthermore, health literacy in many SSA populations is relatively low, which could lead to under reporting or over reporting of some of these conditions (Agrawal & Agrawal, 2016). While I argue that self-reported information can still provide credible information to enable estimation of the multimorbidity burden, there is a need for comprehensive data collection instruments that are uniform, valid and reliable.

There was considerable heterogeneity among the included studies in terms of conditions listed, age range studied, and instruments used to collect data, and I was therefore unable to conduct a meta-analysis to estimate the pooled prevalence of multimorbidity. This made it challenging to draw precise conclusions about the patterns of multimorbidity in SSA because studies included different conditions and used different analytical methods to investigate multimorbidity patterns.

As described, I developed and carried out a rigorous search strategy, but acknowledge the possibility that I may have missed relevant studies. However, I tried to mitigate this through the use of a range of terms representing multimorbidity, including the MeSH term “comorbidity”.

4.6 Chapter Summary

This chapter assessed the in the literature evidence on the prevalence and patterns of multimorbidity in sub Saharan Africa. 37 studies met our inclusion criteria, and prevalence estimates were highly heterogeneous, ranging from 1.4% to 69.4%. The literature shows that multimorbidity is higher among females, urban residents and older adults. It is evident that the research output on the topic is still very limited in SSA, as evidenced by the relatively few studies I was able to retrieve. There were also considerable variation in the way multimorbidity is measured. There is a need to explore a possibility of having a uniform operational definition of multimorbidity for the region, that takes into account the coexistence of noncommunicable diseases and communicable diseases. The reported multimorbidity patterns suggest that hypertension, diabetes and HIV are important conditions in the context of this region. This review therefore offers evidence that could be used to launch conversations around policy and treatment guidelines for patients with multimorbidity.

Chapter 5 Prevalence of multimorbidity in Botswana: A cross sectional analysis of the Botswana Demographic Survey 2017

5.1 Overview

While the topic of multimorbidity is well researched in HICs, it is still understudied in LMICs such as Botswana. Using secondary data from the 2017 Botswana Demographic Survey (BDS), this chapter seeks to improve understanding of the prevalence and patterns of multimorbidity in the adult population of Botswana. My aims in this study were to (1) determine the frequency of distinct chronic diseases and multimorbidity; (2) examine whether and how these disorders are related to sociodemographic and lifestyle variables; and (3) examine the most frequent disease combinations (disease dyads) among persons 18 and older. This study is the first to examine the combination of NCDs and communicable diseases in describing the scope of multimorbidity in the setting of Botswana; it will therefore provide valuable information that takes into consideration the coexistence of these conditions.

5.2 Background

Multimorbidity, commonly defined as the coexistence of two or more chronic conditions in one person, is a growing public health problem globally (Sciences, 2018; World Health Organization, 2016). Interest in investigating and understanding prevalence, patterns, outcomes of multimorbidity has been increasing in both developed and developing countries (Xu et al., 2017b).

Although much has been learnt of the epidemiology of multimorbidity from developed countries (Xu et al., 2017b), there is still limited evidence from (LMICs) (Abebe et al., 2020). However, with the rapid increase in the burden of noncommunicable diseases (NCDs) in these countries, and improved life expectancy which will ultimately lead to ageing populations, it is imperative to generate context specific evidence to deal with this challenge (Sciences,

2018). A recent systematic review which included a meta-analysis of thirty-nine studies from LMICs, reported a prevalence of between 0.7% to 81.3%, with a pooled prevalence of 36.4% (Asogwa et al., 2022). In my previous systematic review as part of my PhD, I identified limited evidence regarding the prevalence of multimorbidity in Sub Saharan Africa, with rates ranging from 1.4% to 69%, reflecting methodological heterogeneity. This study, focusing on Botswana, builds upon this context to investigate multimorbidity patterns within the country.

Botswana, like other countries in the sub Saharan Africa region, is facing a rapid increase in the prevalence of noncommunicable diseases (NCDs) such as cancer, cardiovascular diseases, diabetes and chronic respiratory diseases. In 2016, the World Health Organisation (WHO) estimated that NCDs were responsible for 46% of all deaths in the country (Botswana Government, 2019a). Not only is the country struggling with NCDs and their risk factors, but also a high burden of HIV/AIDS and other communicable diseases. In 2017 it was estimated that 23.7% of the population aged 15 years and over in Botswana were living with HIV infection, and over 300,000 were receiving antiretroviral therapy (ART) (Botswana Government, 2019b). Botswana was one of the first countries in SSA to provide free ART to its citizens. There is growing evidence that with the success of the country's ART program, many people living with HIV are surviving into their middle and older ages (Masupe et al., 2019; Matlho et al., 2019), and that there is a significant burden of NCDs among these individuals (Haacker et al., 2019).

Although the interaction of NCDs and major chronic infectious disease in Botswana has been established, and the presence of multimorbidity has been recognised, the magnitude of the problem, as well as the most frequently occurring combinations of these conditions in the general population is poorly understood, and as in other LMICs there is still limited scientific evidence on this issue (Arokiasamy, Uttamacharya, Jain, Biritwum, Yawson, Wu, Guo, Maximova, Espinoza, Rodríguez, et al., 2015). The few multimorbidity studies that have been conducted in Botswana focused on a limited number of

conditions or did not include chronic communicable diseases (Keetile et al., 2020; Letamo et al., 2017; Ntiyani et al., 2022). The prevalence of multimorbidity in these studies ranged between 2.6% and 5.4%.

Understanding the true burden of multimorbidity and its patterns is important in the context of Botswana as the country moves towards promoting integrated care at primary care level. My research therefore aimed to address this gap in the literature by studying the prevalence, patterns and determinants of multimorbidity in Botswana taking into account the coexistence of NCDs and chronic communicable diseases such as HIV.

5.3 Research Aims & Objectives

This quantitative study aimed to determine the prevalence of multimorbidity among Botswana's adult population as well as to investigate the various sociodemographic and lifestyle factors associated with it.

5.3.1 Study Objectives

- To estimate the prevalence of multimorbidity among the adult population in Botswana.
- To examine the socio-demographic and lifestyle factors associated with multimorbidity among the adult population in Botswana.
- To determine the most frequently occurring combinations of chronic conditions in the adult population in Botswana.

5.3.2 Research Questions

- What is the prevalence of chronic disease multimorbidity in the adult population of Botswana?
- What socio-demographic factors are associated with multimorbidity in the adult population of Botswana?
- Which chronic conditions are the most prevalent in this population?
- Which chronic conditions in this study population commonly co-occur?

5.4 Materials and Methods

5.4.1 Data Sources

This analysis utilises data from the fourth Botswana Demographic Survey (BDS) conducted in 2017 (Botswana Government, 2018). This survey marks the fourth iteration since Botswana's independence in 1966, following previous surveys conducted in 1987, 1998, and 2006. This is a population based cross-sectional survey designed and administered by Statistics Botswana, the government agency responsible for all official statistics in Botswana. Statistics Botswana conducts this nationwide survey every five years in tandem with the national population and housing census which is conducted every ten years. The BDS serves as a critical tool for updating census data and gaining insights into various socio-demographic and health-related parameters. It covers a wide array of topics including fertility, migration, mortality, nutritional status, disability, and family planning. Moreover, it captures socio-demographic data, such as age, gender, education, economic activities, and household characteristics.

The 2017 survey represents a significant milestone in the BDS history as it introduced questions on NCDs for the first time. This addition underscores a growing recognition of the need to address emerging health challenges within the country. The incorporation of NCDs into the BDS is not only a commendable step forward but also aligns with global recommendations for LMICs. LMICs are increasingly urged to leverage existing research infrastructure, such as national surveys, to address emerging health challenges comprehensively [16]. By integrating NCDs like diabetes, hypertension, asthma, and depression alongside prevalent health issues such as HIV and TB, the BDS aimed to enrich its scope and offer a more nuanced understanding of the nation's health landscape. This proactive approach underscores Botswana's commitment to staying abreast of evolving health priorities and ensuring that healthcare interventions and policies are responsive to the country's dynamic health needs.

5.4.2 Sampling and Data Collection

The BDS adopted a nationally representative approach, employing a two-stage stratified sampling design consistent with other household survey methodologies in the country. The survey operationally leveraged the existing stratification of Botswana's twenty-seven (27) census districts, each reflecting heterogeneity and aligned with administrative districts. Within this framework, census districts were further categorized into three distinct domains: cities/towns, urban villages, and rural areas.

The survey exclusively targeted households across all census districts and subdistricts, with data collection focused solely on individuals residing in private dwelling areas. Notably, institutionalized residences, such as prisons, army barracks, hospitals, and other institutions, were excluded from the sampling frame, along with specific geographic areas like the Ngamiland Delta, Central Kalahari Game Reserves, and industrial zones.

Employing a stratified two-stage sampling design facilitated by the 2011 Population and Housing Census, the survey first selected Enumeration Areas (EAs) as Primary Sampling Units (PSUs) using Probability Proportional to Size (PPS), where the measure of size was the number of households in each EA as outlined in the census. This initial stage yielded a representative sample comprising 478 enumeration areas drawn from across all census districts. In the second stage, households were designated as Secondary Sampling Units (SSUs) and were systematically selected from the listed households within the selected EAs (PSU). Twenty (20) households were systematically selected in each sampled enumeration area, yielding a sample of 9560 households for participation in the survey. Importantly, the survey encompassed all individuals residing within the selected households, including visitors who spent the night with the household. However, for the purposes of this study I restricted my analysis to participants aged 18 years and above. Table 7 below summarises the sample size for BDS 2017.

Table 7: Sample Size of Botswana Demographic Survey,2017

Domains/ Strata	Final EAs in the Sample	Final Households in the sample
Cities/Towns	122	2440
Urban villages	187	3740
Rural villages	169	3380
Total	**478**	**9560**

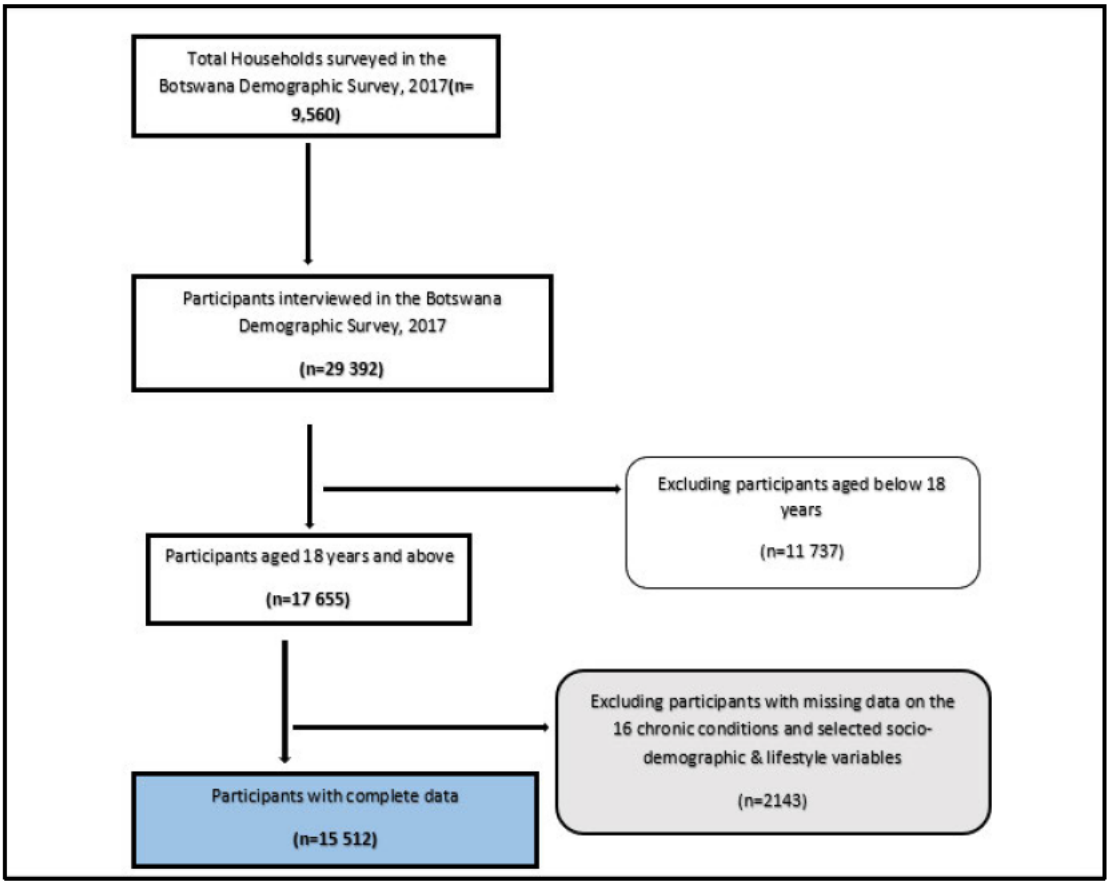
(Source: Adapted from the Botswana Demographic Survey Report, 2017)

The data collection process for the BDS was conducted in a rigorous structured manner to ensure comprehensive coverage and data accuracy. Prior to data collection, Statistics Botswana recruited and conducted training for data collectors and supervisors, totalling one hundred and ninety (190) individuals. This comprehensive training program was conducted in two phases; training of trainers or supervisors in the first phase, followed by the training of interviewers. Thirty-five (35) individuals underwent two weeks of training to assume the role of supervisors. One hundred and fifty-five (155) individuals subsequently joined the supervisors in interviewer training. The curriculum included lectures that covered topic such as questionnaire content, survey rationale, and interview techniques. In addition, practical practice or mock interviews and assessments were incorporated to evaluate participants' understanding and competence in survey procedures.

Data collection spanned a period of three (3) months from August to October 2017. The data were collected by twenty-seven (27) teams, each having one (1) supervisor, four (4) enumerators and two (2) drivers. For the first time in this survey, a Computer-Assisted Personal Interview (CAPI) system was utilised to record participants responses. The survey had one electronic questionnaire which consisted of three parts being the household questions, the under-five and questions for women aged 15-49. The survey questionnaire provided as an attachment in Appendix 9.

Enumerators employed electronic tablets equipped with the Survey Solutions (SS) platform, to carry out face-to-face interviews at participants' homes, gathering self-reported conditions, socio-demographic information, disability, and other variables. To achieve comprehensive coverage, data collection teams made multiple visits to households where eligible members were initially unavailable. Each household was given a minimum of three attempts before it was classified as unsuccessful. During enumeration, data were directly inputted onto tablets by enumerators, with field supervisors and quality controllers overseeing data validation, editing, and coding processes. This careful validation procedure aimed to address data gaps and discrepancies in real-time, such that where possible issues could be addressed while enumerators were still in the field, enhancing the overall quality and accuracy of collected data. In addition, the utilisation of an electronic-based data capture method enabled the prompt transmission of rectified data to the headquarters for subsequent analysis.

Figure 5: Flow Diagram of Study Participants



5.4.3 Study Variables

In this section, I give detailed information of the selected variables and how they were coded.

5.4.3.1 Dependent/ Outcome Variable

The BDS collected data on numerous NCDs, mental health disorders, and infectious/ communicable diseases. Participants self-reported information on chronic conditions from a pre-specified list of conditions. Participants were asked if they had ever been diagnosed with any of the 18 listed conditions listed in Table 8. Only three conditions could be recorded per individual. In addition to the listed conditions, participants were given an option to report or specify any additional conditions they had. This means that participants had the flexibility to report a combination of conditions from the predefined list and

additional conditions in the "specify" module, as long as the total did not exceed three conditions per individual.

I evaluated the “specify” module responses and determined the prevalence of the listed conditions. There was a combination of acute and chronic conditions among the responses, and the prevalence of the majority of chronic conditions mentioned (arthritis, stroke) was less than 0.1%. Consequently, they were deemed insignificant and excluded from this analysis. Based on the systematic review findings (Chapter 4), where I evaluated the evidence on the prevalence and patterns of multimorbidity from SSA (Disang et al., 2021), as well as previous multimorbidity evidence from the region (Afshar et al., 2015; A. Y. Chang et al., 2019; Keetile et al., 2020) and internationally (Abebe et al., 2020; Ho et al., 2021), I narrowed the list of conditions from eighteen to sixteen conditions. I removed two conditions; dental disease and low blood pressure - from the list as they were considered non-chronic and had not been included in other multimorbidity studies. The sixteen remaining chronic conditions were assigned to one of the three discordant health multimorbidity domains: mental health, NCDs and communicable diseases.

The variable of interest, multimorbidity was defined as two or more chronic conditions from the sixteen listed conditions. A binary variable indicating the presence or absence of multimorbidity was created.

Table 8: Self-Reported Chronic Conditions Included in the BDS

Conditions included in the BDS	Selected Conditions
1. High BP/ Hypertension	**Non communicable Diseases**
2. Diabetes	High BP/ Hypertension
3. Cardiovascular disease	Cardiovascular disease
4. Respiratory disease	Diabetes
5. Osteoporosis	Asthma
6. Asthma	Respiratory disease

7. Depression	Epilepsy
8. Chronic mental disease	Cancer
9. Stomach/ intestinal ulcer	Rheumatism/joint inflammation
10. Rheumatism/joint inflammation	Osteoporosis
11. Chronic Kidney Disease	Stomach/intestinal ulcers
12. Tuberculosis	Chronic kidney disease
13. Anaemia	Anaemia
14. HIV/AIDS	**Mental Health Conditions**
15. Epilepsy	Depression
16. Cancer	Chronic mental disease
17. Low BP	**Communicable Diseases**
18. Dental disease	HIV/AIDS
	Tuberculosis

5.4.3.2 Independent Variables/ Predictor Variables

Guided by previous international literature (Barnett et al., 2012; Tomita et al., 2021; Zhang, Lu, Shi, Zhang, & Chang, 2019), and prevalence studies conducted locally (Letamo et al., 2017; Ntiyani et al., 2022), as well as the information available in the dataset, the following self-reported socio-demographic factors were assessed.

Socioeconomic and demographic Factors

1. *Sex:* this variable was adopted as is in the dataset, where it has two categories (male and female).

2. *Age Groups*: this analysis has been restricted to adults aged 18 years and above. The reported age of respondents (continuous variable) was grouped into the following six age bands (18-24, 25-34, 35-44, 45-54, 55-64 and ≥65).

3. *Area of Residence:* This variable was adopted as is in the dataset, with the three settlement categories: cities/towns, urban villages and rural.

In Botswana, settlements are categorised into these three groups. There are two cities (Gaborone and Francistown), five towns (Lobatse, Selibe Phikwe, Orapa, Jwaneng and Sowa). A location is considered urban if at least 75 percent of its labour is engaged in non-agricultural activities and the population is at least 5,000. Urban villages are usually local government administrative headquarters, and then all other locations which do not meet the urban locations classification are identified as rural.

4. *Religion:* Participants were asked to state their main religion from the following: Christianity, Islam, Bahai, Hinduism, Badimo, No Religion and Other. This variable was then recoded into the following categories; No Religion, Christianity, Other and Badimo (which is the indigenous belief system of ancestors).

5. *Citizenship:* This variable was adopted as is from the dataset, with two categories categorised: Batswana, for individuals who indicated that they were citizens of Botswana, and Non-Batswana, for individuals who indicated that they were citizens of any other country besides Botswana.

6. *Marital Status:* Respondents were asked about their current marital status. This variable was recoded into the following categories; Never married, Married, living together, Divorced, Widowed and Separated. Widowed, Divorced and Separated were combined into one category. This was done for uniformity with other local studies.

7. *Education Attainment:* The level of education variable was computed in the following way:

- Those who had never attended school were categorised as never been to school
- Those who had completed primary and below were categorised as primary/less
- Those who had complete secondary and brigades' certificates were categorised as secondary
- Those who had an education college certificate, university certificate, education college diploma, university diploma, other diploma, HIS diploma, university degree, post graduate and other degree were categorised as having a tertiary/ higher qualification.

8. *Employment Status:* Participants were asked the following question in the survey to determine their economic activity; "what has…. been

doing mainly in the past 12 months?" Responses were categorised into three groups.

i. Seasonal Work: paid & unpaid
ii. Non-Seasonal Work: paid & unpaid
iii. Other: job seekers, home maker, student, retired, sick, and other (specify).

A binary variable of Employed versus Unemployed was created. Individuals who responded that they were in seasonal paid and non-seasonal paid employment, were classified as Employed, while seasonal unpaid, job seekers, students, retired and home makers were classified as Unemployed.

Behavioural and Lifestyle Factors

1. *Body Mass Index (BMI):* was calculated as weight (in kilograms) divided by height (in meters squared). This variable was estimated from the weights and heights of respondents provided in the BDS. The BMI was categorised as: (a) Underweight :< 18.5 kg/ m2; (b) Normal: 18.5–24.9 kg/m2; (c) Overweight: 25.0–29.9 kg/m2 and (d) Obese: ≥30.0 kg/m2.
2. *Fruit Consumption:* respondents reported how often they consumed fruits. The following responses were collected; 1) Everyday, 2) Three times a week, 3) Once a week, 4) Once in a while 5) Too young and 6) Never. This variable was re-coded such that those who indicated that they consumed fruits everyday were classified as "Daily" and those who never consumed fruits as "Never", those who consumed fruits Once in a while, once a week or Three times a week were regarded as "Moderate".
3. *Vegetable Consumption:* similarly, consumption of vegetables was assessed using the self-reported responses from the participants on how often they consumed vegetables. Those who indicated that they consumed vegetables everyday were classified as "Daily" and those who never consumed vegetable as "Never", those who consumed

vegetables once in a while, once a week or three times a week were categorised as “Moderate”.

5.4.4 Statistical Analyses

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 27.0. First, I summarised the participants socio-demographic and lifestyle characteristics using descriptive statistics. Categorical data was reported using frequencies and percentages in tables. Age was also reported as continuous variable using the mean and standard deviation (SD). The prevalence of individual chronic conditions was also be computed as frequencies and percentages. I further assessed the prevalence of these conditions by age and sex.

The prevalence of multimorbidity was also estimated with a count of the number of chronic conditions existing in each individual, and this was presented as frequencies and percentages in relation to population characteristics. In the next stage, the Chi-square test was applied to measure differences in the prevalence of chronic conditions, number of diseases, multimorbidity and the sociodemographic variables.

Binary logistic regression models were used to assess the relationship between multimorbidity and sociodemographic and lifestyle characteristics. The analytical process involved four sequential models. Initially, crude odd ratios (cORs) with their corresponding 95% confidence intervals (95% CIs) were calculated for each individual variable. In the second model, socio-demographic variables were assessed in relation to the outcome variable, multimorbidity. The third model included all three lifestyle factors to explore their relationship with multimorbidity. The fourth and final model included all the variables, both socio-demographic and lifestyle, to derive adjusted odds ratios (aOR) along with their 95% CIs. Throughout the analysis, a significance threshold of **$p<0.05$** was employed to determine statistical significance.

To explore the patterns of multimorbidity, within the study population, a sub-analysis was conducted specifically among individuals with multimorbidity. Simple counts of the frequencies of all possible pairs of diseases were calculated for individuals with multimorbidity in SPSS and presented in tables.

5.5 Results

5.5.1 Sociodemographic characteristics of the study population

The characteristics of the 15,512 adults included in this analysis are summarised in Table 9. The analysis comprised a total of 15,512 adults aged 18 and above. The mean age of the sample was 39.6 years with a standard deviation of (SD: 16.2 years). The age distribution was as follows: 18.4% were aged 18-24, 27.6% were aged 25-34, 22.2% were aged 35-44, 13.7% were aged 45-54, 9.3% were aged 55-64, and 8.8% were aged 65 and older. The sample consisted of slightly more females (55.2%) than males. Nearly half of the respondents (45.4%) reported that they had never been married. In terms of educational background, 46.1% of respondents had completed secondary school, while 11.5% had never attended school. The participants were distributed across different residential areas with 42.6% residing in urban villages, 25% in cities and towns, and 33.4% in rural areas (33.4%). Many participants identified as Batswana (95.6%). Approximately 88% self-identified as Christians.

5.5.2 Lifestyle and behavioural characteristics of the study population

The lifestyle characteristics of the study population are presented in Table 10. When it comes to dietary habits, the majority of participants reported limited consumption of fruits and vegetables. Specifically, less than one-fifth of the participants reported daily fruit consumption (17.9%), whereas daily vegetable consumption was more prevalent with 45.1% of respondents indicating daily intake. The distribution of BMI within the study population was as follows: the majority of participants fell within the category of normal BMI, comprising 48.5% of the sample. A substantial proportion of participants were classified

as overweight, accounting for 22.8% of the population. A notable proportion of respondents were classified as obese, representing 17.5%.

To assess the representativeness of the study population, I drew comparisons with characteristics observed in larger, nationally representative surveys conducted in Botswana, specifically the Botswana AIDS Impact Survey (Letamo et al., 2017) and the Botswana WHO STEPs survey (Ntiyani et al., 2022). These comparisons revealed striking similarities in demographic characteristics, such as age distribution, marital status, place of residence, and educational attainment, further supporting the claim that this sample is representative of the broader population. Additionally, similar patterns emerged in lifestyle factors, particularly fruit and vegetable consumption, as evidenced by both my analysis and the WHO STEPs survey (Botswana Government, 2015), both indicating that a significant proportion of the population falls short of the recommended daily intake of five servings. Notably, the BDS used the Census of 2011 as the sampling frame, enhancing the credibility of the representativeness of this sample.

Table 9: Sociodemographic characteristics of respondents

Variables	Frequency (n)	Percentage (%)
Sex		
Male	6955	44.8
Female	8557	55.2
Age		
18-24	2852	18.4
25-34	4279	27.6
35-44	3438	22.2
45-54	2127	13.7
55-64	1437	9.3

Variables	Frequency (n)	Percentage (%)
≥65	1379	8.9
Marital Status		
Married	3377	21.8
Never Married	7042	45.4
Living Together	4129	26.6
Separated/Divorced/Widowed	964	6.2
Education Level		
Never Attended	1787	11.5
Primary/Less	2945	19.0
Secondary	7154	46.1
Tertiary/Higher	3626	23.4
Employment Status		
Unemployed	8254	53.2
Employed	7258	46.8
Residence		
Cities & Towns	3723	24.0
Urban Villages	6604	42.6
Rural	5185	33.4
Citizenship		
Batswana	14828	95.6
Non-Batswana	684	4.4
Religion		
Christianity	13472	86.8
Badimo	376	2.4
Others	113	0.7
No religion	1551	10.0

Table 10: Lifestyle Characteristics of Respondents

Variables	Frequency (n)	Percentage (%)
Fruit Consumption		
Never	594	3.8
Daily	2783	17.9
Moderate	12135	78.2
Vegetable Consumption		
Never	209	1.3
Daily	6990	45.1
Moderate	8313	53.6
Body Mass Index		
Underweight	1706	11.0
Normal	7519	48.5
Overweight	3543	22.8
Obesity	2744	17.7
Total (N)	**15512**	**100**

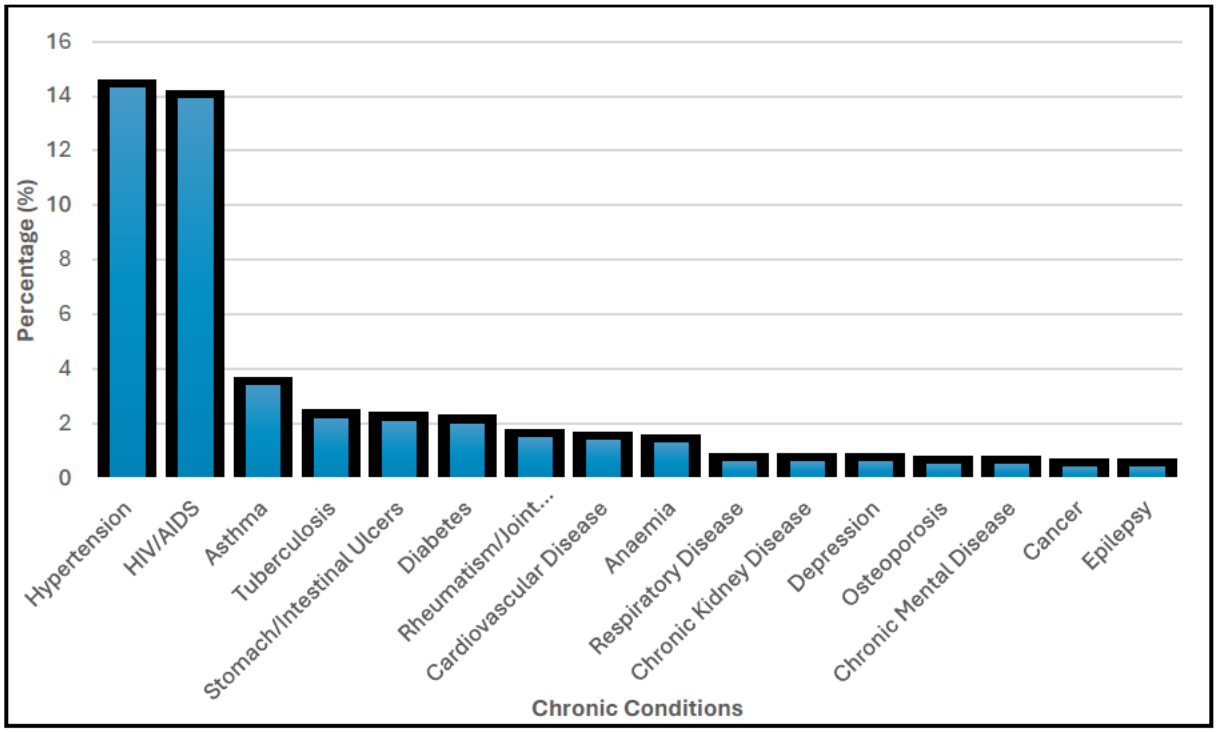
5.5.3 Prevalence of single chronic conditions

The distribution of chronic conditions among the participants in this study is presented in Figure 6. The prevalence of these conditions varied, ranging from 0.4% for epilepsy to 14.3% for hypertension. The top five self-reported morbidities were hypertension (14.3%), HIV/AIDS (13.9%), asthma (3.4%), tuberculosis (2.2%), and gastric ulcers (2.1%). In contrast conditions such as epilepsy (0.4%), cancer (0.4%), chronic mental disease (0.5%), osteoporosis (0.5%), depression (0.6%), chronic kidney disease (0.6%), and respiratory disease (0.6%) exhibited the lowest prevalence, all falling below the 1% threshold.

Chronic diseases were further classified into three major groups: NCDs, mental health illnesses, and communicable diseases. NCDs, encompassing a

range of chronic health issues, were identified in 22.6% of the study population. Mental health illnesses affected 1.1% of the participants. Meanwhile, communicable diseases were prevalent in 15.3% of the study population.

Figure 6: Prevalence of Chronic Conditions Included in the Multimorbidity Definition



5.5.4 Distribution of Individual chronic conditions by sex and age

Table 11 presents the frequency of assessed chronic conditions stratified by sex and age. There were significant differences in the distribution of chronic conditions between males and females ($p<0.05$), except for respiratory disease ($X^2=3.004$, $p=0.083$) and epilepsy (X^2 2.104, $p=0.147$). The majority of the sixteen conditions exhibited notable sex-based disparities, with higher prevalence rates among females compared to males. Exceptions for this trend included respiratory disease (0.5% among female vs 0.7% among males), chronic kidney disease (0.4% among females vs 0.8% among males), epilepsy (0.3% among females vs 0.4% among males), chronic mental disease (0.4%

among females vs 0.7% among males), and tuberculosis (2% among females vs 2.5% among males).

In terms of age, a general trend emerged where the frequency of most chronic conditions increased with advancing age. However, there were a few exceptions to this pattern for specific conditions, including asthma, epilepsy, depression and chronic mental health disease. These conditions did not exhibit statistically significant differences in their distribution across various age groups. For instance, asthma demonstrate a prevalence of 3.9% among participants aged 18-24 years and 4.0% among those aged 65 years and older (X^2=4.567, p=0.471), indicating no significant age-related variation in asthma prevalence.

Table 11: Frequency of Chronic Conditions by Age and Sex

Conditions	Total		Male		Female		P value	18-24		25-34		35-44		45-54		55-64		≥65		P value
	n	%	n	%	N	%		n	%	n	%	n	%	n	%	N	%	n	%	
Non communicable Diseases																				
Hypertension	2215	14.3	644	9.3	1517	18.4	<0.001	32	1.1	182	4.3	333	9.7	490	23.0	534	37.2	664	46.7	<0.001
Diabetes	309	2.0	111	1.6	198	2.3	0.001	2	0.1	11	0.3	34	1.0	75	3.5	91	6.3	96	7.0	<0.001
Cancer	55	0.4	11	0.2	44	0.5	<0.001	1	0.0	5	0.1	13	0.4	12	0.6	8	0.6	16	1.2	<0.001
Cardiovascular Disease	210	1.4	73	1.0	137	1.6	0.003	21	0.7	22	0.5	41	1.2	29	1.4	41	2.9	56	4.1	<0.001
Respiratory Disease	91	0.6	49	0.7	42	0.5	0.083	9	0.3	11	0.3	13	0.4	17	0.8	15	1.0	26	1.9	<0.001
Asthma	532	3.4	195	2.8	337	3.9	<0.001	111	3.9	136	3.2	113	3.3	72	3.4	45	3.1	55	4.0	0.471
Osteoporosis	73	0.5	15	0.2	58	0.7	<0.001	4	0.1	11	0.3	6	0.2	7	0.3	17	1.2	28	2.0	<0.001
Stomach/Intestinal Ulcers	325	2.1	89	1.3	236	2.8	<0.001	33	1.2	89	2.1	72	2.1	59	2.8	36	2.5	36	2.5	0.001
Rheumatism/Joint Inflammation	240	1.5	78	1.1	162	1.9	<0.001	7	0.2	23	0.5	29	0.8	32	1.5	43	3.0	106	7.7	<0.001
Chronic Kidney Disease	92	0.6	59	0.8	33	0.4	<0.001	6	0.2	10	0.2	13	0.4	19	0.9	17	1.2	27	2.0	<0.001
Epilepsy	55	0.4	30	0.4	25	0.3	0.147	14	0.5	17	0.4	6	0.2	6	0.3	7	0.5	5	0.4	0.315

Anaemia	200	1.3	16	0.2	184	2.2	<0.001	32	1.1	77	1.8	38	1.1	35	1.6	7	0.5	11	0.8	<0.001
Mental Health Conditions																				
Depression	89	0.6	30	0.4	59	0.7	0.034	13	0.5	22	0.5	19	0.6	19	0.9	11	0.8	5	0.4	0.236
Chronic Mental Disease	85	0.5	47	0.7	38	0.4	0.052	8	0.3	24	0.6	18	0.5	16	0.8	8	0.6	11	0.8	0.22
Communicable Diseases																				
HIV/AIDS	2159	13.9	706	10.2	1453	17.0	<0.001	100	3.5	369	8.6	757	22.0	580	27.3	257	17.9	96	7.0	<0.001
Tuberculosis	339	2.2	172	2.5	167	2.0	0.027	16	0.6	34	0.8	85	2.5	78	3.7	61	4.2	65	4.7	<0.001

5.5.5 Prevalence of multimorbidity

5.5.5.1 Number of self-reported conditions

As reported in the methods section (5.4.3.1), participants in the BDS were limited to reporting a maximum of three chronic conditions; thus, the number of conditions present in a single individual ranged from zero to three. I divided the participants into three groups according to the number of chronic conditions they reported. The majority of participants (65.3%) reported having none of the sixteen assessed conditions, while 25.8% had at least one chronic condition, 7.0% reported two conditions, and 2.0% reported having three chronic conditions. Notably, significant variations in prevalence, categorised by the number of chronic conditions, were observed across several demographic and lifestyle factors, including age, sex, residence, religion, citizenship, education level, marital status, employment status, fruit consumption and BMI ($p<0.05$). Figures 7 and 8 show the percentage of respondents self-reporting chronic conditions by sex and age, respectively.

Figure 7: Prevalence of Respondents Self-reporting Chronic Conditions by Sex

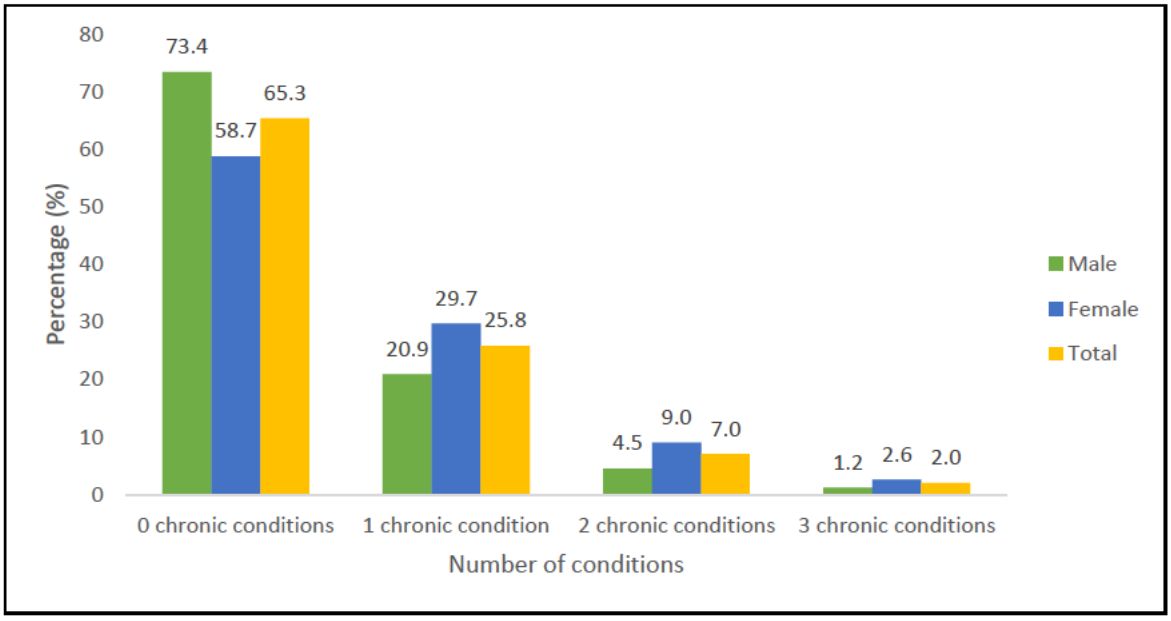
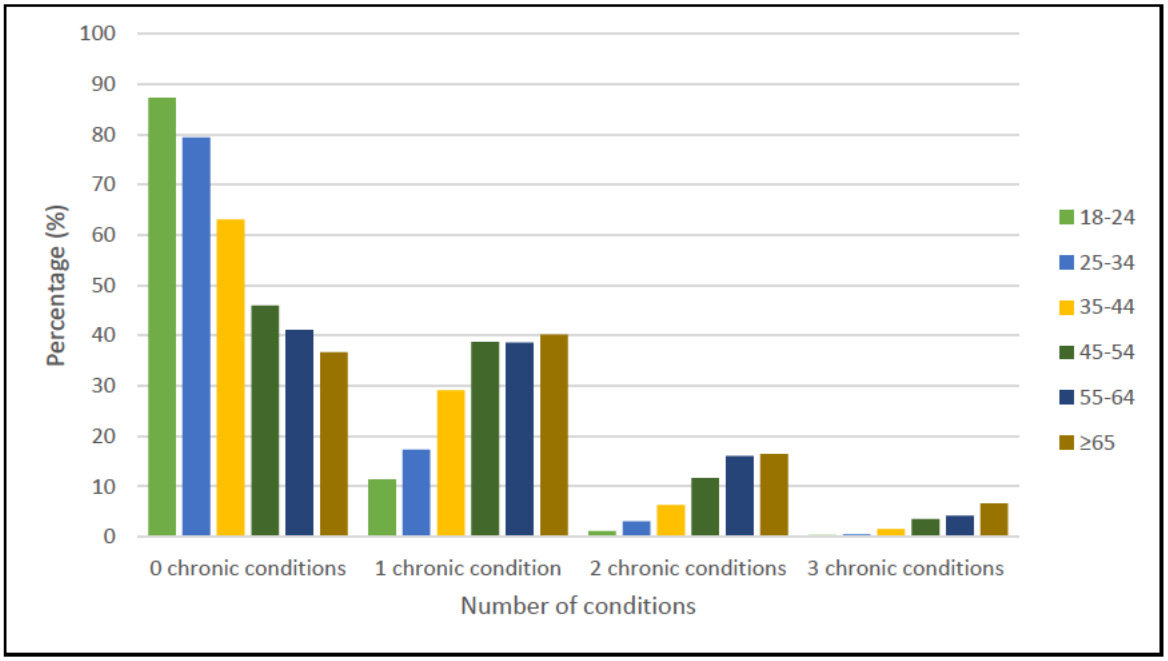


Figure 8: Percentage of Respondents Self-reporting Chronic Conditions by Age



5.5.5.2 The prevalence of multimorbidity and associated factors

The prevalence of self-reported multimorbidity, as defined by the presence of two or more chronic conditions, in the Botswana Demographic Survey in 2017 was 8.9%. In general, a substantial difference in the prevalence of multimorbidity was observed between socioeconomic and lifestyle factors. The distribution of multimorbidity in relation to the selected covariates is shown in Table 12. Multimorbidity was significantly more prevalent among older age groups, females, rural residents, Batswana, those with a lower level of education, those who believed in Badimo, the unemployed, and those who were divorced, widowed, or separated. Regarding lifestyle factors, the Chi-square test revealed that the prevalence of multimorbidity varied significantly by BMI and fruit consumption, but not by vegetable consumption ($X^2 = 0.17$, $p = 0.918$).

Table 12: Distribution of Multimorbidity by Sociodemographic and Lifestyle Factors

Characteristic	No Multimorbidity		Multimorbidity		Chi-square	P value
	n	%	N	%		
Sex						
Male	6560	94.3	395	5.7	163.152	<0.001
Female	7568	88.4	989	11.6		
Age Groups						
18-24	2814	98.7	38	1.3	1042.196	<0.001
25-34	4135	96.6	144	3.4		
35-44	3169	92.2	269	7.8		
45-54	1804	84.8	323	15.2		
55-64	1146	79.7	291	20.3		
≥65	1060	76.9	319	23.1		
Residence						
Cities & Towns	3447	92.6	276	7.4	17.456	<0.001
Urban villages	6013	91.1	591	8.9		
Rural	4668	90.0	517	10.0		
Religion						
Christianity	12231	90.8	1241	9.2	16.311	<0.001
Badimo	339	90.2	37	9.8		
Others	109	96.5	4	3.5		
No Religion	1449	93.4	102	6.6		
Nationality						
Batswana	13461	90.8	1367	9.2	36.483	<0.001
Non-Batswana	667	97.5	17	2.5		
Education Level						
Never Attended	1513	84.7	274	15.3	463.384	<0.001

Characteristic	No Multimorbidity		Multimorbidity		Chi-square	P value
	n	%	N	%		
Primary or less	2447	83.1	489	16.9		
Secondary	6768	94.6	386	5.4		
Tertiary	3400	93.8	226	6.2		
Marital Status						
Married	2993	88.6	384	11.4	307.154	<0.001
Never married	6567	93.3	475	6.7		
Living together	3824	92.6	305	7.4		
Widowed/divorced/separated	744	77.2	220	22.8		
Employment Status						
Unemployed	7438	90.1	816	9.9	34.793	<0.001
Employed	6734	92.8	524	7.2		
Fruit Consumption						
Never	532	89.6	62	10.4	8.644	0.013
Daily	2572	92.4	211	7.6		
Moderate	11024	90.8	1111	9.2		
Vegetable Consumption						
Never	192	91.9	17	8.1	0.170	0.918
Daily	6364	91.0	626	9.0		
Moderate	7572	91.1	741	8.9		
Body Mass Index						
Underweight	1564	91.7	142	8.3	141.994	<0.001
Normal	7016	93.3	503	6.7		
Overweight	3191	90.1	352	9.9		
Obese	2357	85.9	387	14.1		

5.5.6 Patterns of Multimorbidity

In this analysis, I narrowed my focus to individuals with two or more chronic conditions, constituting the multi-morbid subpopulation (n=1384). Among this group, hypertension emerged the most prevalent chronic condition, affecting 65% of individuals, followed by HIV/AIDS (43.4%), diabetes (18.6%), asthma (15.2%), and tuberculosis (13.2%). These conditions significantly influenced the patterns of multimorbidity observed in the study population. Conversely, epilepsy (1.4%), cancer (2.9%), chronic mental disease (3.4%), depression (4.0%), osteoporosis (4.4%), and chronic kidney disease (4.5%) were less prevalent, each accounting for less than 5% on the multi-morbid population.

To determine the patterns of multimorbidity, a simple descriptive method was employed in which the frequencies of disease pairs were used to generate an exhaustive list of all possible pairs. In Table 13, I present data exclusively for combinations with a prevalence exceeding 1%. The five most prevalent dyads included hypertension co-occurring with HIV (24.1%), hypertension with diabetes (18.8%), HIV with tuberculosis (9.9%), hypertension with rheumatism (9.1%), and hypertension with cardiovascular disease (8.2%). HIV emerged as the second most prevalent co-occurring condition, frequently appearing alongside tuberculosis, asthma, gastric ulcers, anaemia, and diabetes.

Table 13: Prevalence of the Most Common Chronic Disease Dyads (n=1384)

Conditions	Frequency (n)	Prevalence (%)
Hypertension + HIV	333	24.1
Hypertension + diabetes	260	18.8
HIV+ tuberculosis	137	9.9
Hypertension+ rheumatism	126	9.1
Hypertension + cardiovascular disease	116	8.4
Hypertension +Asthma	102	7.4
Hypertension + Stomach Ulcer	86	6.2
Asthma + HIV	73	5.3
Hypertension + tuberculosis	58	4.2
HIV + stomach ulcer	53	3.8

Conditions	Frequency (n)	Prevalence (%)
HIV + anaemia	43	3.1
Hypertension+ osteoporosis	38	2.7
Diabetes + HIV	31	2.2
Cardiovascular disease + HIV	31	2.2
Hypertension + chronic kidney disease	28	2.0
Hypertension + anaemia	28	2.0
Hypertension + chronic respiratory disease	28	2.0
Cardiovascular disease + asthma	27	2.0
Stomach Ulcer + rheumatism	27	2.0
HIV + rheumatism	27	2.0
Hypertension + cancer	26	1.9
Hypertension + depression	25	1.8
Chronic kidney disease + HIV	23	1.7
HIV + depression	20	1.4
Diabetes + cardiovascular disease	20	1.4
Cancer + HIV	20	1.4
Chronic respiratory disease + asthma	19	1.4
Hypertension + chronic mental disease	18	1.4
Chronic Respiratory disease + HIV	17	1.2
Diabetes + asthma	17	1.2
Cardiovascular Disease + rheumatism	17	1.2
Osteoporosis + rheumatism	17	1.2
Diabetes + rheumatism	16	1.2
Asthma + stomach ulcer	16	1.2
Asthma + tuberculosis	15	1.2
Stomach ulcer + anaemia	14	1.0

5.5.7 Determinants of Multimorbidity

The results of the binary logistic regression analysis of sociodemographic and lifestyle determinants of multimorbidity are presented in Table 14. In the univariate analysis, several socio-demographic and lifestyle factors demonstrated varying degrees of association with multimorbidity. Notable findings included that females exhibited a greater likelihood of multimorbidity (OR = 2.17; 95% CI = 1.92 to 2.25; p0.001). Elderly individuals also displayed a higher likelihood of having multiple diseases. In contrast, there were no significant associations between multimorbidity and having a primary or lower level of education or believing in the Badimo religion. Regarding lifestyle factors, the unadjusted analysis revealed a significant positive association between multimorbidity and BMI, with higher odds of multimorbidity observed among the obese (OR=2.29; 95% CI=1.99-2.64, p<0.001). Similarly, the odds of multimorbidity were higher for those who occasionally consumed fruits and those who never ate fruits. There was no association between vegetable consumption and multimorbidity in the crude analysis.

The multivariable logistic regression demonstrated that gender remained independently associated with multimorbidity, with higher odds among females with an adjusted odd ratio of (aOR = 1.83; 95% CI = 1.59-2.00; p 0.001). Similarly, age remained significantly associated with multimorbidity; as age increased, so did the likelihood of multimorbidity. Compared to the younger age group of 18-24 years, those aged 65 and older were 23.17 times more likely to have multimorbidity (aOR = 23.17; 95% CI = 15.67-34.24; p 0.001).

In the adjusted model, the odds of multimorbidity were greater for individuals who had never been married (aOR 1.24; 95% CI 1.06-1.46; p=0.008) and for those who lived together (aOR 1.21; 95% CI =1.02-1.44; p=0.03), compared to participants who were married. Furthermore, primary/less education remained an independent predictor of multimorbidity (aOR = 1.34; 95% CI = 1.12 to 1.51; p = 0.001). Being non-Motswana (aOR=0.332; 95% CI=0.20-0.55, p0.001) and residing in a rural area (aOR=0.87; 95% CI=0.69-0.99, p=0.03), were independently associated with a decreased likelihood of multimorbidity. Regarding lifestyle factors, underweight (aOR=1.27; 95% CI=1.03-1.56, p=0.025), and obese (aOR=1.33; 95% CI=1.14-1.56, p=<0.001) participants had a higher likelihood of multimorbidity compared to individuals with normal BMI.

Table 14: Logistic Regression Results of Factors Associated with Multimorbidity

Characteristics	Model 1			Model 2			Model 3			Model 4		
	COR	P value	95% CI	OR	P value	95%CI	OR	P value	95% CI	AOR	P value	95% CI
Sex												
Male	(ref)			ref						Ref		
Female	2.170	<0.001	1.92-2.25	1.923	<0.001	1.69-2.19				1.823	<0.001	1.59-2.09
Age												
18-24	ref	<0.001		ref						Ref		
25-34	2.579	<0.001	1.80-3.70	2.731	<0.001	1.90-3.94				2.693	<0.001	1.866-3.886
35-44	6.286	<0.001	4.46-8.86	7.029	<0.001	4.94-10.00				6.762	<0.001	4.739-9.649
45-54	13.259	<0.001	9.43-18.65	14.582	<0.001	10.15-20.94				13.841	<0.001	9.606-19.944
55-64	18.804	<0.001	13.32-26.55	20.829	<0.001	14.31-30.32				19.685	<0.001	13.470-28.770
≥65	22.286	<0.001	15.80-31.43	24.328	<0.001	16.50-35.88				23.166	<0.001	15.673-34.242
Marital Status												
Married	Ref			ref						Ref		

Characteristics	Model 1			Model 2			Model 3			Model 4		
	COR	P value	95% CI	OR	P value	95%CI	OR	P value	95% CI	AOR	P value	95% CI
Never Married	0.564	<0.001	0.49-0.65	1.210	0.018	1.03-1.42				1.243	0.008	1.06-1.46
Living Together	0.622	<0.001	0.53-0.73	1.186	0.056	1.00-1.41				1.211	0.033	1.02-1.44
Separated/Divorced/ Widowed	2.305	<0.001	1.92-2.77	1.173	0.118	0.96-1.43				1.179	0.107	0.97-1.44
Education Level												
Never Attended	ref			ref						Ref		
Primary/Less	1.124	0.155	0.96-1.32	1.373	<0.001	1.16-1.63				1.336	0.001	1.12-1.51
Secondary	0.315	<0.001	0.27-0.37	1.223	0.068	0.99-1.52				1.167	0.170	0.94-1.45
Tertiary/Higher	0.367	<0.001	0.31-0.44	1.012	0.919	0.80-1.28				0.941	0.623	0.74-1.19
Employment Status												
Unemployed	ref			ref						Ref		
Employed	0.703	<0.001	0.63-0.79	0.890	0.082	0.78-1.02				0.885	0.069	0.776-1.010
Residence												
Cities & Towns	ref			ref						Ref		
Urban Villages	1.228	0.007	1.06-1.43	0.870	0.09	0.74-1.02				0.883	0.129	0.751-1.037
Rural	1.383	<0.001	1.19-1.61	0.792	0.008	0.67-0.94				0.872	0.034	0.693-0.986

Characteristics	Model 1			Model 2			Model 3			Model 4		
	COR	P value	95% CI	OR	P value	95%CI	OR	P value	95% CI	AOR	P value	95% CI
Citizenship												
Batswana	ref			ref						Ref		
Non Batswana	0.251	<0.001	0.16-0.41	0.336	<0.001	0.20-0.55				0.332	<0.001	0.201-0.548
Religion												
Christianity	ref			ref						Ref		
Badimo	1.076	0.678	0.76-1.52	1.029	0.877	0.72-1.48				1.051	0.788	0.731-1.510
Others	0.362	0.046	0.13-0.99	0.765	0.613	0.27-1.16				0.744	0.576	0.263-2.099
No Religion	0.694	<0.001	0.56-0.86	0.842	0.129	0.67-1.05				0.843	0.135	0.674-1.054
Fruit Consumption												
Daily	ref						ref			Ref		
Moderate	1.228	0.009	1.05-1.43				1.340	<0.001	1.14-1.57	0.978	0.806	0.818-1.169
Never	1.421	0.021	1.05-1.91				1.717	0.001	1.24-1.38	0.922	0.654	0.648-1.313
Vegetable Consumption												
Daily	ref						ref			Ref		
Moderate	0.995	0.982	0.89-1.11				0.988	0.837	0.88-1.11	0.908	0.136	0.800-1.031
Never	0.990	0.682	0.54-1.49				0.773	0.356	0.77-2.20	0.850	0.579	0.480-1.507

Characteristics	Model 1			Model 2			Model 3			Model 4		
	COR	P value	95% CI	OR	P value	95%CI	OR	P value	95% CI	AOR	P value	95% CI
Body Mass Index												
Normal	ref						ref			Ref		
Underweight	1.266	0.017	1.04-1.54				0.803	0.027	0.66-0.98	1.266	0.025	1.030-1.556
Overweight	1.539	<0.001	1.33-1.77				1.260	0.027	1.03-1.55	1.088	0.282	0.933-1.268
Obesity	2.290	<0.001	1.99-2.64				1.883	<0.001	1.54-2.31	1.331	<0.001	1.137-1.559

5.6 Discussion

5.6.1 Summary of main findings

Using nationally representative data from the Botswana Demographic Survey of 2017, I aimed in this chapter, to investigate the prevalence and patterns of multimorbidity, as well as factors associated with multimorbidity, among adults aged 18 years and over. The most common self-reported chronic conditions in the general population were hypertension, HIV/AIDS and asthma, and in the population with multimorbidity, hypertension, HIV/AIDS and diabetes emerged as the top three prevalent conditions.

To estimate the magnitude of multimorbidity, I adopted a simple count of conditions. This study estimated that around a quarter of the study population (25.8%) had atleast one chronic condition, and 9% of Botswana's adults aged 18 and older were living with two or more chronic conditions. Among the sociodemographic factors evaluated, older age, female gender, marital status (particularly never married and living together categories), primary education or less, rural residence and non-Batswana nationality were independently associated with multimorbidity. Among the lifestyle factors examined, being underweight and obese were significantly associated with multimorbidity.

5.6.2 Comparison with other literature

Although this study reported a slightly higher prevalence of multimorbidity compared to three other Botswana-based multimorbidity studies, the results are comparable. In a study conducted by Letamo et al., national data from the Botswana AIDS Impacts Survey for adults aged 10 to 64 years revealed a prevalence of 2% in 2013 (Letamo et al., 2017). A cross-sectional examination of NCDs in three cities, fifteen urban villages, and fifteen rural villages in 2016 reported a prevalence of 5.4% among those aged 15 and older (Keetile et al., 2020). In addition, Ntiyani and colleagues used secondary data derived from the 2014 Botswana WHO STEPS survey and reported a prevalence of 3.5% among adults aged 20-64 years (Ntiyani et al., 2022).

Despite the fact that all four of these studies investigated the prevalence of multimorbidity in the general population, the prevalence estimates varied. This may be due to disparities in the list of diseases used in the multimorbidity measures: two studies included only three conditions in their measures (Letamo et al., 2017; Ntiyani

et al., 2022) one study included ten conditions (Keetile et al., 2020), and the present study included sixteen conditions. In addition, unlike the other three studies, my study based on the BDS included HIV, tuberculosis, and mental health conditions. There have been calls for the inclusion of mental health conditions and chronic communicable diseases in SSA multimorbidity measures (Sciences, 2018). In comparison to other LMICs, the prevalence estimated in this analysis of BDS data was below the pooled prevalence from a recent systematic review of NCD multimorbidity in LMICs (Asogwa et al., 2022), which reported a prevalence of 36.4%. The variation in multimorbidity prevalence between the BDS analysis and the pooled prevalence from the systematic review could be due to a number of factors including the differences in the specific chronic conditions examines, the demographic and health profiles of the diverse populations across countries, and variations in healthcare access and health seeking behaviours. These multifaceted factors have been highlighted in other literature as contributing to variations in multimorbidity measures (Ho et al., 2021; Rifqah Abeeda Roomaney et al., 2022)

Consistent with previous literature, there were some significant differences in the distribution of individual chronic conditions frequencies by age and sex. For example, the majority of the conditions were more prevalent in females except for tuberculosis, respiratory disease and chronic kidney disease. A previous study conducted in South Africa also reported a higher prevalence of tuberculosis among males compared to females (Wong et al., 2021).

This study also demonstrated that the majority of chronic conditions were significantly more prevalent in older ages compared to younger ages, and that the magnitude of multimorbidity increased with advancing age, as demonstrated by the significant increase in the odds of multimorbidity in older ages. This finding is consistent with previous multimorbidity studies conducted in various contexts in HICs (Barnett et al., 2012; Fortin et al., 2012), LMICs (Abebe et al., 2020; Zhang et al., 2022), and sub Saharan Africa (Alaba & Chola, 2013a) which attribute this trend to the accumulation of chronic diseases caused by ageing. While multimorbidity is considered a norm in older ages, limited evidence from LMICs suggests that NCDs presents much earlier in younger age groups (Abebe et al., 2020; Basto-Abreu et al., 2022) compared to HICs. This, along with the fact that NCDs are typically diagnosed late, and treated

inadequately, is likely to result in complications and the development of multimorbidity in younger ages (Basto-Abreu et al., 2022). In my study, 451/1384 (32.6%) individuals with multimorbidity were between the ages of 18 and 44, indicating the presence of multimorbidity among younger adults.

Moreover, this study found that the likelihood of multimorbidity was substantially higher among women, a finding consistent with previous research in other contexts. This has been attributed to a number of factors, including the fact that women generally have a longer life expectancy than males, exposing them to more NCD risk factors at older ages. The other possible explanation is that women tend to utilise healthcare facilities more frequently than males, allowing them to be screened for NCDs and other conditions, such as HIV. As this study relied on self-reported conditions, it is possible that women were more aware than males of the presence or absence of their chronic conditions.

This study also found that having a primary or less education was associated with an increased likelihood of multimorbidity. Previous local (Ntiyani et al., 2022) and international (Arokiasamy, Uttamacharya, Jain, Biritwum, Yawson, Wu, Guo, Maximova, Espinoza, Rodriguez, et al., 2015; Garin et al., 2016) research has established that a higher level of education is associated with lower risk of multimorbidity. These studies linked the reduced risk of multimorbidity among highly educated individuals to their access to information and empowerment to engage in healthy behaviours, screening of chronic conditions and adoption of preventative measures to delay the onset of chronic conditions.

Regarding place of residence, this study found that the odds of multimorbidity were substantially lower in rural areas. This supports the findings of a recent systematic review and meta-analysis (Asogwa et al., 2022) that examined the prevalence and determinants of multimorbidity among adults aged 18 years and older in LMICs, where urban residents were found to have a higher risk of multimorbidity than their rural counterparts. In another study conducted in India (Chauhan et al., 2022) that also found a lower prevalence of multimorbidity among adults in rural areas, the researchers attributed this to urbanization, arguing that urban residents are more likely to adopt sedentary lifestyles, consume unhealthy diets, and be less active, which increases their risk for chronic diseases. A second possible explanation is that rural

residents may underreport multimorbidity due to limited screening and diagnosis of chronic conditions. This also applies to Botswana, where access to NCD services remains limited [16].

We found a significant positive association between the occurrence of multimorbidity and two categories of the BMI variable: underweight and obesity. This was the only significant association among three lifestyle factors assessed in this study (fruit consumption, vegetable consumption, and BMI). Previous studies (Agborsangaya et al., 2013; R. A. Roomaney et al., 2022b) have demonstrated an increased risk of multimorbidity among obese individuals, establishing a relationship between obesity and multimorbidity. Similarly, a study conducted in Botswana found that obese individuals were six times more likely to have multimorbidity than underweight individuals, contradicting the current finding that underweight is associated with an increased risk of multimorbidity. In another study conducted in Malaysia, underweight was associated with lower odds of multimorbidity (Shariff Ghazali et al., 2021).

The analysis of disease pairs revealed that hypertension and HIV/AIDS co-occurred frequently with other chronic conditions. Hypertension and HIV/AIDS, hypertension and diabetes, HIV/AIDS and tuberculosis, hypertension and rheumatism, and hypertension and cardiovascular disease were the most prevalent pairs. This result was not unexpected, as previous research has demonstrated that the most prevalent individual diseases included in multimorbidity measures frequently occur in pairs or clusters (Prados-Torres et al., 2014; Violan et al., 2014; Zhang et al., 2022). Intriguingly, these patterns revealed the contribution of communicable diseases to multimorbidity patterns in countries where HIV is prevalent, such as Botswana. A recent systematic review that assessed prevalence, patterns and determinants of communicable and noncommunicable diseases multimorbidity in LMICs, also found that hypertension, HIV/AIDS and diabetes frequently co-occurred with other conditions (Kaluvu et al., 2022).

5.6.3 Strengths and limitations of the study

My research significantly contributes to the body of knowledge regarding the epidemiology of multimorbidity in Botswana. First, I conducted a thorough investigation utilising data representative of the entire nation. The analysis incorporated participants from various geographical locations, socioeconomic strata,

and demographic groups, within Botswana. The survey covered twenty-seven districts, including rural, semi-urban, and urban areas. Therefore, the implications of my results can be broadly generalised to the entire population of Botswana, given they were derived from a sample that is representative. The BDS, conducted over four repetitions, implemented stringent methodologies in sampling, data collection, and quality control to ensure the reliability and validity of the data. The findings of this study provide substantial evidence that can inform national-level healthcare policy, interventions, and resource distribution.

Secondly, this study addressed a noteworthy gap in previous multimorbidity research in Botswana by taking a holistic approach that included a wide range of chronic conditions commonly found in the country's disease profile. A distinctive feature is the inclusion of HIV and tuberculosis (TB), reflecting their substantial contribution to the nation's illness burden. Unlike prior investigations, this study recognises the importance of incorporating these conditions when evaluating multimorbidity, offering a nuanced understanding of the health landscape. By analysing HIV and TB alongside other chronic illnesses, the study provides valuable insights that extend beyond traditional measures, enhancing comprehension of the complex interaction among different health conditions in Botswana. Additionally, the study strategically includes mental health conditions in the analysis of multimorbidity, aligning with current suggestions to take mental health into account alongside physical health conditions [2, 38, 39].

Third, my research involved a thorough examination of multimorbidity prevalence and its relationship with different sociodemographic and lifestyle factors in Botswana. The use of logistic regression models aided in this analysis, providing valuable insights into the factors that contribute to multimorbidity in the country. Understanding these factors is crucial for informing targeted interventions and public health policies that aim to tackle multimorbidity and its related risk factors in Botswana. It is noteworthy that previous studies have uncovered contradictory findings about the association of multimorbidity and several factors, including income, education, gender, and geographic location. This emphasises the significance of taking into account contextual aspects in our analysis. My work improves its analytical rigour and offers a thorough picture of the factors that

contribute to multimorbidity in Botswana by considering a diverse range of sociodemographic and lifestyle factors. These findings have important implications for directing programmes and policies that attempt to alleviate multimorbidity and reduce health inequalities within the population. However, this study has some limitations which must be considered carefully when interpreting the findings.

The first notable drawback of this study is that the prevalence estimates are based on self-reported data have not been verified against medical records or physician diagnoses. This problem has been acknowledged in other similar studies [12, 33, 40]. All of the conditions used to quantify multimorbidity, as well as socio-demographic and lifestyle characteristics, were self-reported by the individuals. This methodology is often utilised in health surveys and epidemiological research because to its inherent simplicity and cost-effectiveness.

One of the primary concerns with self-reported data is the potential recall bias. Participants may not accurately remember or report their medical conditions leading to underestimation or overestimation of the true prevalence of multimorbidity. Moreover, self-reporting of health conditions is susceptible to social desirability bias. Individuals may be hesitant to report certain conditions owing to stigma or embarrassment, or they may overreport conditions to appear more unwell. Further, respondents could have underreported stigmatised conditions such as HIV and mental illness. Self-reported data may have resulted in under-reporting or over-reporting of conditions. For example, in 2017 the national HIV prevalence in Botswana among adults aged 15 years and older was 23.7% [7], while the 2014 Botswana WHO STEPS survey estimated that hypertension prevalence was around 30% among adults aged [13, 41]. This suggests that there is a possibility that the prevalence of HIV/AIDS and hypertension were under-reported in the BDS.

Additionally, my analysis was limited to the available data provided in the survey. In terms of the conditions included in the multimorbidity measure, only 18 conditions were assessed in the survey. In addition, participants restricted to reporting only three conditions from a predefined list, potentially overlooking less prevalent and undiagnosed conditions. Furthermore, the exclusion of certain chronic conditions deemed insignificant based on low prevalence rates may underestimate the true burden of multimorbidity. As indicated in the description of the variables, in addition

to the listed conditions, participants were given an option to report or specify any additional conditions they had. This means that participants had the flexibility to report a combination of conditions from the predefined list and additional conditions in the "specify" module, as long as the total count did not exceed three conditions per individual. I evaluated the “specify” module responses and determined the prevalence of the listed conditions. There was a combination of acute and chronic conditions among the responses, and the prevalence of the majority of chronic conditions mentioned (arthritis, stroke) was less than 0.1%. Consequently, they were deemed insignificant and excluded from this analysis. The exclusion of these conditions might as well as the removal of dental conditions and low blood pressure in my analysis may overlook their potential contributions. Previous research suggests that including a larger number of conditions may increase the likelihood of identifying multimorbidity in the population [24, 42].

The manner in which conditions are listed can pose a significant limitation when assessing multimorbidity. In the BDS, some conditions are individually listed, such as high blood pressure, diabetes, or depression, while others were grouped into broader categories like cardiovascular diseases, chronic mental disease or respiratory diseases. This inconsistency in listing formats can lead to confusion both for participants reporting their conditions and for researchers collecting the data. In order to obtain precise measurements of multimorbidity, it is essential to ensure that there is uniformity and transparency in the listing of different health conditions. Notably, recent consensus from a Delphi study highlights the importance of counting individual conditions rather than grouping them by body system categories [38].

Numerous studies on multimorbidity have delved into socio-demographic and lifestyle factors, recognizing their importance for targeted interventions and policy development. However, utilizing secondary cross-sectional data often confines researchers to the available variables in the dataset, restricting their ability to comprehensively assess these factors. The BDS survey, for instance, gathered limited socio-demographic and lifestyle data, failing to capture critical behavioural factors like alcohol consumption, tobacco use, and physical inactivity—known risk factors for many NCDs in the country. Even variables like fruit and vegetable intake weren't measured according to WHO recommendations. This limitation runs the risk

of overlooking nuanced socio-economic, cultural, or environmental determinants that contribute to multimorbidity.

I estimated the prevalence of multimorbidity and identified the most common comorbidities using a simple count of conditions. This approach implies that chronic conditions affect individuals equally, and therefore does not account for the severity of these various conditions or their non-random co-occurrence. In addition, the survey question, "have you ever been diagnosed with this condition?" does not capture information regarding whether the condition is currently active. This suggests that while this analysis is a reasonable starting point for determining the magnitude of multimorbidity, it is insufficient for establishing the complexity of multimorbidity and the interactions between different conditions [39, 42].

Another important limitation in the data collection exercise is the exclusion of individuals living in institutionalised residences and other geographically and socially marginalised locations such as the Ngami Delta and Central Kalahari Game Reserve (CKGR). This discriminatory practice not only continues and maintains systemic disparities but also denies these marginalised communities crucial representation in public health research. By excluding these people, we unintentionally continue a pattern of being unseen, depriving them of crucial healthcare resources and interventions designed to meet their unique needs. Furthermore, the lack of data from these areas compromises the reliability and inclusiveness of our research efforts, hindering our capacity to formulate evidence-based policies and interventions that truly depict the different circumstances in Botswana. Lastly, due to the cross-sectional nature of the data, I could not investigate causal relationships between independent variables and multimorbidity.

Despite these limitations, this study has generated valuable information on the burden of multimorbidity in Botswana's adult population and potential risk factors, which can inform future research and policy discussions regarding multimorbidity and the integration of HIV and NCD health services.

5.7 Chapter Summary

This study presents the first comprehensive investigation of multimorbidity in Botswana, utilising nationally representative data that includes a diverse range of chronic conditions, including communicable diseases such as HIV and tuberculosis. The results of this study provide novel insights into the epidemiology of multimorbidity within a nation undergoing the convergence of both communicable and noncommunicable diseases. The research paper identifies various sociodemographic and lifestyle variables, including gender, age, education, marital status, residence, and BMI, as significant factors that are associated with multimorbidity. Nevertheless, it is crucial to acknowledge that the BDS questionnaire did not encompass specific risk factors such as tobacco use, alcohol consumption, and physical inactivity. This omission underscores the necessity of incorporating these factors in forthcoming demographic surveys to enable international comparisons.

The highlights the identification of distinct combinations of chronic conditions that frequently occur together within the study population. Notable examples include the co-occurrence of hypertension and HIV/AIDS, hypertension and diabetes, and HIV/AIDS and tuberculosis. Understanding these frequently co-occurring conditions is essential for developing effective guidelines and interventions for individuals with multiple long-term conditions.

The increasing life expectancy in Botswana, particularly among individuals affected by HIV, coupled with the escalating prevalence of noncommunicable diseases, is expected to result in a significant rise in multimorbidity rates. This phenomenon is not limited to Botswana alone but is also projected to occur in other low- and middle-income countries (LMICs). This highlights the significance of producing empirical data that takes into account the prevalence of diseases and the socioeconomic inequalities that exist. Further investigation is warranted in future studies to expand the scope of research on multimorbidity. This expansion should encompass not only the quantification of its extent, but also the examination of its effects on diverse outcomes such as health-related quality of life, healthcare utilisation, self-reported health, and mortality. To enhance our understanding of multimorbidity, it is imperative to invest resources towards the acquisition of population-level health data, which encompasses

longitudinal studies. This approach is crucial as it enables the ongoing monitoring of evolving multimorbidity patterns over time.

Chapter 6 Study 3- Perspectives of Healthcare Professionals: Qualitative Study

6.1 Overview

Botswana, like many other SSA countries, faces a dual challenge of communicable diseases and NCDs. This convergence of health conditions creates a complex multimorbidity landscape, placing significant demands on healthcare resources and infrastructure. Understanding the perspectives of healthcare workers and policymakers is therefore crucial, given their pivotal roles in delivering chronic care services and shaping healthcare policies and programs. Exploring the experiences and views of these key stakeholders is essential for gaining a comprehensive understanding of the challenges, opportunities and potential solutions surrounding multimorbidity care in Botswana. It is worth noting that the existing body of evidence on multimorbidity care predominantly originates from high income countries. To date, there is dearth of published research on multimorbidity care in Botswana, emphasising the critical need for studies that specifically address the unique challenges and context of this country. This chapter begins with a description of the methods I utilised in this qualitative component, followed by the results of the interviews in the form of themes and subthemes. Lastly, I will discuss the findings in relation to the existing literature on multimorbidity care.

6.2 Aims and Objectives

The purpose of this study was to explore the experiences and perspectives of healthcare providers and policymakers on the care and management of people with multiple chronic conditions. The specific objectives were:

1. To explore how healthcare workers in urban and rural settings in Botswana understand and perceive multimorbidity
2. To evaluate their experiences and practices in organising and delivering care to individuals with multiple chronic conditions.

3. To identify barriers and opportunities in providing multimorbidity care within Botswana's primary healthcare system.
4. To elicit views on strengthening the primary care response to multimorbidity care and prevention.

6.3 Methods

Full details on the methodological approach for this qualitative study are described in Chapter 3. To allow for a thorough understanding of multimorbidity from healthcare professionals' perspectives, a qualitative approach was adopted. I utilised semi-structured in-depth individual interviews.

6.3.1 Ethics Review

This study was carried out in accordance with the principles of the International Conference on Harmonisation Tripartite Guideline for Good Clinical Practice (ICH GCP). I obtained ethical clearance from multiple institutions, including the Edinburgh Medicine Research Ethics Committee (EMREC) and local ethics committees in Botswana, where data collection occurred. EMREC granted ethics clearance on January 20, 2022 (Appendix 10), while the University of Botswana's Office of Research and Development approved the study on November 16, 2021 (Appendix 11). Additionally, the Ministry of Health and Wellness, through the Health Research and Development Division, issued a research permit on November 26, 2021 (Appendix 12). To ensure district-level compliance, I submitted my protocol and ethics clearance letters to the Research Committees in the four participating health districts. This caused a one-month delay in the data collection process. Approval letters from the four districts are attached in (Appendix 13).

6.3.2 Sampling

As mentioned in the methods chapter, my study targeted healthcare workers (doctors, nurses, social workers, community health workers, pharmacists), and policymakers across relevant health related organisations. Purposive sampling was used to select health districts in this study. Out of the 27 health

districts, I selected 4 health districts. These districts namely, Greater Francistown, Greater Lobatse, Boteti and Kgalagadi South, were selected based on their rural and urban distinctive characteristics and availability of healthcare resources. This study was conducted in 14 primary health care facilities across the four selected health districts.

6.3.3 Recruitment of participants

Prior to data collection, I engaged the NCD and HIV units in the Ministry of Health to become familiar with the key stakeholders and policymakers who could potentially take part in my study. The Ministry of Health shared information on key stakeholders who had been involved in the NCD strategic framework, national health policy, and HIV national framework. I started with phone calls and emails introducing myself and my study (Appendix 14), and those who showed an interest were sent more information about the study. Recruitment of healthcare workers began by engaging gatekeepers in the form of DHMT Coordinators in the four health districts where my study was based. I made a telephone call followed by a letter which were sent via email introducing my study, (Appendix 14), giving details of the study and seeking permission to do the study in their districts. The coordinators were invited to share the study details with healthcare workers in their districts. I also shared a flyer my study on social media platforms such as Facebook, Twitter and LinkedIn. Recruitment flyers (Appendix 16), showing the aims of the study was put up in these platforms with my contact details. I also made phone calls directly to healthcare facilities to enquire about their availability to participate in the study. Participants who showed an interest in the study were then sent information sheet (Appendix 17) and consent forms (Appendix 18) via email or post-office. They were afforded 2-3 days to review the provided information sheet before granting their consent. Once they confirmed their participation, I scheduled an interview at their convenience. Due to the COVID-19 situation, consent forms were also administered remotely. Participants with access to a computer, scanner, internet, or email sent a signed copy (scanned/photographed) to my university email address. For those unable to

send a signed copy electronically, oral consent was obtained via phone at the outset of the interview.

6.3.4 Data collection

Data collection took place between March and June 2022. I conducted telephone interviews lasting between 28 and 69 minutes (average 56 minutes) with healthcare workers and policymakers. The interviews were informed by a semi-structured interview guide that I developed drawing on previous research exploring multimorbidity and NCDs, especially in low-income settings. Two separate interview guides were developed for healthcare workers and policymakers. The interviews were carried out in English, but participants were free to use the local official language, Setswana, if they wanted to express themselves better. Appendix 19 shows the interview guide for healthcare workers and Appendix 20 is an interview guide for policymakers.

6.3.5 Data analysis

The interviews were audio-recorded and subsequently transcribed by a graduate student at the University of Botswana. The transcriber is proficient in both English and Setswana and also provided translations for the portions of the interviews conducted in Setswana. To ensure accuracy, I conducted a thorough review of the transcripts, comparing them against the original audio recordings, and took measures to anonymise the data before commencing my analysis. After repeated reading and immersion in the data, transcripts from two healthcare worker and two policymaker interviews were used to generate initial codes. I did this with my primary supervisor Dr Christine Campbell (CC). We initially did this coding exercise independently and came back to discuss our codes.

Analysis of the interview transcripts was conducted using thematic analysis (Braun & Clarke, 2006). All anonymised transcripts were uploaded onto Nvivo12 software. To ensure a logical flow of the chapter, I have organised the findings by themes, with sub-themes discussed in greater detail under each overarching theme. Participant quotes are included to support and illustrate

my analysis and interpretation of the data. To ensure confidentiality and anonymity, all participants were assigned codes instead of using their real names. For healthcare workers/ clinicians I used the code HCW1, HCW2, and so on, whereas policymakers were identified as PM1, PM2, etc.

6.4 Findings

6.4.1 Study Participants Characteristics

I interviewed twenty-seven (27) participants with differing roles within the healthcare system of Botswana. Fourteen (14) were healthcare workers from different primary care facilities within the four selected health districts. Thirteen participants (n=13) were at policymaking level in different organisation within the healthcare sector. These included programme implementers and senior government officials at the Ministry of Health, researchers, and representatives from International Organisations who are involved in policymaking and strategic decision making. There was sufficient variation of participants in terms of their professional portfolio responsibilities, and their years in service. The healthcare workers group consisted of general nurses, family nurse practitioners, pharmacist and medical officers/physicians with age ranging from 29 to 57 years, and years of experience between 4 to 36 years. Among policymakers, their age range was between 38 to 60 years, while years of experience ranged from 10 to 35 years. Table 15 provides further details on the participants' characteristics.

Table 15: Demographic Characteristic of Study Participants

Demographic Character	Categories	Frequency (n)	Percentage (%)
Gender	Male	11	40.7
	Female	16	59.3
Age	24-35	3	11.1
	36-45	7	25.9
	46-55	12	44.4
	≥55	5	18.5
Years of Experience	< 5 years	2	7.4
	5-10 years	2	7.4
	11-20 years	12	44.4
	>20 years	11	40.7
Profession	General Nurse	6	22.2
	Family Nurse Practitioners	2	7.4
	Medical Officers	5	18.5
	Pharmacists	1	3.7
	Policymakers	13	48.1

6.4.2 Thematic Analysis

6.4.3 Theme 1 Understanding Multimorbidity

This theme outlines participants' understanding of the concept of multimorbidity: specifically, how the stakeholders define or understand this concept, and whether they utilise the concept in their work. This theme also examines healthcare professionals' awareness of the interconnectedness of chronic conditions, including their shared risk factors, and their interactions. Their responses were captured in two sub-themes: "conceptualisation of multimorbidity", and "awareness of the complexity of multimorbidity".

6.4.3.1 Conceptualisation of multimorbidity

Participants were asked if they were familiar with the concept of multimorbidity. There were variations in terminology usage and awareness, with some

healthcare workers expressing a clear understanding of multimorbidity, while others were less familiar with the specific term. The majority of healthcare professionals generally understood multimorbidity as the presence of multiple health conditions or chronic illnesses in a single individual.

> *“My understanding of multimorbidity is that it means having more than one health problem at a time. If someone has more than one problem or morbidity, it cripples more than one organ of the body.” (HCW10)*

> *“A patient would come, let us say for sugar diabetes, and you will realise that this patient also has hypertension, maybe the patient is also suffering from morbid obesity, the person might also have HIV.” (HCW2)*

Healthcare workers most often used terms like “comorbidity" and "multiple chronic conditions" interchangeably with multimorbidity, indicating a familiarity with the concepts but not always using the term “multimorbidity” explicitly.

> *“For us because we have been dealing with HIV, and also studying diabetes, we have clinical trials looking at hypertension, we are already used to the issue, you might call it coinfection or comorbidity.” (PM2)*

> *“We just generalise them and say comorbidities or just chronic conditions. When I saw it in the documents you sent me, I just said to myself, maybe its terminology used in research. I think we use the concept of multiple conditions or comorbidity, even when patients are admitted there is always that main one put in front like maybe say, if it is HIV, the rest then follow. Every time you see a patient you focus on that one first before you go on to deal with the others. Even when we register the patient you would probably put HIV as the core one and the others become secondary.” (HCW14)*

Some policymakers highlighted the relevance of multimorbidity in the context of global health and healthcare policies. They viewed multimorbidity as an important concept that encourages a shift from a narrow focus on treating single conditions to adopting a more holistic approach to healthcare.

> *"Yes, I was aware of the concept because you know this concept may come in different forms, the term that is usually used is integration, a one-stop solution where we try and look at the patient holistically without just thinking or managing one condition at a time." (PM10)*

> *"No, I have not heard of it, but it sounds like something that is very important. I like the multimorbidity thing because it is something that is driven by global finance mechanisms... So, that terminology can really assist us if we can understand it and use it in our documents to move away from that attitude. (of single disease focus)" (PM13)*

6.4.3.2 Awareness of the Complexity of multimorbidity

The study participants recognised that multimorbidity poses a significant challenge within the healthcare system of Botswana. Healthcare workers particularly shared real-world examples of multimorbidity cases they encountered in their clinical practice. A consensus emerged from these discussions, highlighting the changing disease profile in Botswana — from primarily infectious/ communicable diseases to a rising prevalence of NCDs. Study participants reported the most prevalent conditions they deal with in their daily work, including hypertension, diabetes, heart disease, chronic kidney disease, HIV/AIDS, cancer (cervical and breast cancer), asthma and musculoskeletal conditions. The most common reported comorbidities was hypertension, diabetes and HIV/AIDS.

> *"Yes, yes. It's a major problem because I have seen most of the patients hardly have one chronic condition; most of them*

usually have a medical condition accompanied by another; either hypertension, with diabetes, or hypertension with kidney disease." (HCW13)

"Back in the day we used to worry about infectious diseases like HIV, and now with drugs people can manage to live with it for many, many, years. We also see now noncommunicable diseases coming into the picture." (HCW11)

Healthcare workers and policymakers identified several key risk factors contributing to multimorbidity. They suggested that lifestyle and environmental factors might be playing significant roles in the prevalence of multimorbidity.

"I also think that something that may cause people to have these conditions in our area is shortage of water. The water this side is hard, it affects kidneys and other things. Alcohol use is visible, and it is one of the risk factors that may lead us to having these NCDs. We also have a challenge this side, we do not have vegetables, if I may say so plus like I already said, we have shortage of water. But we always make sure to encourage them to engage in physical activity as it is critical for people with these NCDs." (HCW7)

"Mostly it is women, there are not many men coming to the facility for consultation. That is why I said I am not sure if it is culture related because it's like women this side engage a lot in physical work; they work at the cattle posts or at the ploughing fields, so maybe they lift heavy things, so they tend to have conditions such as hypertension and arthritis. (HCW9)

Furthermore, participants shed light on the significant role of age on multimorbidity burden. They observed that the ageing population, particularly among those living with HIV has led to a noticeable increase in the likelihood of NCDs coexisting with communicable diseases.

"Yes, it is true as I have just said that as you grow older, the NCDs set in, conditions such as High Blood Pressure, things like hyperlipidaemia, and cardiovascular conditions. HIV as it were, I think it promotes aging because people are no longer dying because of survival." (PM12)

Additionally, the participants also noted the co-occurrence of chronic conditions such as HIV, TB, hypertension, arthritis and diabetes among younger age groups, challenging the perception that these conditions primarily affect older individuals, raising a concern about the early onset of multimorbidity and its long-term implications.

"NCDs are growing, and what is mainly worrisome is that nowadays we see them even occurring among the younger population... They are leading to a lot of premature mortality". (PM6)

The coexistence of HIV/AIDS with NCDs was also highlighted as a major component of the multimorbidity burden in the healthcare system of Botswana. Participants noted that individuals living with HIV/AIDS are more likely to develop other diseases, resulting in multimorbidity. Participants stated that along with HIV, patients often have comorbidities and acknowledged that the combination of these conditions exacerbates the complexity of managing multiple conditions in these patients.

"People with HIV develop NCDs along the way... this complicates their care." (PM1)

"Botswana is a young country, so when HIV started it affected the younger people... the concept of aging with HIV is there... So, we still go back to the NCDs. They survive, they are working, they are productive, and they get obese like I said. With obesity, they get cardiovascular conditions like diabetes and others." (PM12)

Reflecting on their experiences of providing care to patients with multimorbidity, healthcare workers acknowledged the complex nature of multimorbidity, recognising the challenges it poses for both patients and caregivers. They underscored the importance of considering potential drug interactions, adverse reactions, and complications that may arise from the presence of multiple illnesses when caring for patients with multimorbidity. Moreover, the participants emphasised the importance of healthcare providers possessing a thorough understanding of the effects of all prescribed medications to ensure their safe and effective use within this population. Furthermore, they highlighted the critical need for effective management of comorbidities within the context of the ongoing COVID-19 pandemic.

> *"But it does not necessarily mean that the patient will always be having diabetes and chronic kidney diseases at the same time, some of them develop chronic renal disease as a result of chronic disease like high blood pressure which is being poorly controlled or poorly managed due to different factors. Uncontrolled diabetes or uncontrolled hypertension can result in damage to the kidneys or even the heart itself, and cause heart failure." (HCW2)*

> *Patients need specialized care from people who understand the pharmacological effects of all the drugs they are taking; possible adverse reactions, interactions of drugs, and complications of the illnesses themselves. (HCW11)*

6.4.4 Theme 2: Experiences in providing multimorbidity care

This theme describes the complexities of providing care for patients dealing with multiple chronic conditions, a situation that demands well-coordinated healthcare approaches. I explored this theme through four sub-themes, covering how healthcare services are organised at the primary healthcare level to address multimorbidity and the vital connections between primary care and

more specialised care, patient monitoring and follow-up, the integration of NCDs and HIV, and the critical role of primary care.

6.4.4.1 Organisation of patient care and referral process

Participants described how patient care is organised and their approach when dealing with patients with multiple chronic conditions. Participants reported that the healthcare system is structured in a hierarchy of facilities, starting from mobile stops and health posts, progressing to clinics, primary and district hospitals, and the highest level of care being referral hospitals. Mobile stops are scheduled visits by healthcare teams, including nurses and health education officers, to clinic catchment areas. They offer healthcare services to communities, particularly individuals who face challenges accessing the main clinic. Services provided include vaccinations, basic check-ups, health education, and referrals for more extensive care at the main clinic. Participants revealed a structured approach where patients are often referred from lower-level facilities to higher-level ones. Participants further highlighted that referral pathways are based on the severity and nature of the conditions, and these could be made to primary hospitals, district hospitals, referral hospitals, or specialised centres.

> *"...So, depending on where the client starts, when they start from mobile stops, they would be sent to the health post, and from the health post they would go to the clinic, from the clinic they would go to the primary hospital which is either Letlhakane Primary or Rakops Primary. And then from there if their condition is not managed then they would be sent to Nyangabgwe or Maun or Serowe." (HCW1)*

> *"There are channels of referral where patients can go if they are seen at a low-level facility and the health worker feels that they need to be seen at another level which would be the primary healthcare level that is the lower-level hospital, then they are referred there to be seen by doctors." (PM6)*

Participants indicated that screening for chronic conditions is usually initiated at the lower level of care. Patients initially present to nurses at the clinic or health post, who will then conduct preliminary assessments, including screening, vital sign measurements, history taking and provide basic consultations before they refer them to doctors for further evaluation and management.

> *"So, in terms of how our system is structured for these patients, when the patient comes, they do not go straight to the medical officer; they have to pass through the nurse first, and if the nurse feels like they cannot manage the patient, then they send them to the doctor." (HCW13)*

> *"Nurses review these patients to a certain extent, in the past they would review and refer to a referral hospital, but these days we have family medicine, and they are referred there, the Family Medicine officer will then talk to the referral hospital." (PM7)*

Healthcare workers explained the link between lower-level facilities and secondary care, indicating that after the nurses have done the preliminary investigations, the patient is referred to a resident doctor/ medical officer either at the clinic or at the primary hospital to review the patient and decide on appropriate intervention. Patients with controlled conditions and who do not need specialised care are managed in local clinics by the nurses and doctors. Those who need specialised care and/ or with complex or unmanageable conditions, are referred to higher-level facilities or specialised centres.

> *"The procedure is the same for both single and multiple conditions and it also depends on the distance between the facilities where they access service and where they access specialist services. For instance, diabetes has specialist clinics unlike hypertension although cardiac diseases have cardiologists but with diabetes, specialist clinics have been set*

up specifically for diabetes in Francistown and Gaborone. But for say arthritis, the patient will be referred to orthopaedic after being stuffed with ibuprofen and paracetamol for a long time unlike diabetes where when we pick that it is elevated, we immediately refer to diabetes clinic for specialists." (HCW10)

"I'm sorry, I will keep on using hypertension and kidney disease as examples in trying to provide answers. For someone with high blood pressure, once they have those kind of signs and symptoms of heart failure, as part of management, we do those investigations then looking at the extent of the symptoms or signs in our DHMT, we refer them first to the physician. We book them to be seen by the physician at the Outpatient Department in our hospital of which after that, the patient can also be referred further to a sub-specialist like a cardiologist in Marina, so that is how it is most of the time. So it is us at the clinic, then physician, then the physician will see. For the patient with the kidney disease, it's the same channel. It is us, the physician then the nephrologist." (HCW2)

The study participants further reported that some patients present with complex conditions that require specialised consultations or uncontrolled conditions. These patients are usually referred to specialised centres, or referral hospitals such as Nyangabgwe or Marina. The referral process often involves communication between healthcare providers, and appointments may be booked for patients at the receiving facility. This may involve direct booking with a specialist, considering the urgency of the situation. Booking systems exist for scheduling specialist appointments, with specific days allocated for different specialties.

"And then on the issue of linking with Nyangabgwe, those that I have seen and determine that they need to see a cardiologist or internal medicine specialist, I call the hospital to book,

depending on the urgency, if it is very urgent, I talk to the specialist directly and they give me a date. If it is a patient that can wait for maybe up to 3 weeks or a month, there is a booking system that the hospital uses. If you want such and such a clinic, there are certain days assigned for bookings for that particular clinic. In that case, we just make a list of those patients, say the ones who need to see a cardiologist we book for them on Fridays" (HCW12)

"So, when you look at health care setup at our level, I think we are doing well but as cases become more complex, that is when we say we need help because when cases become more complex and they need more specialised services, they need more sophisticated equipment, that is where now we need to refer and people in higher facilities tend to specialise. That is why we have the concept of centres of excellence where you have these diabetes clinics, like Block 6 in Gaborone, Donga in Francistown, these facilities have a role more especially for complex cases that cannot be managed by an average health care worker" PM10

6.4.4.2 Patient monitoring and follow up

Patients with multimorbidity receive ongoing care and monitoring to ensure their conditions are well-managed. Healthcare workers revealed that the frequency of monitoring varies, with some patients undergoing monthly check-ups, while others have less frequent assessments. These check-ups include regular blood tests to evaluate their overall health and the effectiveness of their treatment. Healthcare providers emphasised the importance of attending these regular appointments to maintain optimal control of the conditions and prevent complexities.

"While they are on treatment, they are monitored either on monthly basis or after three or six month's basis depending on

what the doctor has found. There are some investigations that can be carried out to see if the impact of the condition or how it has progressed." (HCW10)

"Well, as their doctor my main responsibility is to make sure that their chronic conditions are controlled; if they have a BP, I make sure that the BP is controlled, they get proper medication and give the patient review dates to see if the medication you are giving for the BP is working. And of course, the patients will come for regular check-ups of BP or sugar levels when we are trying to control the sugar diabetes and control the BP for chronic hypertension. So, the main goal is to make sure that both of the conditions are controlled in every patient, and this what we want to achieve when see this patient." (HCW10)

6.4.4.3 Integration of HIV and NCDs services

Some healthcare workers reported a significant prevalence of comorbidities of HIV and NCDs. They highlighted the historical practice of segregating healthcare services for different conditions. This separation often results in patients being seen in different places for HIV, diabetes, hypertension, and other chronic conditions. Patients may not readily disclose their HIV status in non-HIV clinics due to this segregation.

"You also talked of HIV that we have a problem of HIV in the country, so people who are HIV positive are seen in their specialised clinics but you also find that HIV leads to suppression of immunity leading to the patient developing these other NCDs. But what happens is that when they are seen at their specialised clinic, only the HIV part is being attended to. They still have to go see the doctors or nurses for their diabetic care, they will still need to go and see a different somebody for their hypertension care, if they also have cancer, they will still need to go to a different place to be attended. That is very tiring

for the patient because they have to go to different places. Like I mentioned earlier that we have high care HIV, TB clinics and then we are having NCDs with very less funding. So, sometimes you find that with NCDs, the care is not that advanced compared to HIV." (PM6)

"There are a lot who will also be taking HIV treatment. Mostly I saw most of them where it appeared like there are issues with renal function. There is still this thing whereby patients are used to this arrangement where there is IDCC where they are seen for their HIV medication and then there is where they are seen for diabetes and hypertension. When you see them they are rarely forthcoming in revealing that they are on ARVs unless if there is something that forces you to probe and ask them whether there is any treatment that they are taking and that is when they will tell you that they are on ARVs, not that they are hiding it, just that they are used to this segregation of services where there are seen in different places for different conditions."(HCW12)

Efforts to integrate HIV and NCD services within healthcare settings was mentioned as a pivotal strategy to shift away from separate clinics for HIV care. Participants indicated a decisive move towards an integrated service delivery model that seeks to combine HIV and NCD care. This shift was said to be driven by the recognition that patients benefit from holistic care. Participants indicated that the primary goal of integration is to streamline patient care and reduce the need for multiple clinic visits.

"We have an IDCC clinic, when a patient comes for ARVs, we would have a doctor, nurse and pharmacy technician, so when they are there, they are screened thoroughly and if found to have other conditions such as high blood and diabetes they are provided with care right at that clinic. Even on days that we do

not have IDCC clinic, an HIV positive person walking in for his health services, or maybe if it is a first timer with high blood, we investigate them holistically, we do not send them back on the grounds that they will come on Wednesday to be attended at IDCC. If it is a new client with diabetes or high blood, we do everything here and then we would book them for IDCC where they continue getting all the services/care." (HCW7)

"Like taking for example the IDCC, which has always been regarded as HIV clinic, now they are being compressed so that they can see all chronic conditions. If you are HIV positive and you also have diabetes, there should be one care, one stop. You are seen there and given all the necessary care without having to move around the whole clinic. And also the availability of drugs, that a patient can get their HIV drugs as well as drugs for other conditions in the same place." (PM9)

Despite the push for integration, challenges related to infrastructure and stigma persist as significant barriers. The use of separate infrastructure for HIV services contributes to stigma, with patients automatically labelled as HIV positive when accessing these facilities.

"The infrastructure that was set up, in most facilities, IDCCs are run from caravans, people who go there automatically are known to be HIV positive and then there comes in the stigma that as long as you are getting service from the IDCC, you are living with HIV. We were advocating that even though infrastructure may be restricting, let us try to allow these people to access service anywhere, when I enter the consulting room, I should be able to be attended to for everything that I am coming with without me having to move from one service point to the other." (PM5)

6.4.4.4 The role of primary care

The role of primary care in the management of multimorbidity, as described by both healthcare workers and policymakers is undeniably central and pivotal. Despite the challenges faced by primary care facilities in the districts – characterised by limitations in specialist services, constraints imposed by their primary healthcare designation, and growing demands on their healthcare infrastructure – primary care remains the primary point of contact for a diverse patient population. This setting assumes the responsibility of providing comprehensive care, addressing the complex needs of individuals grappling with multiple chronic conditions.

> *We also provide services through mobile stop, we go to these farms, the cattle post where you will find that most of these disadvantaged people stay there. So, this is one way of taking services to them. (HCW3)*

> *"I cannot really say but in our DHMT, most of the staff like the doctors at Athlone Hospital, Athlone Hospital is like a district hospital for the DHMT, somehow, we managed to make an arrangement, to at least have one doctor at a clinic on a particular day. For example, in Lobatse I think there are four or five clinics, so, in those clinics, from Monday to Friday, we have asked them to make bookings for a certain number of patients each and every day so that the doctor can see those patients. The challenge is because of the number of staff; we can only send one doctor per day." (HCW2)*

Some healthcare workers were of the view that the introduction of family physicians in some districts has improved the management of patients with multiple chronic conditions. Family physicians serve as gatekeepers between primary and secondary care and can manage various conditions locally, reducing the need for referrals.

"I am going to be frankly honest, before we had a family physician, they (patients) were disgruntled they, really did not like having to go to Francistown or Maun Letsholathebe to be seen by specialist to be able to control all their conditions. But since we've had a family physician in the district, they are now a lot happier because it's like a one stop shop, they can come with all their conditions, and they get help from one person without having to move from one place to another." (HCW1)

"...but in Letlhakane here, the patients are seen every day, Monday to Friday. So, they are seeing around 10 to 15 patients per day, so if the doctor seeing the patients now, that is the Family Physician, then the eye clinic will be after a day or two from there or the patient is seen the same day. In my area, the management of these patients I would say is done well especially among the family nurse practitioners, doctors, and the family physician." (HCW3)

Participants also highlighted the pivotal role of Family Nurse Practitioners (FNPs) in the management of chronic conditions, particularly diabetes and hypertension, in various healthcare facilities. FNPs are prominently featured as key contributors to patient care, with instances of established diabetes and hypertension clinics run by FNPs, demonstrating their ability to independently manage these conditions. Collaboration between FNPs and other healthcare professionals is highlighted as a strategy to optimise patient care, especially in areas with limited access to doctors.

"Already I found Family Nurse Practitioners having started diabetes/hypertension clinics here. The plan was to link with FNPs in the area to roll out these chronic care clinics and try to establish them in bigger clinics to avoid having all patients referred to me because otherwise it that becomes the case, it

would then mean my bookings would also stretch and it would not be of benefit to them." (HCW12)

"...but although there is that shortage, we have Family Nurse Practitioners who are clustered so that they can also attend to these patients, but they are also not enough. In one way or the other, they have been trained but I think they can be trained further to enable them to monitor patients' right at the rural areas. Of course, the doctors will come and review them but there is room for giving them the skill so that they manage the patient." (PM7)

Participants underscored the essential role of community health workers (CHWs) in the nation's healthcare system. Their participation was deemed necessary for effectively implementing primary healthcare principles and elevating overall care quality. They function as a bridge between healthcare facilities and local communities and deliver comprehensive health education and services. One notable development, as reported by a participant, involves equipping CHWs with advanced technology and comprehensive training to facilitate integrated care. This includes screening for a broad spectrum of health conditions, including HIV and NCDs.

"Our primary care system is good and like I said we have family welfare educators who know patients that we have in the community and also know their places of residence. We also have community home based care volunteers who check on patients and report back to the facilities, this same process is good for our country." (PM7)

"But at the same time when you look at equipment, you have people who could not measure their blood sugar level and people who could not measure their BP because they do not have gadgets at home. Now we have bought so many of those

and we have teams that are community health workers that will be able to go around and check those things." (PM10)

6.4.5 Theme 3 Health Policy Environment and Governance

Under this theme I explore the interplay between policies, leadership, and tools that shape healthcare in Botswana, particularly when addressing challenges of providing care for individuals with multiple chronic conditions. I will look at the various aspects of health policy and governance, including the key players involved, national health policies and programmes, the distribution of funding, and the active involvement of communities and stakeholders.

6.4.5.1 National Health Policy Context

The National AIDS and Health Promotion Agency (NAHPA), formerly known as the National AIDS Coordinating Agency (NACA), assumes a crucial role in facilitating the coordination of the nationwide efforts to address HIV and NCDs in the country. Policymakers discussed the role of NAHPA, which involves the formulation of strategies and frameworks to guide national response to HIV and NCDs, coordination of multiple sectors, the solicitation of funds, and monitoring of national response to HIV and NCDs. Participants highlighted that the transition to NAHPA, which officially happened in 2018, indicates a shift towards a comprehensive approach to healthcare challenges, especially the interconnected issues of HIV and NCDs in Botswana.

"As a result of this NCDs problem, in 2018 NCDs were transferred to NACA hence the name had to change to National AIDS and Health Promotion Agency. Actually, what has been transferred is the prevention or promotion aspect of NCDs, but the clinical aspect still remains with the Ministry of Health. Ministry of Health is the custodian of all health issues in this country. NAPHA's mandate is to assist Ministry of Health to coordinate the response on NCDs and HIV." (PM 9)

"And I think with NACA (National AIDS Coordinating Agency) being rebranded to NAHPA (National AIDS & Health Promotion Agency) now because what they are trying to do is integrate HIV with other chronic conditions all in one, so I think it's going to take a bit of time, but I am really hopeful that we will get it right and our clients will now start being seen in one place or we will leverage from all the good practices of HIV and provide services to our clients". (HCW 1)

Although the Ministry of Health retains the responsibility for addressing all health issues, developing health policies, and health service provision including NCD clinical management, certain individuals perceived the inclusion of NCDs in the mandate of NAHPA as a demonstration of the government's dedication to prioritising the response to HIV/AIDS and NCDs at the highest levels of authority. NAHPA is located within the Ministry of Presidential Affairs, an arrangement perceived by some policymakers as advantageous in terms of facilitating access to decision-makers and promoting coordination at higher levels.

Coordination aspect; the belief is that for any pandemic or disease to be tackled successfully, it should be a multi-sectoral approach therefore it was found fit to have an agency in the likes of NAPHA, to be given that mandate to do the multi-sectoral coordination, that is why it was very relevant to be under the Ministry of Presidential Affairs whereby instruction will be from there with all sectors; because when we say multi-sectoral, we mean all sectors; government, private, NGOs and the public, that is what multi-sectoral coordination means. (PM9)

Participants highlighted that the National Health Policy is a fundamental document that sets the framework for healthcare delivery in Botswana. It addresses various health conditions, including chronic diseases, and outlines

the government's commitment to providing healthcare services to all. This policy, which some participants reported it is due for revision, promotes universal healthcare by providing free healthcare to all citizens through the public sector.

> *"Also the fact that our healthcare is free is quite beneficial to a lot of patients especially medication even though currently there is a shortage of drugs. It has always been available for free. If we compare to the amount of money that people pay at private pharmacies, you will realise that medication is indeed expensive, but the government is doing very well with the health care system." (HCW14)*

> *"In Botswana our healthcare is free. But now policy wise as much as we know that people are expected to make a small contribution, we do not enforce that they do it strictly. If someone does not bring money, we still assist them, if the person cannot bring co-payment. At the same time, we do not even discriminate. So, the government health system allows that those who have and those who do not have can access a full array of services." (PM10)*

Another key instrument discussed by the participants was the National NCD strategy which was launched in 2019. The NCD strategy was described as multi-sectoral, involving not only the Ministry of Health but also other sectors. This approach aims to address NCDs comprehensively and engage various stakeholders.

> *"We also have the multi sectoral strategy on the prevention of NCDs which I feel it is another strength because it is not only focusing on the Ministry of Health, but it involves other sectors which would then have to know the role they can play in*

addressing the issue of NCDs in the country. We have actually limited our scope to deal with the four major ones. There are other NCDs that we could be looking into, but because NCDs is a very broad area, so we have actually narrowed down to these ones which are considered to be a major problem." PM6

We have what we call multi-sectoral strategy on prevention and control of NCDs for 2018-2023. It is comprehensive in the sense that even though it is looking at NCDs more especially the four NCDs that are highlighted by WHO as deadlier and the four risk factors that WHO pronounced as high-risk factors for NCDs but the approach is comprehensive. It is comprehensive in the sense that it includes everybody even people who are coordinating HIV, when it trickles down, it will include everyone that is why it is called multi-sectoral NCDs strategy." (PM9)

6.4.5.2 Collaboration across Sectors

Healthcare professionals acknowledged that addressing multimorbidity requires engagement and collaboration with various stakeholders, including government, civil society organisations, NGOs, and private sector entities. They discussed government collaboration efforts with development partners to improve healthcare services, mobilisation of resources including funding and capacity building.

"What happens also is that the Government itself engages development partners like Global Fund, UN bodies like WHO, UNAIDS, UNICEF and PEPFAR amongst others to assist it. So, it is working very well with these organisations helping government." (PM12)

"Then there are a lot of partners that are willing to help, not only in this district, like I previously mentioned the likes of FHI 360, BONELA and there is Debswana in the region. These are

organisations which are always willing to offer a helping hand, sometimes they even volunteer their help by coming forward to see where they can be of assistance. That is also a plus." (HCW12)

Some participants highlighted the interconnectedness between health and other social sectors such as education, transportation, and employment. They emphasised the need to recognise that healthcare is influenced by various sectors and that a collaborative effort involving multiple sectors is necessary to prevent and control multimorbidity effectively. The successful multisectoral approach used in combating HIV was frequently cited as a model for addressing emerging health issues including multimorbidity.

"So, the way that HIV was dealt with from the beginning, it took a multi-sectoral approach. It is not just a health issue; it is a social issue. So, the same goes for NCDs. We also appreciate that in order to respond effectively to prevent and control NCDs, we need a multi-sectoral approach, and everyone should be involved." (PM11)

"And then for the healthcare system to work well, it depends on other stakeholders. When you look at the issue of access, you might be talking about less than 5 km but when you look at the roads, sometimes they make it difficult. When you look at the availability of transport, the government might have money to pay for someone but when you do not have good public transport routes that go that way, someone can get stuck even though there is potential for them to be assisted by the government." (PM10)

In addition, the involvement of communities and CSOs/NGOs was noted as significant in multimorbidity care and prevention. Participants mentioned that government collaborated with CSO, FBO and community structures to drive

community-based healthcare initiatives and local solutions. The involvement of community volunteers and multisectoral committees at grassroots level was perceived as a strength in the healthcare system. Participants were of the view that engaging local communities can lead to better understanding of health behaviours, ensure visibility, and improve service delivery. The involvement of the private sector in supporting efforts to provide some healthcare services was also noted as a plus:

> *We are quite advanced, we have mobilised the civil societies that are working in the area of NCDs such as prevention and management of cancer, so we are working with NGOs that actually prevent breast cancer, NGOs like anti-tobacco those who are dealing with the issues related to tobacco, all the risk factors related to NCDs. (PM8)*

> *The private sector is also involved. For instance, Lion Club would do screening and at times private practitioners come together to do the health screening. Like today there is a cycling event and they requested us to put up a stall there so that we can do the health screening. (PM7)*

6.4.5.3 Funding and Resource Allocation

Inequitable distribution of financial resources within the health sector, specifically in relation to the allocation of funds between infectious diseases such as HIV, TB, and NCDs, emerged as a notable obstacle. Whereas diseases such as HIV and TB have received significant financial support, NCDs face challenges due to limited dedicated funding. It was acknowledged that the historical vertical funding of programs that prioritise certain diseases has led to disease-focused interventions often neglecting NCDs and other health issues. The current approach, driven by funding priorities, presents a challenge to holistic care and limits the ability of the healthcare system to effectively address multiple health conditions.

“I think it is taking time and mostly its being driven by disease focused funding. For example, if you take PEPFAR, if you are not doing HIV or if you do NCDs without HIV, they will not fund you. So, you will find that most people will do HIV and AIDS and NCDs and very few people will do NCDs alone. It just reflects on the nature of funding. So, it will carry a lot for the country to invest in focusing on NCDs and look at multi-occurrence or multimorbidity without infectious diseases like HIV and TB.” (PM2)

"The problem that we see mainly with the NCDs is that we do not have any funding that is dedicated to NCDs programme. We are always looking for funding. Programmes like HIV, TB, those ones they even have sponsors, there are people who are funding those programmes. So, that is why you find that there is a lot of interest in them, but when it comes to these NCDs sometimes even to train the health care workers becomes a challenge. Even the health care workers themselves, sometimes they even lose interest. So, it is really a big challenge that we are facing because even these sponsors when they come, you find that they have their own area of interest that they want to focus on.” (PM6)

Several participants were of the view that there was a significant political commitment to financing the healthcare sector in Botswana, as evidenced by the comparatively high allocation of the national budget every year, towards health. Nevertheless, a commonly held belief was that the main cause of the challenge primarily stemmed from the lack of prioritisation accorded to chronic health conditions within the budgetary allocation. The COVID-19 pandemic was cited as a significant example of how financial allocations can result in a re-evaluation of priorities, resulting in the diversion of resources from essential healthcare services.

"They would rather take money away from cancer, especially during COVID when a lot of services were stopped and most of the funding was transferred to fighting COVID, people felt the brunt of that, but it is not only COVID, there is always money being taken to prioritise one service over the other depending on a lot of things." (PM3)

"When you look at staffing, we pushed a lot of our resources; money, people, ICT, and everything in the direction of COVID such that when COVID became a priority all other medical conditions suffered. It was not like these conditions were not a problem, they were still a problem, it is just that we had one that overshadowed everything. Now, it is more like removing a mask, now we can deal with the situation for what it is, and it does not look good. (PM10).

Several of the participants acknowledged the availability of good infrastructure, a network of healthcare facilities that offer relatively accessible care, and a commitment to improving patient access to services particularly in rural areas as a plus for the healthcare system of Botswana.

The first strength is the availability of health care facilities together with the presence (although it may not be enough) of the skilled manpower or workforce which is able to deal with any emerging health situations or problems. The other strength is the perseverance/determination of the workforce (HCW10)

However, significant disparities in resource distribution and equity within the healthcare systems were noted. The participants felt that the prioritisation of HIV has resulted in a skewed allocation of resources leading to advanced treatment centres and protocols. In contrast, essential equipment, and resources for managing NCDs often lag behind.

“Like I mentioned earlier that we have high care HIV, TB clinics and then we are having NCDs with very less funding. So, sometimes you find that with NCDs, the care is not that advanced compared to HIV. Some remote areas have excellent HIV outreach, but when it comes to general healthcare services, they are barely covered." (PM6)

Participants stressed the need for policy changes that prioritise equitable resource allocation, support holistic healthcare services, and address the diverse health needs of the population. Integrated care was mentioned as a way to address the challenges of vertical programs, funding silos, and uncoordinated efforts.

“We are currently in the process of making an Investment Case for NCDs in Botswana which I think will highlight how NCDs in Botswana can be assisted in terms of finances. Investment case will even show how much we are spending as a country in extending care to patients with NCDs, even deaths that occur as a result of these NCDs because our interest is on the prevention side. And just so we know that this is how much money we would save for health if NCDs were well prevented. I think that is another strength.” (PM6)

Some participants discussed the initiatives that the Government of Botswana has introduced to improve chronic care. One of the initiatives involves partnering with private pharmacies to provide chronic medications to patients. Participants reported that patients with chronic conditions were given a card that allows them to access certain medications free at private pharmacies when stock shortages occur at public health facilities. The government bears the cost of these medications.

“It also turns out there is an arrangement by government that allows these patients to get medication at the private

pharmacies at the government's expense It is a new arrangement if I may so." (HCW5)

Recently there is a solution that was found by the Ministry of Health, there is some kind of a partnership with some private pharmacies in town whereby we can refer patients to go and collect their medication at a private facility. This is a new arrangement; we are actually implementing it now as we speak. I think I referred my first patient two days ago.

Another important initiative is where patients needing some form of specialised care, that the public health sector cannot currently provide, are supported by government to receive that care. Participants reported that in some cases patients who need complex operations or treatments are taken to facilities outside the country at the expense of government.

"...currently we have patients who are undergoing treatment which we do not have in the government sector, but the government is actually facilitating that those patients receive those services from the private facilities. Not only medication but treatment in general, for instance in the country we do not have a radiation facility for cancer, patients are seen in the private sector and the government pays fully for that. There are other treatments that patients receive from South Africa."PM6

Interviewees frequently mentioned the collaboration of healthcare workers and social workers to support and address the needs of patients with low socioeconomic status, especially concerning transportation and access to food. There was a recognition that patients with low socio-economic status often struggle to afford to transport themselves to other facilities for further care, or struggle to follow the recommended diet as part of their treatment. To address this issue, healthcare workers refer such patients to social workers

who can assess their needs. Social workers are accessible in many of these facilities, making it convenient for patients to seek assistance.

> *"If it is genuinely an issue of low socio-economic status, even you knowing that this particular person cannot afford, you refer them to the social worker and they will assess the client and if they are satisfied that the patient needs assistance they will put them on the food basket programme. There are those whom doctors have recommended that they eat a certain diet but they cannot afford it, we refer them to the social workers for the food basket programme, although it is not enough, it is something." (HCW10)*

> *"We are cognisant of the fact that people have limitations, yet health is a right that is why I was mentioning that even in our system whether you refer someone or you offer them services that are offered at a tertiary level far away from where they are, government will sponsor their travel to that area through the Ministry of Health itself or through S&CD at Local Government. We can actually even give them stipend for overnight stay so that they can be able to stay where they can get help without using any money from their own pocket. So, there are ways that we support everyone to ensure they get what they need." (PM10)*

The limitations of these programmes were also highlighted. Participants reported that in some cases, there are financial constraints within the social welfare programs, leading to challenges in providing adequate support. Additionally, social workers may face difficulties in assessing patients promptly due to their caseloads.

6.4.5.4 Training and Capacity Building

Policymakers mentioned that the Ministry of Health was committed to enhancing the capacity of their workforce through the development of integrated training programs and curriculum. It was also discussed that these efforts aimed at empowering healthcare professionals to provide holistic and integrated services. Moreover, the allocation of funding for education and continuous learning was highlighted as a tangible demonstration of the Ministry of Health's dedication to building workforce capacity.

> *"Across the country, healthcare workers were trained on this integration of health services, and we are now implementing" (HCW3)*

> *"As a ministry we are also committed to continuous learning, when you look at the budget and the policies that we have, they all encourage continuous learning throughout the working life of the health care professionals, be it through workshops or further education because you will notice that nurses themselves go to specialise with government paying for everything. These are good policies that encourage health care workers to continue learning. You would appreciate that when someone goes through a residency programme, every year, they get elevated to a higher salary scale so that they can also be motivated to study. It is an incentive for people to study." (PM10)*

Additionally, an important training initiative focuses on equipping community health care workers with the knowledge and skills needed to address a broader spectrum of health concerns. Beyond their role in HIV-related services, these workers are being trained to target risk factors associated with noncommunicable diseases (NCDs) using integrated approaches. Furthermore, ongoing efforts are directed towards enhancing the capacity of these community health care workers to conduct thorough screenings for

various health conditions, encompassing critical aspects like assessing risk factors such as tobacco use and promoting safe practices like condom use. This multifaceted training strategy aims to create a more comprehensive and effective healthcare system, capable of addressing a wider range of health needs within the community.

> *"So, we also train those community health workers so that they do multiple things. They will provide condoms, they will provide education for TB or deliver TB dose, we have not done it intensively but sometimes delivering ARVs to the community or homes through civil society." (PM12)*

6.4.6 Theme 4 Navigating Multimorbidity Care Amidst the Pandemic

The global impact of the COVID-19 pandemic on healthcare systems has been acknowledged widely. The data for this study was collected at a critical period in the timeline of the pandemic, characterised by upsurge in COVID-19 infections and related deaths, limited resources, uncertainty and fear, challenges in vaccine distribution, among many other challenges. This theme therefore offers a glimpse into the unique intersection of multimorbidity care and the COVID-19 pandemic, as perceived by the healthcare workers and policymakers in Botswana. By delving into first-hand accounts of those engaged in healthcare provision, this section examines their narratives through three sub-themes; impact on the healthcare delivery system, impact on multimorbidity care and of care, and lessons learned.

6.4.6.1 Impact on the healthcare delivery system

Many participants discussed how the pandemic led to an immediate shift of focus from certain programs and services, to manage the pandemic primarily. Participants noted that due to the immediate risk posed, COVID-19 necessitated diversion of resources such as finances, human resources, and infrastructure towards the pandemic response. As staff and funds for different programs and services were re-allocated to address the crisis, routine

healthcare services and the overall functioning of healthcare facilities were impacted.

> *"COVID also affected provision services to our clients because attention had shifted to managing it and even resources were diverted to dealing with COVID related matters and in the process relegating all the others." (HCW7)*

> *"Covid did affect our healthcare system in the sense that financially more resources were diverted, even human resources, and all were diverted towards fighting COVID-19. Even our statistics indicate that of the services were affected." (PM1)*

Several participants acknowledged that essential healthcare services such as immunizations, NCDs management, TB, and HIV care, alongside other routine non-COVID services, experienced setbacks due to decreased capacity in healthcare facilities. Staff members were often redeployed from their usual roles to assist with COVID-19 testing, contact tracing, isolation centres, and other pandemic-related tasks. This resulted in a reduction or temporary halt in regular outpatient clinics and services, affecting patient care.

> *"Covid has also affected the medical field, because of pulling of doctors and nurses from the clinics and hospitals to go and assist in Covid isolation centres and other Covid-related programmes. This alone put a strain on the facilities and sort of reduced the delivery of services to these patients." (HCW13)*

Respondents further highlighted resource constraints, including sharing of medical personnel, vehicles, and medical supplies between different facilities and departments. The need to establish isolation centres and provide care for COVID-19 patients strained available resources further.

“As I said, now, the government had to look for money, money that was meant for other programmes to buy vaccines. So, what does that mean? That is money that was never budgeted for so, it means that other services will have to suffer. This is where we are now. The government is over-burdened with health care. The consequences are that now other commodities may not be in continuous supply, you see that.” (HCW11)

6.4.6.2 Workforce Burden

Healthcare workers and policymakers widely discussed the significant impacts of the COVID-19 pandemic both at professional and personal level. They described challenges related to increased workload and inadequate staffing, arising from the need to balance between routine duties and the novel responsibilities related to the pandemic such as testing, contact tracing, and isolation management. They reported that the abrupt upsurge in COVID-19 cases often translated into an increased workload.

"It greatly affected me because there were times when you are off or you are not on call, and you are called from home to come and assist. It added on to our workload, we were called from home at odd hours to come and assist..." (HCW6)

“There was the issue of testing which meant one nurse would be allocated for testing the whole day or the whole testing session whilst other services were still continuing, there was also contact tracing and many other things. Some of us were taken and deployed to the isolation centres that were set up, it was the same staff that was on the ground resulting in us being short staffed, there was no time for new recruitments because we were responding to the situation as it came at the time.” (HCW10)

Additionally, pre-existing shortages in the workforce coupled with COVID-19 related challenges intensified the workload. Some participants reported that in most instances, facilities had to operate with fewer staff members due to quarantines, isolations, and infections among the healthcare workforce. This shortage placed a substantial burden on those who remained, necessitating extended working hours and additional responsibilities.

> *"So, if it's a colleague, it means they will be off work for 10 or 14 days depending on whether it is quarantine or isolation, this means more work for others, we would work long hours." (HCW8)*

> *We already had shortage of manpower pre-COVID, so the workers worked long hours, contracting COVID, they were to quarantine and isolate at homes, phones were busy from patients seeking help from their homes". (PM7)*

Furthermore, participants expressed deep concern over the tragic loss of colleagues to COVID-19, a reality that introduced both emotional and practical challenges. The absence of fellow healthcare workers placed a greater burden on the remaining staff, contributing to feelings of burnout and exhaustion.

> *"We were working like machines and unfortunately, it happened that we also lost a few colleagues, people we were working with." (HCW4)*

> *"We lost some of our colleagues to COVID hence shortage of staff." (HCW9)*

6.4.6.3 Impacts on multimorbidity care

Participants in the study reported that COVID-19 pandemic had a substantial impact on healthcare services leading to the suspension of certain clinics and healthcare facilities. The primary reasons for the suspension of services were related to unavailability of staff, isolation

requirements, and other personal issues. Many patients faced significant challenges in accessing healthcare facilities for their routine check-ups and medication refills. This disruption in care was a cause for concern as it had the potential to lead to uncontrolled chronic conditions and the development of potential complications.

> *"It really hit them (patients) because there are some services which were suspended. For example, some clinics had to be suspended because of this COVID issue primarily due to unavailability of staff; some due to isolation, some due to other personal issues." (HCW2)*

> *"*Well, Covid has done a lot of damage I believe. One way the pandemic has affected services, like the one we just mentioned, because it has caused economic recession, which led to shortage of chronic medications and therefore affecting or having a rise in patients that are having chronic conditions that are uncontrolled, and leading to complications of these conditions that we were always trying to avoid." (HCW13)

Another notable issue that emerged was the reduction in access to specialised services, particularly affecting patients with comorbidities like diabetes. Participants reported that specialised services such as eye checks, which are crucial for monitoring the health of diabetes patients, were interrupted, or entirely halted, during the pandemic. This interruption in specialised care had implications for the overall well-being and management of individuals with multiple chronic conditions.

> *"Post COVID, we realised that a lot of patients defaulted on a number of treatments as a result of COVID and some of them took advantage of that and some were in places where they could not access services. Even in the facilities, there were restrictions, for example, a patient who has diabetes, at certain*

stages, they need their eyes checked, some services like eye services were interrupted and, in some areas, other services were stopped altogether." (HCW12)

Participants in the study consistently reported that the COVID-19 pandemic had a profound effect on patients' adherence to their treatment plans for chronic conditions. The primary reasons for this decreased adherence were related to the restrictions and challenges imposed by the pandemic.

"In terms of managing comorbidities, that was also affected as some people missed their appointments because of either isolation or quarantine. A patient will tell you that they could not come for their HIV medication because they were quarantined in Gaborone and there was no how they could travel to access care." (HCW6)

"What happened is that chronic conditions like hypertension, diabetes, people did not go to the facilities to get their medications, they stayed home, sugar levels went high, it was a little bit complicated, that is why we saw people dying in large numbers, some because now their conditions worsened." (PM9)

The pandemic was associated with the development of new chronic conditions in individuals who had contracted COVID-19. These conditions included hypertension and diabetes, which were previously absent in these individuals. This phenomenon raised concerns about the potential long-term health impacts of the virus on survivors. Healthcare professionals expressed uncertainty about the long-term health consequences of COVID-19, especially regarding the development and progression of chronic conditions in survivors. Continuous monitoring and research were deemed essential to better understand and address these emerging health complications.

"Yes, basically here most of the patients we see have multiple conditions because they come there, we have realised that COVID is even giving them conditions like hypertension, some of them are developing DM (Diabetes Mellitus) because of the contraction of COVID. So, we end up having to deal with multiple conditions. Some of them end up affecting the kidneys, the lungs and the liver." (HCW14)

"Not yet but we are starting to suspect that it has left people with some illnesses probably start looking at post COVID complications that we are sitting on to see what we can do but not at policy level yet. We see people who did not have diabetes, post COVID starting to show signs of higher blood sugar levels. We saw others starting to have hypertension, slight enlargement of the heart. It is not a study that one can put on the table, but we see one or two cases that tells us that that could have happened." (PM4)

6.4.6.4 Learning and Adjusting

Participants shared the adaptive measures taken by healthcare systems and professionals in response to the challenges posed by the COVID-19 pandemic and the management of chronic conditions. Respondents noted that the pandemic prompted the adoption of technology and virtual care options, which allowed for remote consultations and efficient dissemination of health information. The rapid integration of digital platforms allowed to bridge the gap between patients and providers.

"People were provided with cell phones and tablets for registering patients, provision of internet in places such as Lorwana, things we have cried for before, mind you. Our health care system can afford them, there was a crisis, but we can still go on beyond COVID because it is costly to send an ambulance

just to go collect a printout of results when I could just go into the system and access them. (HCW14)

During the COVID-19 pandemic, participants observed a significant shift towards a more active role for doctors in the review and management of patients with chronic conditions. This transition includes patients who were formerly under the care of nurses or local clinics now being referred for doctor reviews. This proactive involvement of doctors is widely regarded as a positive step towards enhancing the quality of care. Moreover, the pandemic has served as a vital lesson for healthcare professionals, underlining the utmost importance of vigilance in effectively managing outbreaks and pandemics, with a specific focus on providing comprehensive care for individuals with chronic conditions.

"Considering the fact that these patients with chronic conditions are at a higher risk of having severe form of COVID or even death, we have strengthened the review. Basically, the majority of patients with chronic conditions like hypertension, sugar diabetes or obesity are reviewed by doctors nowadays. Even patients who were initially seen by nurses or were just going to the local clinic, nowadays they are referred to be reviewed by a doctor. I think somehow it has improved their level of care." (HCW4)

Some participants however held a different opinion. They acknowledged that despite an increased awareness of the heightened risk faced by individuals with comorbidities during the Delta variant phase of the COVID-19 pandemic, there were significant missed opportunities in managing chronic conditions effectively. The healthcare system primarily concentrated on treating and averting COVID-19 deaths, neglecting to address the comprehensive management of chronic conditions such as hypertension and diabetes.

> "So I think it really has raised some awareness, but in terms of how did we handle that, we got information, but how did we utilize it to make sure that we push the issues of management of chronic conditions, I don't think we did a really good job at doing that. We were more concentrated on treating and averting deaths from COVID-19 versus saying, "ohh. Currently if you are hypertensive, please make sure that you take your medicines, you are controlled and you do this and that…"." (HCW1)

> *"Ahhh…no! I wouldn't say we have really…for now, we haven't really changed much on going forward about this and even the management of this chronic conditions. It is still the same old way of doing things." (HCW13)*

It was observed that healthcare professionals implemented strategies to mitigate the risk of COVID-19 transmission and minimise patient visits to healthcare facilities. Specifically, stable patients were provided with multi-month medication supplies (ranging from 3 to 6 months). This approach aimed to reduce the frequency of facility visits, thereby decongesting healthcare settings and decreasing the potential for COVID-19 transmission.

> *"During the COVID time, those who were stable were given the multi-months' supply of 3 or 6 months of their medication. So, for reasons of decongesting the facilities, their reviews were not as frequent as they were pre-COVID. Ordinarily they frequent the facilities but due to fear of COVID, they stayed home more so that they had enough supply of medication. Normally they go for their medication on monthly basis but this time around they were given supply for multiple months." (PM7)*

Participants underscored that during the pandemic, patients in isolation or quarantine were permitted to designate proxies or representatives to collect

their medications from healthcare facilities. Additionally, contact tracing teams and healthcare providers played a pivotal role in ensuring that patients who faced challenges accessing healthcare services had their medications delivered to them.

> "For those who were on medication and were quarantined in their homes, we did follow-up to check how life was in isolation that is when they would notify us that they are running short on medication and the visiting nurse will then take their medical cards with them to the clinic to either me or the pharmacy technician so that we add more tablets on what is left for them and then we give the new appointment date*." (HCW6)*

After the COVID-19 era, healthcare workers and organizations, including program officers and partner organizations, worked hard to follow up with patients who had defaulted on their treatments during the pandemic. Partnerships with organizations like FHI 360 and BONELA were established to identify and link patients back to care.

> *"It has affected a lot of patients in terms of management of comorbidities. Post COVID we see programme officers trying very hard to follow up those who have defaulted during the COVID era, I would not say they are loss to follow up, even the partners such as FHI 360, BONELA and the like are helpful, they have projects running that are trying to identify people and link them back to care." (HCW12)*

6.4.7 Theme 5: Barriers to Multimorbidity care

The provision of high-quality healthcare services is essential for the wellbeing and overall health of individuals and communities. For patients with multiple chronic conditions who in most instances attend healthcare facilities, it is imperative that their care is coordinated and well organised to improve their health outcomes. However, their care is often hindered by various challenges

and limitations within the system. This thematic area explores the significant challenges faced by healthcare providers in managing and providing care to patients with multiple multimorbidity. I separated the barriers into two categories: (i) patient related barriers and (ii) healthcare system related barriers.

6.4.7.1 Patient Barriers

This sub-theme discusses barriers at the patient level. These are factors that hinder an individual's access to and receipt of healthcare services. These obstacles can differ depending on the context, but they typically involve the patient's personal circumstances, characteristics, beliefs, and behaviours.

6.4.7.1.1 Patients' attitudes and beliefs

According to the healthcare professionals, one of the challenges they come across is the negative attitude of patients towards caring for their conditions, with some patients seemingly uninterested in managing their health. Furthermore, patients may struggle to accept their medical conditions.

> "Then the other thing is the negative attitude where you find that the patient is not really interested in caring for the condition that they have." (HCW6)

Cultural and traditional beliefs also present difficulties, with some patients preferring to consult traditional healers, or being influenced by religious beliefs to discontinue medications. One participant noted that there is a lot of misinformation and commercial interest work in healthcare, with some products claiming to cure illnesses, leading patients to stop taking their medications.

> *"The other challenge is cultural beliefs. We have different people in our community, and some will prefer to consult with traditional healers. There is also the issue of religious beliefs, it*

is very common for a patient to tell you that my prophet said I should stop taking ARVs, and they do quit." (PM7)

6.4.7.1.2 Adherence

Participants also stated concerns regarding patients' lack of adherence to treatment and follow-up appointments. Some of the healthcare workers discussed that patients' lack of understanding of the importance of adhering to their medication regimen, as well as their lack of knowledge of their conditions may be contributing to their non-adherence to treatment, missed appointments and poor health seeking behaviours.

"I think by the way our district is designed or the architecture, the people we have here, we have a lot of Basarwa, we've got people from different backgrounds, so you find that others do not really understand the importance of adhering to their medications especially diabetes and all the others." (HCW1)

"Like this other man just today, who had defaulted on diabetic medication, and now has a fracture, wounds and on top of that is hypertensive. And he is ignorant, you know I had to explain to the daughter and the man himself to say, look, for your wounds to health on time your diabetes have to be well controlled" (HCW11)

In addition, healthcare professionals brought up individuals who are hesitant to commit to medicine use over the long term. This highlights the patient's lack of comprehension of the chronic nature of these conditions and the significance of long-term management, which can result in improper management of the conditions and a delay in seeking treatment.

"And I think the main challenge is when they don't come for appointment and only come when they feel sick; some don't come for regular check-ups and they don't want t to take their

medication, they do not want to accept that they will be taking medication for the rest of their lives. They still don't believe they have diabetes and all those, now you have to spend time talking to them and trying to make them understand." (HCW13)

Participants shed light on the high treatment burden experienced by people with chronic conditions. They stressed that the difficulty of following medication schedules was a major factor in the treatment burden. People who have more than one chronic condition often have to deal with the difficult task of sticking to several different medications, figuring out how to handle possible drug interactions, and following complicated treatment schedules.

"But the other thing is that these patients end with these conditions hard to control, like maybe uncontrolled hypertension or uncontrolled diabetes. And they may also end up having a lot of medications to take, which is also worrisome because of pill burden, which can lead to them not taking some medications and having these conditions uncontrolled." (HCW 13)

"Patients are given a lot of pills and I think this is a burden on them. Somebody with HIV, taking medication for hypertension too and diabetes, making it 3 types of medication for one person. They have to pitch up for their appointments. They have to do blood investigations and they take a lot of medication." (HCW6)

6.4.7.1.3 Financial Constraints

Participants in the study consistently reported that individuals with a low socio-economic status often face significant challenges in affording essential healthcare services and medications. Many individuals simply lack the financial means to cover the costs associated with their medical needs, and

this financial strain is exacerbated when specialised diets or treatments are prescribed for specific conditions. Moreover, participants highlighted that transportation barriers pose a considerable obstacle to accessing healthcare, particularly for those residing in remote areas or facing financial constraints.

> *"Not only do they spend on the medication, but there is also consistent transport issues, which means sometimes when they have an appointment in Francistown, and they end up having to transport themselves there because we are unable to do that for them this side, and so those are some of the issues that we end up encountering or well they complain about." (HCW1)*

> *"We know that with these diseases sometimes the patients are now forced dig deeper into their pockets to access some of care that they cannot access here at the clinic, and it can be very difficult for them because some really live in disheartening conditions. Yes, because some people are unemployed. That is why I talked about increasing the number of doctors so that they can be placed in clinics where they can assist patient without the need for patients to travel elsewhere to access care" (HCW5)*

6.4.7.2 Health system barriers

Healthcare system-related barriers are obstacles that originate from the system's own structure, organisation, and operation. These obstacles can restrict individuals' access to healthcare and impede the delivery of high-quality care. Healthcare professionals shared a number of challenges within the healthcare system that hampers good management and the care of people with multiple chronic conditions.

6.4.7.2.1 Poor communication within the healthcare system

Interviewees expressed concern and frustration about the lack of effective communication and information sharing among healthcare professionals. For example, both nurses and doctors emphasised the difficulties they encountered in obtaining feedback from specialists who provided care to referred patients. The absence of proper communication was identified as a major hindrance to effective patient management, particularly for individuals with complex medical conditions and mental health issues.

> *"But the specialist just see the patients and send them back, no communication with us, we just see on the medical card. We also have a challenge because some of the specialists do not write notes, they just jot down that which makes sense to them." (HCW12)*

> *"There is a problem when this patient is seen by different professionals, specialists and also going back to the local facility, and there is no communication between the healthcare providers. As professionals there is nowhere in the process where we link up, or where we discuss our care plan," (HCW5)*

Participants attributed the communication gap to the absence of effective systems to facilitate information sharing among healthcare professionals. The lack of standardised tools, such as electronic health records, hindered the smooth transfer of patient data and updates between professionals. For example, some primary healthcare providers reported that they relied on handwritten medical records, which are often difficult to read, exacerbating communication issues.

> *"Besides their medical records, which are handwritten and most of the times very difficult to read-there is no how we get to know what the doctor or specialist found, what they recommended or what they think should be done." (HCW 9)*

“Even if they do not communicate, when they leave Letsholathebe Hospital, the clinic that referred them, the information should be there in the system. If the information has been entered in the system, you should be able to access it from any healthcare facility”. (PM11)

The existing ICT infrastructure and patient management systems were considered inadequate and fragmented. The lack of networking among healthcare facilities hampers efficient healthcare delivery. Participants also expressed frustration over poor internet connectivity and frequent system downtime, saying this hinders retrieval of crucial information, sometimes leading to delayed care.

“It is only that the system that we are using is very difficult, it needs internet, and our internet is down most of the time. And even when the internet is up, the system itself would be slow. It can really be slow, it never even allows you to see up to 10 patients in a day, sometimes you even struggle to access patients’ results to a point where we are forced to return them home without reviewing them.” (HCW12)

“So, if it is there on the system across all the facilities, we can be able to know the previous history of our patients such that when they come to us, there will be no need for us to do new investigations, maybe we could have something that can lead us on and that way, it becomes it easy.” (HCW14)

Despite these challenges, some healthcare workers and facilities have implemented initiatives such as WhatsApp messaging and phone calls, to improve inter-professional communication and patient-provider interactions. For instance, one healthcare worker adopted a proactive approach by collecting patient contact information to follow up with specialists and patients after referrals. These efforts have shown promise in enhancing continuity of

care and enabling alternative treatment solutions through information exchange between healthcare providers.

> *"The other thing I do is that every time I see them (patients), I take their names and phone numbers, and number of their next of kin. After referring them to a specialist in Nyangabgwe and they do not come back to me with feedback, I call them to determine how it went. That's how I manage it". (HCW12)*

6.4.7.2.2 Waiting Times

The issue of long waiting time was identified as a major problem that patients normally experience at various stages of their healthcare journey. Participants reported that patients normally have to wait for appointments with doctors and specialists, often resulting in delays of weeks, months or even years. This problem was partly linked with the shortage of medical personnel and specialists, leading to a limited capacity to provide timely care.

> *"The specialists are only found at the hospital, which then means we refer patients to them, only for them to take a rather long time to actually be seen by the specialist, for example, you can refer a patient today only to be booked a date for next year, I mean 2022 has only just begun, but some patients are booked to see certain specialists in 2023, some even 2024". (HCW5)*

> *"Even if you were to look at people who have diabetic foot or people with uncontrollable BP, their waiting period to get services are very long. This is due to the fact that we have few specialised centres and at the same time we do not have a lot of skilled personnel at that level. So that is why we have challenges." (PM10)*

Interviewees also indicated that the turnaround time for investigations and test results is often lengthy. Healthcare providers in primary care facilities have to

send blood samples and other specimen to external labs for testing, and this is characterised by long queues, leading to delays in diagnosis and treatment. Providers were of the view that these delays were made worse by the limited availability of resources such as diagnostic equipment and medical supplies.

> *"Our turnaround time at the laboratories in terms of the results of the specimen we sent, is 7 days, but sometimes it takes longer than 7 days. Others such as scan, where we book for them, they wait on the queue depending on how long the queue is because the lab is for Kgalagadi South, there are 22 facilities using that lab. They can wait up to 7 days before they are given a date for the scan." (HCW6)*

In addition, participants observed that patients experienced long queues and overcrowding in healthcare facilities either when they go for their specialists' appointments in hospitals, or in accessing a clinic appointment.

> *"When they get there (at the hospitals), they join long queues, you are not even sure if they did go." (HCW9)*

> *"...Somebody who is sick and needs emergency intervention in Old Naledi, they have to go through Old Naledi Clinic, to go and queue there, and it is always full, and there is shortage of staff, there is no medicines, no doctors, few nurses and all these challenges." (PM3)*

The extended waiting periods were particularly notable among individuals residing in rural areas who had to travel to urban centres for specialised care. This meant that patients not only had to endure the travel but also faced prolonged wait times at healthcare facilities. Furthermore, the impact of the COVID-19 pandemic exacerbated the situation by suspending certain services, thereby increasing the waiting lists.

6.4.7.2.3 Human resources challenges

Participants consistently mentioned a shortage of healthcare professionals, including doctors, nurses, specialists, pharmacy technicians, and other support staff. This shortage is particularly acute in rural areas, leading to disparities in healthcare access between rural and urban regions. Participants stressed the need for increased recruitment and deployment of healthcare workers to address this issue.

> *"As much as I was saying that doctors are a blessing to our system, there is a serious shortage of the same and other cadres. You find situations whereby the nurse does registration, consults, and also dispenses medication. There is a serious shortage of other specialties, and this makes management of comorbidities quite difficult for us. I will be managing a diabetes patient, on the other hand I have to consult children, taking blood samples too and transporting them to the hospital. COVID has also shown us that there is shortage of health care workers in general. This then affects our management of comorbidities and other conditions in general" (HCW14)*

> *"So, our major challenge is that we don't have enough Doctors and Specialists, even if we find them and hire them, the other challenge is retaining them with the current levels of salaries, and it's a big challenge." (PM1)*

A recurring concern was that healthcare professionals sometimes provide sub-standard care particularly in the management of chronic conditions like hypertension. This was attributed to the lack of training and limited awareness of guidelines.

> *There is need for regular upskilling but in most cases, it really never happens. They (healthcare workers) also need to be upskilled; they need a lot of education on NCDs." (HCW5)*

“I do not think there is enough people who are well rounded or trained to handle NCDs the way they should be handled in Botswana.” (PM2)

One of the challenges frequently discussed was related to staff transfers within the healthcare system. Healthcare professionals often experience frequent transfers, which can disrupt the continuity of care and hinder the utilisation of specialised skills acquired through training. Participants expressed concerns that these transfers may lead to healthcare workers being assigned to facilities or areas that do not align with their training and expertise.

> “The only problem comes when you have acquired that skill, the next thing you get transferred to a different facility where you would probably not apply the skill that you acquired and that time they pulled you out, you either were a focal person or hands on in a certain programme or something.” (HCW14)

> “When today you come, it is me in the clinic, the next month you are coming it is somebody else in the clinic, the one who has been trained for some of these things has been transferred. Again that is another issue complicating our primary health care system where health care workers can be transferred anywhere in the country and they have to accept and it does not even matter whether you are a trained oncology nurse, you can be sent to a primary care facility where there is nothing that you can work with, it is a very small clinic where you cannot apply your training.” (PM3)

Healthcare workers expressed frustration over the absence of recognition and incentives for their efforts. They pointed out that the healthcare sector lacks the kind of incentives and rewards seen in other sectors, which can lead to

demotivation. It was emphasised that healthcare professionals should receive better remuneration for their work. The low pay and lack of financial motivation were seen as challenges that need to be addressed.

> "We have our attitudes and beliefs to also work on as a people, we do not believe in our own, we have lots of people who are well trained, but we prefer to look at and take advice from help coming from outside. We welcome help from outside, but you cannot build your own health system depending on those people whose relatives, friends and family do not use the health system. I can go on and on." (PM3)

> "The opportunity cost of working in health going for all these educational trainings and socially you are set back, people will be taking 3-year courses, buying houses, getting married and you will be at least 8 years behind your colleagues. We are going to get into a situation where children will no longer want to go into the health sector, and we are going to have to start getting expatriates health care workers. I just think that if the *salaries, remuneration and the incentives for health care workers were reviewed so that people can focus on doing the right thing and not run after earmarked funding. We need to change our attitudes and review the way we motivate the people who work in our health system." (PM13)*

Another challenge reported by healthcare workers was the overwhelming nurse-centric structure of many healthcare facilities, particularly clinics. Nurses are primarily responsible for a wide range of duties that extend beyond their traditional roles. This structure places a significant burden on nurses, stretching their capabilities thin. They are required to juggle administrative

tasks, consultations, dispensing medication, managing referrals, and even transportation of patients. This often leaves them feeling overworked and stressed.

> *"We have a serious shortage of staff; you find that a nurse works from morning to morning without a break. If we had the numbers, it would give our nurses the breaks they need. They end up being burnt out." (HCW7)*

> *"Even this morning I caught the tail end of the conversation, I think there were phone-ins about nurses leaving the country in large numbers and the predominant thing was that we just cannot work in this system. The work overload is unmanageable." (PM3)*

6.4.7.2.4 Lack of resources

The study participants discussed several resource constraints within the healthcare system that pose significant challenges for provision of quality of healthcare services to people with multimorbidity. Lack of transport was cited as one of the major problems, especially in rural areas. Healthcare facilities face a shortage of ambulances, leading to delays in patient transportation and emergency care, and some health facilities struggle to transport medical specimens to laboratories.

> *"No, we do not have much resources and like I said most of the time we refer people to other facilities and then the problem of transportation arises which is such a big challenge. We cannot transport them because there is a shortage of ambulances, it's been 3 weeks a big clinic like this one not having an ambulance." (HCW6)*

> *"Even the issue of specimen, some of the health facilities have to transport specimen to laboratory facilities in a different location, and because of the transport and other logistical*

issues, by the time the specimen reaches the lab, they are not in a good state to perform any tests or investigations on them, and this brings a lot of problems for the patients and the healthcare workers in the rural areas." (PM1)

Participants also discussed challenges related to the availability and adequacy of essential equipment. They revealed that facilities often lacked crucial machinery, leading to challenges in diagnosing and treating patients. Inadequate equipment, including X-rays, CT scans, ultrasound, and laboratory tools, hindered healthcare providers' ability to offer comprehensive care. Additionally, the maintenance and accessibility of equipment were problematic, causing delays and disruptions in patient care. Addressing these equipment and resource shortages was recognised as essential to improving healthcare services for patients with multimorbidity.

"Most of the resources are centered at Nyangabgwe and Marina, physicians and specialists are there. Equipment should also be provided in our facilities, as it is at the moment, we all go to queue up in Marina for patients to do CT scans from different parts of the country. Yes, but equipment should also come with skilled manpower or alternatively train the already available personnel because we also need the manpower." (HCW14)

"There are no resources, machines are always broken, things are not maintained, and patients are thinking health care workers are not treating us well, they must go anyway. We have lots of machines that we have bought brand new, but we did not take out maintenance plans for those, they are sitting there where you now have a CT scan in one hospital in the country because the CT scan that we have in a government facility is not working." (PM3)

6.4.7.2.5 Shortage of Medication

Healthcare professionals consistently highlighted the problem of medication shortages, particularly for chronic conditions such as hypertension, diabetes and other NCDs. One of the reasons given for these shortages was the COVID-19 pandemic, which led to disruptions in the supply chain and difficulties in procuring medication supplies in a timely manner.

> *"First of all medication for these chronic conditions is not there, and sometimes you find that patients are not controlled because they do not have the medications; you prescribe medications and they are all out of stock." (HCW13)*

> *"There is also the issue of chronic medications, recently we had a very big challenge where chronic medications were out of stock in our facilities. We run out of medication, it goes back to the patients, even where we though we have achieved something in terms of managing the condition, this then means our efforts go down the drain." (PM6)*

6.4.7.2.6 Lack of comprehensive guidelines

The healthcare workers discussed the absence of comprehensive guidelines that specifically address multimorbidity as another challenges in the healthcare system. Existing guidelines tend to focus on individual diseases or conditions (e.g., diabetes, hypertension), rather than providing guidance on managing multiple conditions concurrently. This gap in comprehensive guidelines makes it challenging for healthcare workers to develop holistic treatment plans for patients with multimorbidity.

> *"There is the Botswana Primary Care Guideline which is for all conditions that we treat at primary care level, there is nothing else that we follow. I feel that if we can have guidelines focusing on multiple conditions, it would really be helpful because in case you are seeing a patient with sugar diabetes co-occurring*

with hypertension, if there is a guideline guiding you on how to treat them, it lowers the chances of any mistakes happening when offering treatment because these drugs have contra-indications but if it comes in that guide form it would really abet any mistakes that could happen." (HCW9)

"Yes, we have. There are some guidelines that we have; we have the Botswana Primary Health Care Guidelines, it's the 2017 or 2018 version if I am not mistaken, that has all the other conditions except cancer. For the cancers we also recently developed some guidelines for cervical cancer, breast cancer, I think there were four which were recently developed. Yes, the guidelines are there. It speaks to them individually. It is for the health care worker to know that if there is a patient presenting with this condition, this is how they are supposed to treat the patient. So, it addresses the conditions separately." (PM6)

6.4.7.2.7 Fragmentation of health services

Participants reported that patients often need to visit different clinics or healthcare facilities for various chronic conditions, such as HIV, diabetes, and hypertension, leading to fragmented care, increased travel, and a lack of comprehensive treatment. Furthermore, they highlighted the issue of managing patients in different service points, which requires more staff and time. Participants emphasized that this fragmented approach results in duplicated services and can lead to delayed diagnoses and treatment initiation. Additionally, they pointed out that the practice of booking appointments for different conditions on different days contributes to fragmented healthcare services, making it difficult for healthcare providers to gather a complete picture of the patient's health status, potentially leading to delayed or incomplete treatment.

"And like we mentioned we have ARV clinics, if a person is living with HIV, it would mean today the appointment is at

Satellite clinic, for diabetes they go to Donga, for eye testing they go see the nurse at Area W or Tshwaragano clinic. Yes, indeed it takes the patients from one point to the other but we do not know how it can be worked out, but it is not going to be easy to put them under the same roof for provision of integrated services. Yes, as it currently is, it promotes a lot of movement, like right now for orthopaedic, you go to Mahalapye, for eye health you go to Serowe etc." (HCW10)

"I remember I have done some interviews with some patients for other researches and one of the things that keeps coming out, I tend to do research with patients with diabetes, is this concept that today you are at the clinic or the hospital out-patient to collect your blood pressure medication, tomorrow you are at the clinic for diabetes, then you are at the clinic for arthritis, then you go to IDCC for HIV and you almost come to a point where you do not know what to tell your employer each time you ask for permission to go and see health care professionals, it becomes a problem." (PM3)

6.4.8 Theme 6 Strategies to improve multimorbidity care

Healthcare professionals participating in the study highlighted a few key areas that could be improved to enhance care and management of people with multimorbidity in primary care settings in Botswana. This theme reports on those recommendations.

6.4.8.1 Integration - moving away from a siloed approach to healthcare delivery

Some participants suggested a proactive solution to address the challenges of fragmented care and improve healthcare delivery for individuals with multimorbidity. They proposed transforming existing clinics, such as the Infectious Disease Control Centre (IDCC), into dedicated chronic care clinics. These specialised clinics would offer comprehensive care to individuals with

multimorbidity, including those who are living with HIV. The primary goal of this approach would be to streamline healthcare services by enabling patients to receive all their specialised care for various conditions in one centralised location. Such a strategy could reduce the burden on patients, who often need to attend multiple appointments at different healthcare facilities and promote integrated care models that provide comprehensive and coordinated services to more effectively manage multimorbidity.

> *“So we could leverage from that already existing IDCC clinics and just recoin them, and call them chronic care clinics where now when you are coming as an HIV positive client, you are seen for everything else and even if you have multimorbidity you can be seen in those clinics by a specialist who knows what they are doing, even if its doctors or its nurses they can help you just at a go, and you get everything and its done all at the same time instead of you coming to IDCC, after IDCC you are going to see another doctor at OPC , that could really reduce the dilemma.“ (HCW1)*

> *“Another thing is why not just set up a whole clinic for chronic conditions, where there is dedicated personnel and we know that patients have some level of care, it will be different from what patients are accessing when they visit, when they go to a known specialised centre, the level of care will be different.” (HCW4)*

Some healthcare workers and policymakers emphasised the importance of patient-centred care, where healthcare providers prioritise patients' perspectives and actively involve them in their own care. This entails engaging in dialogue regarding the patients' medical conditions, understanding their concerns, and actively involving them in the decision-making process about their treatment. The establishment of an open and ongoing dialogue between medical professionals and patients was widely recognised as a critical factor

in improving patient understanding and satisfaction, as well as in delivering more efficient and patient-focused healthcare.

> *"Improve on quality of services that we offer, and their care should be patient centred and not health care provider centred so that we improve the quality of their lives. I mean that there needs to be a dialogue between the patient and the healthcare provider whenever they meet in the consultation room there has to be a meeting point where the patient is also engaged in the management of their condition. Not a situation where the health care provider believes that what they say goes without getting the input from the patient on how best they think they should be assisted." (HCW6)*

> *"We must provide a service that will satisfy the needs of a patient who comes in and has any condition, not a service where a cancer patient would wish that they had HIV because they see that if you have HIV, you get the best service." (PM3)*

6.4.8.2 Training and workforce development

To enhance the care provided to individuals with multiple chronic conditions at primary care level, participants emphasised the importance of additional training and specialisation in chronic disease management. One nurse proposed that primary care staff should have opportunities for specialised courses to elevate the quality of care within primary care settings, recognising the pivotal role of primary care in managing individuals with multimorbidity. Others suggested continuous in-house training through workshops, short courses, and seminars.

> *"Let us, those at primary care be taken for further training, let us be taken for specialty courses and be trained on these conditions, let us become oncology nurses and other*

specialties so that each district will be able to be independent in some of these things." (HCW14)

"I think with us we need regular upskilling; I must admit that we do attend workshops, but it is not enough. Things change with time, and we have to keep up as things keep evolving, clearly the knowledge I acquired at HIS is insufficient in this day and age. We ought to be re-trained especially seeing that management of conditions keep changing. I am from in-patient care, and I get here, a lot has changed, regarding management of conditions and I am clueless on a lot of things. I am trying to learn some things." (HCW9)

6.4.8.3 Prevention

The participants collectively underscored the central importance of prevention of chronic conditions and multimorbidity. They emphasised the need to intensify prevention measures, particularly in educating individuals about chronic conditions and encouraging healthy lifestyles. They stressed the value of a community-based approach to prevention that extends beyond healthcare facilities and reaches families and communities. Lifestyle changes, such as healthier diets and increased physical activity, are seen as pivotal components of prevention efforts. Moreover, experts advocate for wellness clinics and health promotion teams to deliver cost-effective prevention strategies and reduce the strain on healthcare resources and the economy. Healthcare provider-patient communication was emphasised for effective preventive care. Additionally, they encouraged clear and open communication between patients and providers, saying it allows healthcare providers to educate patients about the importance of primary prevention. Patients need to understand how lifestyle choices, such as diet, exercise, and smoking cessation, can impact their long-term health.

"Generally, I will recommend intensifying education such that even when I see an individual patient in the consulting room, I

should be able to involve their family, one way or the other so that if other family members can prevent themselves from getting the conditions, if it is something that can be prevented, then the family members should get into the preventive mode plus it would help even support our clients if it is like when you see a patient you go back even to the family and involve the community around that particular person. So, our prevention should be more community-based than to think we can try it when we are already at the hospital, at the hospital we are already in the curative mode which means like we had said, we would already be in a higher level of costs." (HCW12)

"And now moving forward, as we must also emphasise prevention of these diseases. With prevention of these NCDs, prevention continuity has to be respected. There is primary prevention, secondary prevention, and tertiary prevention. I think we should ensure that primary prevention is core so that people do not develop these conditions." (PM2)

Some participants strongly advocated for policy-level changes that prioritise prevention efforts. This entails the enactment of enabling policies, such as the establishment of state parks and walkways, aimed at fostering healthier living and lifestyles within communities. Importantly, there was a call for a substantial reallocation of funding and resources at both the policy and implementation levels to strengthen preventive measures. Experts asserted that prevention, as the cornerstone strategy, must receive comprehensive support. This approach is deemed crucial for effectively reducing the burden of chronic conditions, emphasizing the significance of addressing root causes rather than addressing consequences in the future.

"So, even digging deeper to put the social networks and the preventive structures and systems in place to support and enable healthy behaviour at policy level. If we had state parks,

state walkways, all these enabling policies enacted which make things easier for people to live healthier. If those policies were in place and we were advocating for them." (PM13)

"I think what we really need to hammer on at policy level, is to emphasise and concentrate our much effort, and not just talk but put much, much, much like 100%, effort on prevention the prevention aspect. Because that is the only way the tide will be dropped, rather than let the pipe burst and later try to deal with the flooding water, when we in fact know where the problem is. So, I would like to see us at policy level, not only speaking about prevention of these conditions, but do something, talk about it, fund it from all perspectives." (PM9)

6.4.8.4 Community involvement

Some participants highlighted the significance of community involvement and mobilisation in addressing various health issues, particularly NCDs. They suggested that community leaders, including councillors and chiefs, as well as existing village health committees and public officers, can play a crucial role in the identification of health issues and the provision of support to healthcare facilities. The success of HIV prevention programs, driven by local communities, was cited as an example of how community engagement can be effective. However, some participants express concerns that community involvement often occurs as an afterthought when healthcare facilities are overwhelmed or lack funding. They advocated for a people-centered approach to healthcare services and stressed the need to empower communities to take ownership of their health.

"The opportunities are that I think our community leaders also have a role to play in the management of these conditions; councillors, Dikgosi (Chiefs). We have a village health committee, village extension team of public officers, all those committees that can identify problems and alert us here at the

clinic of what is happening and how we can be of assistance. Primary care is all about the community, we already have structures in place, and those structures really helped us win the HIV war. We just have to find a way to utilise them to fight NCDs." (HCW6)

We have the community, people who are willing to actually help our health system, help their fellow men but we do not encourage them, we do not use them as well as we could." (PM3)

Participants also highlight the potential of civil society organizations, government, and private sector collaboration at the community level to address lifestyle behaviours and promote multi-sectoral approaches. The role of faith-based organizations in community mobilization is acknowledged, and it is suggested that communities should be prepared to facilitate behaviour change to align with health initiatives. However, there is recognition that communities may be fatigued by the multitude of health topics discussed, emphasizing the need for a more integrated and holistic approach to healthcare policies and education at the community level.

"And there is also civil society involvement, so there is community engagement throughout. All these have really contributed to the successes. The HIV prevention messages from way back were driven by the local communities, because they understand the dynamics of their societies much better than us sitting at the offices, so they were the leaders of the programmes. The issue with NCDs, HIV and all these new health issues we are seeing is that we can't do it alone, we need everyone to play a role." (PM12)

6.4.8.5 Research

Both healthcare workers and policymakers highlighted the critical role of research in strengthening healthcare in Botswana. They stressed the importance of conducting research on health-related topics to inform evidence-based solutions and decision-making, ultimately reducing costs. Some healthcare workers particularly expressed interest in research, both in using research findings, and in participating in research studies. However, they also noted a limited capacity to utilise rich health data at their disposal in healthcare facilities. They recommended improving the quality of data and planning for NCDs by learning from the experience gained in HIV data management.

> *"We do have interest in carrying out research, we just do not know where to start. But the truth is, we are sitting on a lot of data. Like I said, there is an issue that we should start to view research as one of the very critical components of our health system and that nothing should be done on speculation. Things are changing every day, diseases change. Even with COVID, look at us, we are relying on research and everything from developed countries, but our health systems and social systems are not the same." (HCW10)*

> *"Some of the reports that we receive are not that accurate such that when we do planning, we plan on the basis of inadequate or wrong data coming from the facilities. Going forward with NCDs, if we can polish such issues, ensuring that we have relevant people who are able to handle data properly, the credibility and quality of our data would really be helpful in planning." (PM5)*

Interviewees recognised the value of research studies in describing the ever-changing landscape of disease, especially amid the COVID-19 pandemic. They emphasised the importance of studies in exploring the impact of new conditions on those with pre-existing health issues. Furthermore, there was a

collective call for investing in research to gain insights into health issues within the local context. Despite the recognition of NCDs as a significant health challenge, there is a lack of comprehensive research on the specific interactions between HIV and NCDs. Participants advocated for more studies in this area to fill existing knowledge gaps. Collaboration and information dissemination were also considered essential for advancing healthcare practices and policy development.

> *"And also it has taught us (COVID-19) that we need to get more involved in studies, the moment a new condition comes, more studies need to be done, to investigate how this new condition affect people with underlying conditions, and to explore if there is a need to change regime and how all that will affect people with chronic conditions, so really research is very important… research is very important, we need to invest in that, we need to understand these health issues from our very own context." (HCW3)*

> *"It is a difficult one in the sense that there has not been any research done it is difficult to say you know how they interact, personally I have not come across such research. Like in the recent past, preliminary results of the Botswana AIDS Impact Survey (BAIS) were released which are done every four years. So, it is difficult to talk about it to say that people who are living with HIV are at a more risk of having conditions such as renal failure, diabetes or whatever because no research has been done in that area. There are no findings to which I can refer." (PM8)*

6.5 Discussion

This qualitative component sought to explore the perspectives and experiences of healthcare workers and policymakers about the care of patients dealing with multimorbidity within primary care settings in Botswana. It is worth

noting that, to the best of my knowledge, this is the first qualitative study in Botswana to explore this important issue, particularly from the viewpoint of these crucial stakeholders.

6.5.1 Summary of key findings

The study revealed that healthcare workers and policymakers in Botswana were aware of multimorbidity and its complexities, and the impact on patients and the healthcare system. However, they face various challenges in providing care for individuals with multimorbidity, including a lack of clear guidelines, disease-centered care approaches, and difficulties in managing multiple chronic conditions. The COVID-19 pandemic further strained the healthcare system, diverting resources and impacting routine care. Healthcare workers and policymakers identified several patient-related challenges, including denial and lack of acceptance of their chronic conditions, in some instances influenced by religious and traditional beliefs. They also noted medication non-adherence and financial burdens as significant barriers. Additionally, they observed healthcare system issues such as communication gaps, resource shortages, and service fragmentation. To address these challenges, participants proposed strategies such as integrated healthcare services, patient-centered care, workforce development, prevention initiatives, community engagement, and research to bridge knowledge gaps. A detailed summary of the findings is in Table 16.

Table 16: Summary of Key Findings from Qualitative Interviews

Theme 1: Understanding Multimorbidity- This thematic area explores how healthcare professionals conceptualise and understand multimorbidity, and whether they utilise the concept in their daily work.			
Sub-theme	**Explanation**	**Examples of Supporting Quotes**	**Opportunities for Improvement**
1.1 Conceptualisation of Multimorbidity	Participants demonstrated varying levels of familiarity with the concept of multimorbidity. Despite this conceptual heterogeneity, there was a general understanding of multimorbidity as the coexistence of multiple health conditions within an individual.	"My understanding of multimorbidity is that it means having more than one health problem at a time. If someone has more than one problem or morbidity, it cripples more than one organ of the body." (HCW10) "For us because we have been dealing with HIV, and also studying diabetes, we have clinical trials looking at hypertension, we are already used to the issue, you might call it coinfection or comorbidity." (PM2)	Standardisation of terminology by establishing consensus among healthcare professionals, research community and other key stakeholders.

1.2 Awareness of the Complexity of Multimorbidity	The research participants acknowledged the difficulty of multimorbidity, indicating a shift from infectious to noncommunicable diseases. They presented evidence from their professional experience to show the complexity of managing patients with multiple chronic diseases, particularly in the context of HIV, ageing, and the COVID-19 pandemic.	"Botswana is a young country, so when HIV started it affected the younger people... the concept of aging with HIV is there... So, we still go back to the NCDs. They survive, they are working, they are productive, and they get obese like I said. With obesity, they get cardiovascular conditions like diabetes and others." (PM12)	Evaluate existing healthcare practices, available services, treatment guidelines, protocols, and instruments to identify gaps. Develop comprehensive treatment guidelines tailored to the the coexistence of communicable diseases and NCDs. Provide targeted education and awareness programs for healthcare workers to improve understanding and application of multimorbidity concepts in clinical practice. Promote interdisciplinary case conferences when healthcare providers from diverse specialisations discuss complex patient issues sharing clinical experiences, insights, and skills.
Theme 2: Experiences in providing multimorbidity care- This theme describes how healthcare services for patients dealing with multiple chronic conditions is organised within the healthcare system of Botswana, shedding light on the experiences of healthcare providers and the crucial role of primary care in coordinating complete patient management.			

Sub-theme	Explanation	Examples of Supporting quotes	Opportunities for Improvement
2.1 Organisation of patient care and referral process	Participants described a hierarchical structure of Botswana's healthcare system, from mobile stops to referral hospitals. Patients are referred based on condition severity, with initial screening at lower-level facilities. Referral pathways are structured to primary hospitals, district hospitals, or specialised centres.	"So, when you look at health care setup at our level, I think we are doing well but as cases become more complex, that is when we say we need help because when cases become more complex and they need more specialised services, they need more sophisticated equipment, that is where now we need to refer and people in higher facilities tend to specialise. That is why we have the concept of centres of excellence where you have these diabetes clinics, like Block 6 in Gaborone, Donga in Francistown, these facilities have a role more especially for complex cases that cannot be managed by an average health care worker" PM10	Improving accessibility and availability of screening and diagnostic services at lower-level facilities. Improve coordination and communication between different levels of healthcare facilities to ensure seamless referrals and continuity of care. Investigating the potential of digital health technologies including telemedicine, mobile health applications, and electronic health records, to enhance the quality, continuity, and coordination of care for multimorbid patients
2.2 Patient monitoring and follow-up	Patients with multimorbidity receive ongoing care and monitoring to ensure their conditions are well managed. Monitoring frequency	"Well, as their doctor my main responsibility is to make sure that their chronic conditions are controlled; if they have a BP, I make sure that the BP is controlled, they get proper medication and	Utilise mHealth technologies to improve monitoring protocols and educate patients with multimorbidity.

	varies based on individual patient needs.	give the patient review dates to see if the medication you are giving for the BP is working. And of course, the patients will come for regular check-ups of BP or sugar levels when we are trying to control the sugar diabetes and control the BP for chronic hypertension. So, the main goal is to make sure that both of the conditions are controlled in every patient, and this what we want to achieve when see this patient." (HCW10)	Reinforce patient education to help patients understand their medical issues, treatment options, the importance of adherence, and self-monitoring. Strengthen the involvement of CHWs in facilitating regular monitoring and follow-up of patients.
2.3 Integration of HIV and NCDs services	Comorbidities of HIV and NCDs are prevalent, leading to challenges in separate healthcare services. Efforts are made to integrate HIV and NCD services to provide holistic care and reduce the need for multiple clinic visits. Despite integration efforts, infrastructure limitations and stigma remain barriers.	"Like taking for example the IDCC, which has always been regarded as HIV clinic, now they are being compressed so that they can see all chronic conditions. If you are HIV positive and you also have diabetes, there should be one care, one stop. You are seen there and given all the necessary care without having to move around the whole clinic. And also, the availability of drugs, that a patient can get	Investigate NCDs and HIV integration models that may be useful in Botswana context. Enhance infrastructure and capacity to support integrated care delivery. Address stigma associated with accessing HIV services by providing services in non-stigmatising settings.

		their HIV drugs as well as drugs for other conditions in the same place." (PM9)	Ensure comprehensive training for healthcare providers to deliver integrated care effectively.
2.4 The role of primary care	Primary care plays a central role in managing multimorbidity, despite resource constraints. Family physicians and Family Nurse Practitioners (FNPs) contribute significantly to patient care, managing various conditions locally and reducing the need for referrals. Community health workers (CHWs) act as a bridge between healthcare facilities and local communities, delivering comprehensive health education and services.	"I am going to be frankly honest, before we had a family physician, they (patients) were disgruntled they, really did not like having to go to Francistown or Maun Letsholathebe to be seen by specialist to be able to control all their conditions. But since we've had a family physician in the district, they are now a lot happier because it's like a one stop shop, they can come with all their conditions, and they get help from one person without having to move from one place to another." (HCW1)	Provide ongoing training for primary care staff, including family physicians and FNPs, to optimise the management of chronic conditions. Ensure adequate staffing and resources for primary care facilities to meet the growing demands on healthcare infrastructure. Building collaborative teams to leverage expertise and capacities of healthcare professionals including family physicians, family nurse practitioners, nurses, pharmacists, CHWs, and social workers, in a team-based care approach.
Theme 3: Health Policy Environment and Governance- This theme area explores the complex dynamics of healthcare in Botswana, including a comprehensive analysis of health policies, governance structures, and leadership strategies that impact the provision of healthcare services for people living with multiple chronic conditions.			

Sub theme	Explanation	Examples of Supporting quotes	Opportunities for Improvement
3.1 National Health Policy context	Participants provided a comprehensive overview of the policy landscape in Botswana, highlighting the pivotal role of NAHPA in coordinating HIV and NCD responses following its transition from the National AIDS Coordinating Agency in 2018.	We have what we call multi-sectoral strategy on prevention and control of NCDs for 2018-2023. It is comprehensive in the sense that even though it is looking at NCDs more especially the four NCDs that are highlighted by WHO as deadlier and the four risk factors that WHO pronounced as high-risk factors for NCDs, but the approach is comprehensive. It is comprehensive in the sense that it includes everybody even people who are coordinating HIV, when it trickles down, it will include everyone, that is why it is called multi-sectoral NCDs strategy." (PM9)	Regular review of the National Health Policy and other policy instruments to ensure there is alignment with evolving healthcare needs and priorities. Strengthening coordination mechanisms between NAHPA and other relevant stakeholders is essential for smooth implementation of healthcare plans.
3.2 Collaboration across sectors	Collaboration with various stakeholders including government, civil society, NGOs, and private sector cited as a necessity in addressing multimorbidity. Healthcare	"So, the way that HIV was dealt with from the beginning, it took a multi-sectoral approach. It is not just a health issue; it is a social issue. So, the same goes for NCDs. We also appreciate that in order to respond effectively to prevent and control	Creating effective methods of communication and regular platforms for discussion between NAHPA, Ministry of Health, and other players to promote the

	professionals recognised the interconnectedness between health and other social sectors.	NCDs, we need a multi-sectoral approach, everyone should be involved." (PM11)	exchange of information, coordination of efforts, and alignment of priorities. Foster stronger partnerships with private sector entities to leverage resources and expertise for improved healthcare outcomes.
3.3 Funding and resource allocation	Critical challenges in funding and resource allocation were revealed, with inequitable distribution between infectious diseases (HIV, TB) and NCDs. The historical focus on vertical funding of health conditions has marginalised NCDs.	"The problem that we see mainly with the NCDs is that we do not have any funding that is dedicated to NCDs programme. We are always looking for funding. Programmes like HIV, TB, those ones they even have sponsors, there are people who are funding those programmes. So, that is why you find that there is a lot of interest in them, but when it comes to these NCDs sometimes even to train the health care workers becomes a challenge. Even the health care workers themselves, sometimes they even lose interest. So, it is really a big challenge that we are facing because even these sponsors when they come, you find that they have their own	Reassess funding priorities by conducting cost-effectiveness analysis of interventions and programmes. Advocate for increased funding and resources dedicated to NCD prevention and management programs. Align healthcare strategies and policies to Universal Health Coverage principles.

		area of interest that they want to focus on." (PM6)	
34. Training and capacity	The Ministry of Health is dedicated to improving the skills and capacities of its workforce through comprehensive training programmes and curriculum. The goal is to cultivate a highly skilled and flexible team that can effectively meet the various and changing healthcare demands of the population.	"As a ministry we are also committed to continuous learning, when you look at the budget and the policies that we have, they all encourage continuous learning throughout the working life of the health care professionals, be it through workshops or further education because you will notice that nurses themselves go to specialise with government paying for everything. These are good policies that encourage health care workers to continue learning. You would appreciate that when someone goes through a residency programme, every year, they get elevated to a higher salary scale so that they can also be motivated to study. It is an incentive for people to study." (PM10)	Assessing the training needs of healthcare professionals and evaluating training programmes to ensure inclusion of multimorbidity. Developing focused training programmes that target specific needs and issues within different regions or communities.

Theme 4: Navigating multimorbidity care amidst the pandemic- This theme focused on examining the convergence of multimorbidity care and the COVID-19 pandemic in Botswana, with a specific emphasis on the effects on the healthcare delivery system and the provision of multimorbidity care.			
Sub theme	**Description**	**Examples of Supporting quotes**	**Opportunities for Improvement**
4.1 Impact on the healthcare delivery system	Participants revealed the challenges they faced in providing care during the COVID-19 crises, highlighting the shift of focus and resources towards pandemic response.	"COVID has also affected the medical field, because of pulling of doctors and nurses from the clinics and hospitals to go and assist in COVID isolation centres and other COVID-related programmes. This alone put a strain on the facilities and sort of reduced the delivery of services to these patients." (HCW13)	Invest in pandemic preparedness including strengthening health infrastructure, building capacity, stockpiling essential supplies, enhancing disease surveillance. Reinforce primary healthcare to ensure essential services are not compromised during crises.
4.2 Workforce burden	The pandemic had profound impact on healthcare professionals, manifesting in increased workload and staffing inadequacies as they juggled pandemic-related responsibilities. These challenges were compounded by pre-existing	"There was the issue of testing which meant one nurse would be allocated for testing the whole day or the whole testing session whilst other services were still continuing, there was also contact tracing and many other things. Some of us were taken and deployed to the isolation centres that were set up, it was the same staff that	Implementing continuous training programs and proactive recruitment strategies to mitigate healthcare workforce shortages. Implement task-shifting and task-sharing initiatives to fully utilise the available healthcare personnel and delegate

	shortages in the healthcare workforce, which were intensified by COVID-19.	was on the ground resulting in us being short staffed, there was no time for new recruitments because we were responding to the situation as it came at the time." (HCW10)	simpler tasks to lower-level healthcare workers. Establishing welfare initiatives that comprehensively address the physical and mental health well-being of healthcare workers.
4.3 Impact on multimorbidity care	The COVID-19 pandemic had a profound impact on care for multimorbid patients, leading to the closure of specific clinics and healthcare facilities. This suspension of services was primarily attributed to staff unavailability, isolation regulations, and additional personal challenges faced by healthcare workers.	"Post COVID, we realised that a lot of patients defaulted on a number of treatments as a result of COVID and some of them took advantage of that and some were in places where they could not access services. Even in the facilities, there were restrictions, for example, a patient who has diabetes, at certain stages, they need their eyes checked, some services like eye services were interrupted and, in some areas, other services were stopped altogether." (HCW12)	Develop strategies for ensuring continuity of care for patients with chronic conditions during health emergencies. Strengthen telemedicine and remote monitoring initiatives to facilitate access to healthcare services for vulnerable populations. Invest resources towards research and surveillance initiatives to facilitate a better understanding of the long-term impacts of COVID-19.

4.4 Learning and adjusting	Participants shared adaptation and adjustment measures adopted by healthcare systems and professionals in response to the challenges presented by the COVID-19 pandemic, particularly regarding the management of chronic illnesses.	"Considering the fact that these patients with chronic conditions are at a higher risk of having severe form of COVID or even death, we have strengthened the review. Basically, the majority of patients with chronic conditions like hypertension, sugar diabetes or obesity are reviewed by doctors nowadays. Even patients who were initially seen by nurses or were just going to the local clinic, nowadays they are referred to be reviewed by a doctor. I think somehow it has improved their level of care." (HCW4)	Develop and improve digital health infrastructure for remote consultations and monitoring. Empower patients and healthcare providers on digital health technologies. Set up procedures for delivering medications over long distances and giving supplies for more than one month during emergencies like pandemics or natural disasters.
Theme 5: Barriers to multimorbidity care- This theme explores the importance of providing efficient and effective healthcare to persons living with multiple chronic conditions. However, the delivery of high-quality care is frequently hampered by numerous obstacles; the obstacles can be broadly classified as patient barriers and health-system barriers.			
Sub-theme	**Description**	**Examples of Supporting quotes**	**Opportunities for Improvement**
5.1 Patient barriers	Patients face several obstacles when it comes to receiving multimorbidity care, including their negative perceptions towards	"And I think the main challenge is when they don't come for appointment and only come when they feel sick; some don't come for regular check-ups and they don't	Increase patient educational initiatives to enhance health literacy and enable them

	managing their diseases, cultural and traditional beliefs that impact treatment adherence, and financial limitations that restrict access to healthcare services and medications.	want t to take their medication, they do not want to accept that they will be taking medication for the rest of their lives. They still don't believe they have diabetes and all those, now you have to spend time talking to them and trying to make them understand." (HCW13)	to actively engage in the management of their health problems. Foster collaborations with faith-based groups, community leaders, and cultural groups to develop educational materials and programmes that are sensitive to the culture, beliefs and values of the different population groups. Enhance safety nets and social welfare initiatives to address the social determinants contributing to multimorbidity.
5.2 Health system barriers	Healthcare professionals discussed several health-system problems that hinder the provision of high-quality healthcare and limit efficient patient management. These issues covered poor communication, waiting periods, human resources, resource	"And like we mentioned we have ARV clinics, if a person is living with HIV, it would mean today the appointment is at Satellite clinic, for diabetes they go to Donga, for eye testing they go see the nurse at Area W or Tshwaragano clinic. Yes, indeed it takes the patients from one point to the other but we do not know how it can be worked out, but it is not going to	Implement standardised tools and electronic health records to facilitate seamless information exchange among different healthcare providers. Strengthen community-based care models to provide care closer to patients' homes and reduce reliance on facility-based services.

	availability, and fragmentation of services.	be easy to put them under the same roof for provision of integrated services. Yes, as it currently is, it promotes a lot of movement, like right now for orthopaedic, you go to Mahalapye, for eye health you go to Serowe etc." (HCW10)	Develop and execute effective appointment scheduling systems to minimise waiting times and enhance clinic capacity.
Theme 6: Strategies to improve multimorbidity care- This theme explores the healthcare professionals' suggestions and recommendations to improve care and management of people living with multimorbidity in primary care settings in Botswana.			
Sub-theme	**Description**	**Examples of quotes**	**Opportunities for improvement**
6.1 Integration- moving away from the siloed approach	Participants advocated converting existing clinics into dedicated chronic care clinics to address fragmentation and improve healthcare delivery for those with multiple conditions. This proactive solution strives to streamline services, decrease patient burden, and promote integrated care models, with the ultimate goal of	"We must provide a service that will satisfy the needs of a patient who comes in and has any condition, not a service where a cancer patient would wish that they had HIV because they see that if you have HIV, you get the best service." (PM3)	Invest in research to build integrated care models that are relevant and applicable to the Botswana context. Promote collaboration between different healthcare providers to ensure comprehensive care delivery and continuity. Prioritise patient-centered care by encouraging open communication and

	improving patient outcomes and care quality.		collaborative decision-making between healthcare practitioners and patients.
6.2 Training and workforce development	In order to improve the quality of care for persons with multiple chronic conditions in primary care settings, participants stressed the significance of receiving further training and specialising in the management of chronic diseases.	"Let us, those at primary care be taken for further training, let us be taken for specialty courses and be trained on these conditions, let us become oncology nurses and other specialties so that each district will be able to be independent in some of these things." (HCW14)	Facilitate the development and execution of well-organized training programmes for healthcare practitioners, focusing on the management of multiple chronic conditions, interdisciplinary teamwork, and patient-centric approach. Conduct regular skill evaluations and assessments of competency to ensure that healthcare workers remain efficient in multimorbidity management. Provide opportunities for professional development such as case conferences, workshops, and seminars on multimorbidity management and related issues.
6.3 Prevention	Prevention of NCDs emerged as a crucial strategy for reducing multimorbidity burden. Participants	"I think what we really need to hammer on at policy level, is to emphasise and concentrate our much effort, and not just	Implement comprehensive community-based prevention programmes that focus on lifestyle changes.

	emphasised the importance of stepping up preventative efforts by educating the public about chronic illnesses, encouraging healthy lifestyle choices, and advocating for policy changes aimed at supporting prevention measures.	talk but put much, much, much like 100%, effort on prevention the prevention aspect. Because that is the only way the tide will be dropped, rather than let the pipe burst and later try to deal with the flooding water, when we in fact know where the problem is. So, I would like to see us at policy level, not only speaking about prevention of these conditions, but do something, talk about it, fund it from all perspectives." (PM9)	Promote health education programs focusing on behavioural risk factors contributing to the burden of NCDs and multimorbidity. Lobby for policies that create supportive environments for healthy living. Improve access to preventive healthcare services, including routine health screenings, vaccinations, and counselling on lifestyle modifications.
6.4 Community involvement	Participants underscored the significance of involving community leaders and organisations in tackling health concerns and encouraging healthy behaviours. They advocated for a people-centric strategy that allows communities to assume responsibility for their own health.	"And there is also civil society involvement, so there is community engagement throughout. All these have really contributed to the successes. The HIV prevention messages from way back were driven by the local communities, because they understand the dynamics of their societies much better than us sitting at the offices, so they were the leaders of the programmes. The issue with NCDs, HIV and all these new health issues we are	Enhance the flow of information and cooperation among healthcare professionals and members of the community to guarantee regular involvement and input in healthcare activities. Provide comprehensive training and allocate resources to CBOs to enhance their capacity to tackle health issues and

		seeing is that we can't do it alone, we need everyone to play a role." (PM12)	promote positive health practices within their communities. Create structured channels for community members to provide feedback and input on healthcare policy priorities, ensuring their voices are heard and considered in decision-making processes.
6.5 Research	Participants underlined the importance of research in informing evidence-based solutions and improving healthcare decision-making processes. They emphasised the necessity to invest in local research initiatives and investigate HIV-NCD interactions.	"And also it has taught us (COVID-19) that we need to get more involved in studies, the moment a new condition comes, more studies need to be done, to investigate how this new condition affect people with underlying conditions, and to explore if there is a need to change regime and how all that will affect people with chronic conditions, so really research is very important… research is very important, we need to invest in that, we need to understand these health issues from our very own context." (HCW3)	Promote research partnerships among researchers, policymakers, and healthcare practitioners. Develop a research agenda centred on multimorbidity that specifically caters to the needs and capacities of the nation's healthcare system. Invest in research to further understand the epidemiology of multimorbidity, patterns, social determinants, and care models.

			Strengthen data collection efforts by integrating multimorbidity assessment into existing health surveys and surveillance systems, as well as developing longitudinal studies.

6.5.2 Comparison with other literature

Participants in the study demonstrated varying levels of familiarity with the concept of multimorbidity. While some had a clear understanding of the term, others tended to use related terms interchangeably, reflecting a certain degree of conceptual heterogeneity. This finding aligns with a study conducted among general practitioners in Portugal by Prazeres and Santiago (2016), which similarly highlighted the awareness of multimorbidity among participants and the diverse interpretations regarding its definition. This underscores the complexity of the concept and the need for consensus within the research community to establish a clear and universally accepted definition of multimorbidity as highlighted in previous research (I. S. Ho et al., 2022; Nicholson et al., 2019). Considering these findings, it becomes evident that achieving a shared understanding of multimorbidity is essential to advance research and healthcare practices in this area effectively.

The participants in this study demonstrated a keen awareness of the relevance and complexity of multimorbidity within the healthcare system of Botswana. They provided real-world examples, underscoring the high prevalence of conditions such as hypertension, diabetes, and their coexistence with HIV/AIDS. This observation aligns with findings from several prevalence studies conducted in the region (Angela Y. Chang et al., 2019; R. A. Roomaney et al., 2022a; Wong et al., 2021), all of which have emphasised the convergence of NCDs and communicable diseases. Additionally, these studies have consistently reported a substantial burden of multimorbidity in Botswana (Keetile et al., 2020; Ntiyani et al., 2022) further corroborating the participants' insights and highlighting the pressing need for effective multimorbidity care strategies in the country's healthcare system. Furthermore, concerns regarding the preparedness of healthcare systems in SSA (Sciences, 2019), and specifically in Botswana (Tapela et al., 2019) to address this double burden of diseases have been raised, amplifying the urgency of addressing multimorbidity within these contexts.

Healthcare workers and policymakers shared their experiences regarding the provision of care to patients with multiple chronic conditions in Botswana, including the linkage between primary and secondary care. They emphasised the importance of diligent patient monitoring and consistent follow-up. Furthermore, they stressed the central role played by primary care, including family physicians, family nurse practitioners, and community health workers, in effectively managing multimorbidity. The integration of HIV and NCD services is recognised as a pivotal aspect of care (Masupe et al., 2019; Tapela et al., 2019). However, these stakeholders also pointed out that the absence of comprehensive guidelines and a disease-centered approach to care added to the complexity of providing multimorbidity care.

The study explored the Botswana's healthcare policies, leadership dynamics, and the available tools, shedding light on the transformation observed in the NAHPA as it expanded its scope to encompass both HIV and NCDs since 2018 Many participants voiced their belief that the approach used to combat HIV, which involves multiple sectors, could serve as a valuable model for addressing emerging health challenges. They recognised that healthcare is intricately connected to various social sectors. NCDs are a priority area as indicated in the National Development Plan (Botswana Government, 2016) and the National NCD strategy (Botswana Government, 2019a). The study also highlighted the significance of community engagement, facilitated by dedicated community volunteers and multisectoral committees. Participants emphasised the importance of this engagement in gaining insights into health behaviours and enhancing the delivery of services, particularly for individuals with low socioeconomic status. However, it was noted that challenges persist in terms of funding and resource allocation. Historically, vertical funding has prioritised specific diseases over others, creating resource distribution disparities (Basto-Abreu et al., 2022).

This study took place amid the backdrop of the COVID-19 pandemic, which significantly influenced the landscape of multimorbidity care. The pandemic had a profound impact, diverting crucial resources and affecting routine

healthcare services. One notable effect was the reassignment of staff, resulting in increased workloads and workforce shortages, ultimately contributing to burnout among healthcare professionals. Participants reported that patients also encountered substantial challenges, including disruptions in accessing regular care, difficulties adhering to treatment plans, and the emergence of new chronic conditions in the post-pandemic period. Healthcare systems adapted to these challenges by integrating technology and implementing strategies to reduce the frequency of patient visits. However, some stakeholders believed that chronic care was deprioritised in the midst of the pandemic, which had implications for individuals with multiple chronic conditions.

The study revealed a multitude of barriers hindering the provision of effective care for individuals grappling with multimorbidity. Among these barriers were what interviewees considered patient-related factors encompassing attitudes, beliefs, suboptimal treatment adherence, and the substantial financial burdens incurred by patients seeking care. Within the healthcare system, participants underscored the existence of notable communication gaps among healthcare professionals, pervasive resource shortages, and a worrisome level of fragmentation in service delivery. These findings align with research conducted in other countries facing similar healthcare challenges in low- and middle-income countries (Ajisegiri et al., 2022; Amu et al., 2021). Furthermore, they emphasise the global nature of the obstacles faced by healthcare systems in addressing multimorbidity as similar challenges are observed in other contexts (Mechili et al., 2021), and substantiate the need for context-specific strategies to overcome these challenges.

To address these barriers and enhance multimorbidity care, participants proposed a set of key strategies. These strategies encompassed the integration of healthcare services to streamline care delivery (Adeyemi et al., 2021; Njuguna et al., 2018), a shift towards patient-centered care with active patient involvement in decision-making (Peer et al., 2020), workforce development initiatives to better equip healthcare professionals for chronic

disease management (Basto-Abreu et al., 2022), prevention programs to reduce the burden of chronic conditions (Alkhatib et al., 2021) and research to address knowledge gaps, especially concerning the interaction between HIV and NCDs (Sciences, 2018, 2019). Collectively, these strategies aim to improve the quality of care and alleviate the burden of multimorbidity for both patients and the healthcare system.

6.5.3 Strengths and limitations

This qualitative study is the first to date to explore multimorbidity with healthcare professionals in Botswana. It utilised an extensive and diverse sample of participants from various professions, regions, and sectors involved in policy, health programs, and clinical services in Botswana. Conducting semi-structured interviews with this diverse cohort enabled a holistic exploration of multimorbidity, a previously unexplored area with these key stakeholders. Remarkably, this research represents a pioneering effort as the first study aimed at comprehending the complexities of multimorbidity care in Botswana. The inclusion of various healthcare facilities, both rural and urban, further strengthened the study, allowing for a comprehensive examination of challenges in multimorbidity care and offering valuable insights for healthcare professionals and policymakers by providing a contextualised understanding of multimorbidity care organisation and its associated obstacles.

The interviews were conducted during the peak of the COVID-19 pandemic. This timing may have influenced the participants' perspectives on multimorbidity care, as the heightened awareness of the interplay between the virus and comorbidities during the pandemic could have shaped their views and experiences. It's important to recognise that the pandemic context added a layer of complexity to the healthcare landscape, potentially impacting the challenges and adaptations discussed by participants in the study. This temporal context should be considered when interpreting the findings and their relevance to both pandemic and non-pandemic situations.

Due to time and resource constraints exacerbated by the challenges posed by the COVID-19 pandemic, the study did not include individuals with multimorbidity as participants. Their perspectives on multimorbidity care would have provided valuable insights. However, it is important to note that exploring the patient's viewpoint is a significant avenue for future research and remains a vital area of interest that I intend to investigate following the completion of my PhD.

6.6 Chapter Summary

This chapter reported the findings from a qualitative study which entailed semi-structured interviews with healthcare workers from 4 health districts in Botswana, and policymakers, both regional and national from different sectors involved in health policy and programming. The study uncovered a varied awareness of the concept of multimorbidity among healthcare workers and policymakers, emphasising the need for consensus in its definition. It also revealed the complexities of organising care for patients with multiple conditions in Botswana, emphasising diligent patient monitoring, consistent follow-up, and the integration of HIV and NCD services as crucial aspects of care. The central role of primary care in screening, diagnosing, treating, and coordinating care for people with multiple chronic conditions was emphasised. However, the absence of comprehensive guidelines and a disease-centred approach to care added to the complexity of providing multimorbidity care. Integration, prevention, multi-sectoral approach, and capacity building were highlighted as some of the key strategies to strengthen primary care response to multimorbidity. The study's comprehensive approach, drawing from a diverse sample of participants across various professions, regions, and healthcare sectors, allowed for a contextualized understanding of multimorbidity care organization and the associated obstacles.

Chapter 7 Discussion

7.1 Overview

This chapter provides an integration of the key findings of the three components of my study. I will also explain what these findings mean in relation to the wider multimorbidity literature and their contribution to the existing body of knowledge. The main strengths and limitations of the conducted analyses are also discussed. This chapter concludes with implications of the findings for clinical practice, policy and research.

7.2 Thesis Aims and objectives

The overarching aim of this thesis was to comprehensively investigate the epidemiology of chronic disease multimorbidity in Botswana. To address this aim, the study was structured around the following specific objectives:

1. To assess and summarise epidemiological evidence on chronic disease multimorbidity in SSA.
2. To determine the prevalence and patterns of chronic disease multimorbidity among the adult population in Botswana.
3. To examine the various socio-demographic factors associated with chronic disease multimorbidity among the adult population in Botswana.
4. To explore perceptions and experiences of health care providers and policymakers on care and management of patients with multimorbidity in Botswana.
5. To provide a deeper understanding of what is understood by multimorbidity in the local context and recommendations to inform provision of care for patients with multimorbidity in primary care settings in Botswana.

This thesis addressed these objectives through a mixed-method approach which involved conducting a systematic literature review to consolidate existing evidence on chronic disease multimorbidity in SSA. The second component of the study consisted of an epidemiological investigation aiming

to measure the prevalence of multimorbidity and to examine patterns and determinants (demographic, socio-economic and lifestyle) of multimorbidity in Botswana's adult population. This study was a secondary analysis of cross-sectional data from the Botswana Demographic survey of 2017, which were collected between August and October 2017. This is a national survey of over 30,000 people living in Botswana who were sampled randomly from across the country. Participants in the BDS self-reported on conditions that were diagnosed by a health professional. Lastly, qualitative interviews were employed to explore healthcare providers' and policymakers' perspectives and experiences regarding the care and management of individuals with multiple chronic conditions. By integrating these three components, the aim was to generate novel insights that offer a comprehensive understanding of the complex phenomenon of multimorbidity in the SSA context, and to contribute invaluable insights that can inform healthcare policies and practices not only in Botswana but also in other similar contexts facing the growing burden of chronic disease multimorbidity.

7.3 Summary of key findings

7.3.1 Review of the epidemiology of multimorbidity in SSA

This review included 37 studies reporting multimorbidity prevalence and patterns among adults in SSA, published between 2000 and 2020. The studies were carried out in twelve countries.14 out of the 28 single country studies were carried out in South Africa. These studies predominantly employed cross-sectional designs, with only a few utilizing cohort data. Sample sizes varied considerably, ranging from 142 to 47,334 participants. Prevalence estimates exhibited remarkable heterogeneity, largely due to methodological variations in the number and types of conditions considered, study settings, and participant demographics. Conditions varied in number, with studies incorporating as few as 3 to as many as 30 chronic conditions. Notably, the prevalence of multimorbidity ranged from 1.4% to 69.4%. Additionally, the review revealed diverse patterns of multimorbidity, with HIV and TB frequently

co-occurring with conditions like hypertension, diabetes, anaemia, and depression.

7.3.2 Investigating prevalence and correlates of multimorbidity in Botswana

For this analysis I included 15,512 adults aged 18 years and above. Multimorbidity was defined as the presence of two or more of chronic conditions form a list of sixteen. The most common chronic conditions were hypertension (14.3%), HIV/AIDS (13.9%), asthma (3.4%), tuberculosis (2.2%) and gastric ulcers (2.1%). The least prevalent chronic conditions were epilepsy (0.4%), cancer (0.4%), chronic mental disease (0.5%), osteoporosis (0.5%), and depression (0.6%). My study showed that 4410 (25.3%) of participants had at least one chronic condition. Multimorbidity was present in 1558 (9%) of the population and was independently associated with factors such as age, female gender, marital status, education level, residence, and BMI. The findings further revealed that among individuals with multimorbidity, hypertension (65%) and HIV/AIDS (43.4%), diabetes (18.6%), asthma (15.2%) and TB (13.2% were the most prevalent chronic conditions, significantly shaping the multimorbidity patterns. A descriptive analysis of disease pairs identified several and the most common were hypertension and HIV (24.1%), followed by hypertension and diabetes (18.8%), HIV and tuberculosis (9.9%), hypertension and rheumatism (9.1%), and hypertension and cardiovascular disease (8.2%).

7.3.3 Exploring the perceptions and experiences of healthcare professionals in Botswana

I interviewed 14 primary care workers from different facilities in the 4 health districts, and 13 policymakers with diverse professional roles within the healthcare system of Botswana, both at national and regional level. The findings were explored under six thematic areas, which described how healthcare professionals conceptualised multimorbidity, how care for chronic diseases and multimorbidity is organised, the barriers, and challenges they face in providing care. While there were subtle variations in the terminology

used, the core understanding of multimorbidity as the presence of multiple health conditions was shared by both healthcare workers and policymakers. The significance and complexity of multimorbidity were acknowledged, particularly in relation to the interplay between HIV/AIDS and NCDs. The findings revealed that the current healthcare system is characterised by vertical disease programs, limited funding for NCDs and lack of integration, often leading to fragmented services for patients with multiple chronic conditions. Additionally, the absence of comprehensive multimorbidity care guidelines, poor communication among professionals, extended waiting times, and persistent shortages of personnel and essential medications, were highlighted as some of the barriers in provision of multimorbidity care. Respondents articulated several recommendations aimed at enhancing multimorbidity care in Botswana. These encompassed multi-sectoral collaboration, integration of health services, increased staffing, health education, community engagement, policy changes, and the promotion of preventive care, among many other factors.

7.4 Synthesis of Study Findings

7.4.1 Prevalence of Individual Chronic Conditions

Despite the scarcity of comprehensive evidence on multimorbidity in low- and middle-income countries (LMICs), particularly in sub Saharan Africa (SSA), the existing limited data suggests a noticeable change in disease patterns. The rise in the burden of NCDs and their risk factors, alongside communicable diseases is a cause for concern (Maher et al., 2010; Mensah, 2016).

The prevalence study found that hypertension was the most prevalent chronic condition among adults in Botswana with a higher burden observed among women and older adults. This finding is consistent with other studies conducted in Botswana which have highlighted a significant burden of hypertension in the country (Keetile et al., 2015; Letamo et al., 2017; Tapela et al., 2020). The findings from the prevalence study, systematic review, and qualitative interviews converge to underscore the substantial burden of hypertension in SSA region and in Botswana. Several studies in the systematic

literature review which reported the prevalence of individual conditions also reported a consistent pattern of high prevalence across various countries. For example, in one community study in Malawi, the prevalence was 15.8% (Price et al., 2018), 64% in a national survey in South Africa (A. Y. Chang et al., 2019) and 37.4% in Ghana (Agrawal & Agrawal, 2016). Notably, participants in the qualitative interviews highlighted hypertension as a particularly troublesome chronic ailment. They further pointed out that late diagnosis and suboptimal treatment often results in serious complications. Although hypertension screening has been incorporated as a routine practice in primary care settings in Botswana, it is important to note that there are inconsistencies and variations in its effectiveness across different healthcare facilities, hence the concern that many people with this condition are undiagnosed and/or untreated (Tapela et al., 2020).

The second most prevalent condition was HIV/AIDS. A higher prevalence was reported among women than men, and in the middle age groups. Despite the advancement of ART in most SSA countries, HIV/AIDS remains one of the major public health challenges in the region (Coetzee et al., 2019; Dwyer-Lindgren et al., 2019). Botswana is no exception to this, consistently ranking among the highest in the world for HIV prevalence (Botswana Government, 2019b; Matlho et al., 2019).

The systematic review shows that the studies examining the relationship between HIV and multimorbidity in the region have been limited. However, the available studies have presented diverse findings. It is worth noting that certain countries have reported a comparatively lower prevalence of HIV, particularly in studies where individuals self-reported their HIV status (Odland et al., 2020; Weimann et al., 2016), whereas other countries have reported a higher prevalence (Mugisha et al., 2016; Petersen et al., 2019). Methodological differences and settings contribute to these variations in prevalence.

The qualitative interviews complement the quantitative findings, revealing the complex nature of patients' health profiles within Botswana’s primary care system. Participants highlighted the simultaneous presence of HIV alongside

other chronic ailments such as TB, diabetes, hypertension, and different forms of cancer (e.g., cervical and breast cancer were frequently mentioned). Participants further raised concerns regarding new HIV infections, particularly among younger people. This qualitative observation underscores the importance of HIV as a major contributor to the complicated picture of multiple chronic diseases in Botswana and Sub Saharan Africa (SSA).

It is well documented that NCD research in SSA is still limited and therefore understanding the true burden of most of the NCDs is hampered by limited data, among many factors (Gouda et al., 2019; Mensah, 2016). It was not surprising that conditions such as epilepsy, cancer, mental health conditions, and osteoporosis had lower prevalences in my prevalence study. Bearing in mind that these conditions were self-reported, it is possible that they were also underreported due to a number of factors including lack of awareness, recall bias or even stigma associated with some conditions such as epilepsy and depression. Importantly. these results point to a larger problem in SSA: access to healthcare and diagnostic challenges, and limited attention and resources allocated to NCDs. Underdiagnosed chronic conditions means that individuals with chronic conditions are untreated or undertreated, which ultimately can lead to uncontrolled conditions and complications, as well as exacerbation of multimorbidity burden.

7.4.2 Epidemiology of Chronic Disease Multimorbidity

As indicated in Chapter 5, the prevalence of multimorbidity among the adult population in Botswana was 9%, higher than other prevalence estimates reported in prior studies in the country (Keetile et al., 2020; Letamo et al., 2017; Ntiyani et al., 2022). The systematic literature review on the other hand reported a prevalence ranging from 1.4% to 69.4% from settings across SSA. The variations in multimorbidity prevalence estimates have been captured in the literature, with several systematic and scoping reviews also reporting varying results (Abebe et al., 2020; Fortin et al., 2012; I. S.-S. Ho et al., 2022). My estimates of multimorbidity prevalence estimates from both the prevalence

study, and the systematic review, are comparable with other estimates from other LMICs (Abebe et al., 2020; Asogwa et al., 2022; Pati et al., 2015).

The variations observed in the prevalence estimates of multimorbidity (MM) among different countries can be attributed to the complex interplay of various factors including demographic and epidemiological contexts of the countries. Methodological approach also play a pivotal role, including the specific chronic diseases considered in the study, the characteristics of the population under study, and the methods used to collect data (Ho et al., 2021). Moreover, additional factors such as a country's income level, healthcare infrastructure, and access to diagnostic and treatment services further contribute to these variations. As such, understanding the disparities in MM prevalence across countries demands a holistic perspective that accounts for methodological issues, socio-economic determinants, and the broader healthcare landscape, ultimately guiding the development context sensitive approaches of measuring multimorbidity (Sciences, 2018).

7.4.3 Determinants of Multimorbidity

My study found that age was associated with multimorbidity. A similar trend has been found in other studies conducted in the country (Keetile et al., 2020; Ntiyani et al., 2022) and elsewhere (Dhungana et al., 2021; Eyowas et al., 2022; Roberts et al., 2015; R. A. Roomaney et al., 2022a). This finding is also in agreement with the systematic literature review findings and the qualitative interviews, which reported that multimorbidity was more common among older adults. It is however worth noting that multimorbidity was still prevalent in the younger population. As life expectancy in Botswana improves it is imperative the healthcare needs of older adults are taken into consideration of healthcare policy and programmes through targeted interventions.

As previously highlighted, the higher likelihood of females being multimorbid compared to males is a well-established association supported by existing literature (Afshar et al., 2015; Marengoni et al., 2019). This gender disparity in multimorbidity has connections to various factors. Firstly, biological differences

and longer life expectancy among women contribute to the observed trend. Secondly, socio-cultural factors, including gender roles and norms that shape health-seeking behaviours, play a pivotal role. Additionally, economic disparities, which can impact access to healthcare and resources, further compound this issue. Emphasising and addressing gender disparities in the burden of multimorbidity serves as an essential starting point in the pursuit of health equity. Health equity is not only a matter of ethical concern but also a critical element in advancing social development and achieving sustainable, equitable, and inclusive societies.

The association between lower education and multimorbidity as observed in my prevalence study, aligns with previous research (Afshar et al., 2015; Feng et al., 2021; Ntiyani et al., 2022), and resonates with insights from qualitative interviews with healthcare professionals and policymakers. Lower education has often been linked to lower health literacy. It is possible that individuals with limited health literacy may struggle to understand and effectively manage their health conditions. They may also have limited access to economic resources which can in turn affect their access to healthcare and negatively impact their living conditions (Feng et al., 2021). While these observations align with some previous research, it is important to note that not all multimorbidity studies in Botswana have reported a significant association with education (Keetile et al., 2020). This divergence in results underscores the complexity of the relationship and suggests the need for further investigation. The association between multimorbidity and lower educational attainment underscores the pivotal role of education in shaping other determinants of health.

The influence of obesity in the burden of most NCDs and multimorbidity is well established. The high prevalence of obesity observed in the prevalence study, along with its statistically significant association with multimorbidity, underscores obesity's pivotal role as a determinant of multimorbidity in Botswana. These findings again align with insights from the qualitative interviews, where unhealthy habits such as poor diet, physical inactivity, and alcohol consumption were linked to the growing burden of NCDs. Obesity not

only increases the risk of multiple chronic conditions but also complicates their management (Agborsangaya et al., 2013; Alkhatib et al., 2021). Addressing obesity becomes a key strategy for preventing and managing multimorbidity. Public health efforts promoting healthier lifestyles, better nutrition, and increased physical activity are essential. Healthcare systems must be equipped to provide comprehensive care, including obesity management, for individuals with multimorbidity.

7.4.4 Intersection of chronic communicable and noncommunicable diseases

Identifying multimorbidity patterns, that is conditions which commonly co-occur is helps provide crucial information for developing guidelines for treatment and management, as well as prevention interventions. However, there is still limited evidence on multimorbidity patterns and studies that have attempted to establish these patterns have adopted varying methods, and the results may not be applicable to other settings (Ng et al., 2018; Xu et al., 2017a). It is therefore crucial to go beyond measuring the prevalence of multimorbidity, but also explore these patterns or disease clusters. As previously mentioned in Chapter 4, I summarised evidence on clusters of chronic conditions reported in studies conducted in SSA in the systematic literature. I also explore common dyads of chronic conditions in my prevalence study as reported in Chapter 5. A variety of disease combinations were identified in the two studies. While the prevalence and types of patterns found varied significantly, a common thread emerged across most combinations – hypertension. Notably, hypertension featured prominently in the most prevalent pairs, frequently co-occurring with conditions such as diabetes, HIV, tuberculosis, and various cardiovascular and metabolic disorders. The prevalence study confirmed the dominance of hypertension among individuals with multimorbidity, signifying its substantial influence on the overall patterns observed. The dominance of hypertension in most disease combinations have been established in several studies (A. Y. Chang et al., 2019; Eyowas et al., 2022; Lalkhen & Mash, 2015; Nimako et al., 2013).

A unique component of my study involves the exploration of multimorbidity arising from the convergence of communicable and noncommunicable diseases. The co-occurrence of HIV, with several NCDs such as hypertension, diabetes, and cardiovascular diseases, has emerged as a significant pattern, established in both the systematic review and the prevalence study. This shift underscores the evolving epidemiological landscape within the region, showing the intersection of NCDs and communicable diseases. Within this intersection, different combinations were observed, and the most common combination was HIV and hypertension. This finding is consistent with other studies in the region which have established a similar pattern (A. Y. Chang et al., 2019; Sharman & Bachmann, 2019; Weimann et al., 2016). Notably, the prevalence study revealed that HIV was frequently associated with TB, underscoring the relevance of communicable diseases in multimorbidity patterns in the SSA context, as well as the complexity of managing these communicable diseases alongside emerging NCDs. While my prevalence study and some of the studies in the systematic review used descriptive methods to establish these patterns, a South African study using Latent Class Analysis also reached similar conclusion that majority of multimorbid individuals had hypertension and HIV (R. A. Roomaney et al., 2022a). Similarly, a recent systematic review exploring patterns of communicable and NCDs in LMICs demonstrated similar patterns (Kaluvu et al., 2022). These findings collectively illustrate the intersecting dynamics of communicable and NCDs and calls for a holistic and integrated approach in the provision of comprehensive care and disease management.

7.4.5 Healthcare professionals' perceptions on multimorbidity care

The rising burden of multimorbidity raises concerns regarding the preparedness and capability of healthcare systems to extend quality care to individuals with multiple chronic conditions. However, there is consensus that healthcare systems in LMICs including SSA, are ill-prepared for this challenging phenomenon (Basto-Abreu et al., 2022; Beran, 2015). The in-depth interviews conducted with healthcare professionals in Botswana shed

light on the current organisation of healthcare services and how these serve patients with multimorbidity, the policy environment, and the challenges in providing care and managing these patients.

In this study, healthcare workers and policymakers demonstrated profound awareness of the nature and challenges of multimorbidity and reported encountering patients with multiple chronic conditions in their daily work. Interestingly, certain cadres of healthcare professionals, such as medical officers, family physicians and family nurse practitioners, indicated a higher degree of comprehension and confidence when it comes to managing patients with multimorbidity. On the other hand, healthcare workers with less extensive training and exposure to multimorbidity, including recently graduated doctors and some general nursing staff, expressed lower levels of confidence and understanding in dealing with such complex medical scenarios. This recognition of multimorbidity within Botswana's healthcare system, along with its associated complexities is an encouraging step. This is especially significant when considering the scarcity of research on this subject in the region.

The organisation of health services for multimorbidity within Botswana's healthcare system involves a hierarchical referral pathway, with facilities ranging from health posts to specialised centres and referral hospitals. Nurses play a critical role in the provision of care: they are involved in ongoing patient management, including nurse-led clinics for stable patients with chronic conditions, prescription refills, and monitoring. Their collaborative efforts with doctors and other specialists ensure effective care coordination, particularly for patients managing multiple chronic conditions. The role of nurses in the provision of chronic care has been established in other settings (Edna et al., 2021; Maimela et al., 2015; Whitehead et al., 2023). While nurses play a crucial role in managing patients with multiple chronic conditions, it is important to note that for Botswana (as with most countries in the region) they are hampered by the availability of resources, shortage of healthcare workforce and lack of adequate training and treatment guidelines to ensure they can

effectively manage complex multimorbidity cases (Basto-Abreu et al., 2022; Beran, 2015; Kamvura et al., 2022).

Healthcare professionals highlighted the need for a holistic, integrated care approach to address the complex healthcare needs of individuals with comorbidities, emphasising comprehensive screening and assessment. They advocated for ensuring patients are seen as individuals, rather than isolating their conditions, and emphasised that community involvement and a shift in mindset are essential for delivering effective and patient-centered care. This reflects a growing recognition of the importance of integrating services and policies to provide cohesive healthcare for those with multiple conditions, bridging gaps in fragmented healthcare services. Fragmented care has been established as a key concern in multimorbidity care and the implications of patients are well documented including potential conflicting treatment plans, delays in the diagnosis and initiation of treatment, increased healthcare burden (Eyowas et al., 2023; Sinnott et al., 2013; Stumm et al., 2019; Wallace et al., 2015).

In my qualitative interviews with healthcare professionals, a clear consensus emerged, emphasising that the promotion and reinforcement of healthcare service integration is a feasible and viable strategy for improving the care provided to individuals with multimorbidity. The perspective expressed aligns with the results of prior research, which consistently acknowledge integration as a promising approach (McCombe et al., 2021; Njuguna et al., 2018; Vorkoper et al., 2018). The participants in my study emphasised a noteworthy opportunity: the current infrastructure for HIV care can be utilised and capitalised upon to facilitate the delivery of comprehensive care for both HIV and NCDs. Expanding upon the aforementioned groundwork, the subsequent rational progression, as explicated in the Njuguna article (Njuguna et al., 2018), entails the identification of integration models that are most aptly tailored to the distinctive circumstances prevailing in Botswana. The implementation of this strategic move will allow the healthcare system to customise integration strategies that are in line with the unique requirements

and available resources of the nation, thereby enhancing healthcare provision for individuals with multiple chronic conditions in Botswana.

The findings from the interviews with healthcare professionals shed light on the challenges associated with managing multimorbidity within Botswana's primary care system. These included non-adherence to treatment plans and appointments due to low health literacy and the burden of managing multiple medications, a shortage of specialised healthcare personnel and specialists, delayed diagnosis and treatment, and extended waiting periods for specialised care. Socio-economic factors, such as transportation difficulties, further impede healthcare access, especially for individuals with limited financial resources. In addition, medication shortages, and communication gaps among healthcare professionals, are additional challenges. These multifaceted barriers underscore the pressing need for comprehensive strategies and policies to enhance the care and outcomes of multimorbid patients within the healthcare system. These findings are in agreement with several studies conducted in the region (Eyowas et al., 2023; Maimela et al., 2015).

The policy framework for addressing multimorbidity in the country is largely driven by the Botswana Multi-sectoral Strategy for the Prevention and Control of Noncommunicable Diseases (2018-2023) (Botswana Government, 2019a). This strategy emphasises a coordinated and comprehensive approach in addressing NCDs and facilitated the transfer of NCD management to the National AIDS and Health Promotion Agency (NAHPA), at the Office of the President in 2018. This change was made to build onto the experience and capacity of the organisation in managing HIV/AIDS, but also a demonstration of political commitment to escalate NCDs as a top-priority issue in the development and health agenda of the country.

Participants also highlighted issues of financing NCD and multimorbidity services. This study found that NCDs services are not well funded compared to HIV/AIDS programmes, malaria, and other vertical disease programmes. This was highlighted as without adequate funding, it is challenging to invest in health system strengthening efforts. Training of healthcare workers,

infrastructure improvements, and expanding healthcare facilities to meet the growing demand for services are all required (Basto-Abreu et al., 2022; Beran, 2015). Collaboration between various stakeholders, including government bodies, civil society organisations, and community-based entities, was highlighted as pivotal for comprehensive healthcare delivery. This approach has been instrumental in fighting the HIV/AIDS epidemic and has been promoted in similar contexts as Botswana (Eyowas et al., 2023; Kamvura et al., 2022).

This study has shed light on the profound impacts of COVID-19 on individuals with chronic conditions, echoing findings in previous research (Organization, 2020a; Wang et al., 2020). The reported challenges include provision of patient care, lack of healthcare resources, and the impact on chronic care service delivery. The findings suggest that opportunities for early detection and timely treatment of NCDs have been missed, which could have mitigated the adverse impact of chronic conditions during the pandemic. Furthermore, healthcare workers in my study reported instances of post-Covid complications among some patients underscoring the long-term consequences of healthcare disruptions. As the world continues to grapple with the repercussions of the pandemic, it is imperative for healthcare systems, particularly in LMICs, to prioritise the well-being of individuals with chronic conditions and develop resilient healthcare strategies to ensure their continued access to quality care even during health crises.

The findings from this study highlight the significant importance of primary care in effectively managing chronic conditions, especially for patients who are dealing with multimorbidity. Healthcare professionals' recommendations have firmly underscored the role of primary care in delivering comprehensive, patient-centered, and coordinated care for individuals with multimorbidity. These findings are consistent with the prevailing knowledge that primary care, serving as the first point of contact within the healthcare system, has a distinct advantage in addressing the multifaceted needs of these individuals (Tapela et al., 2019; World Health Organization, 2016).

To enhance the efficiency of primary care in Botswana, participants made some strategic suggestions. First, implementing patient education and health promotion initiatives, in line with healthcare professionals' advice, holds the potential to empower individuals to take an active role in their own healthcare, enhancing their capacity to effectively manage their medical conditions. Additionally, community engagement in preventive efforts acknowledges the influential role of social and environmental factors in health outcomes. Encouraging healthy eating, physical activity, and lifestyle modifications at the community level can significantly contribute to the prevention of chronic conditions. Furthermore, advocating for policy changes prioritising prevention aligns with the cost-effectiveness principle that emphasizes prevention over treatment. Allocating resources for preventive initiatives and education reflects a long-term commitment to reducing the prevalence of noncommunicable diseases (NCDs). Finally, reinforcing healthcare teams ensures that individuals with chronic conditions receive comprehensive care. The integration of screening and care for both infectious and NCDs capitalises on existing infrastructure and resource optimisation. These multifaceted strategies collectively promote the pivotal role of primary care in chronic condition management and underscore the importance of a community-centered, proactive healthcare approach in Botswana.

Botswana's adoption of the WHO Package of Essential Noncommunicable (PEN) Disease Interventions for Primary Health Care (WHO PEN) strategy (Organization, 2020b) marked a significant turning point in the country's healthcare landscape. A noteworthy outcome of this strategy was the development of Botswana's first-ever national primary care guideline for adults. This pioneering step underscored the nation's commitment to addressing noncommunicable diseases (NCDs) within primary healthcare (Tapela et al., 2019).

Key strategies, including stakeholder engagement, data analysis, and the integration of NCD guidelines into broader primary healthcare frameworks, were instrumental in this effort. Notably, the incorporation of NCDs into the

National Development Plan (NDP 11) demonstrated a national commitment to tackle the escalating NCD burden. The simultaneous development of a multisectoral national NCD strategy, combined with the integration of NCDs into primary healthcare, is seen as a significant stride toward strengthening the country's primary healthcare system.

However, the challenges of implementation, resource allocation, capacity building, and the imperative task of sensitizing healthcare workers and the broader stakeholder community remain critical concerns. My own study resonates with these key issues, emphasising that while the primary healthcare guideline is a commendable starting point, the complexities posed by multimorbidity demand a reassessment of existing approaches. In this context, my PhD study serves as a catalyst for initiating important discussions and dialogues around the evolving landscape of primary healthcare in Botswana, particularly in the context of addressing NCDs and multimorbidity.

7.4.6 7.5 Strengths and limitations of the study

I have discussed strengths and limitations of each specific study under the relevant chapters. Here I will discuss the overall strengths and limitations of my PhD study. The key strength of my thesis was taking a comprehensive approach to investigate chronic disease multimorbidity in Botswana, using a range of objectives that included systematically reviewing the literature, the epidemiological analysis, and qualitative interviews with healthcare professionals. This approach allowed for a more in-depth exploration of this topic with triangulation of data enhancing the credibility of my findings. To my knowledge, this is the first study to explore multimorbidity in Botswana using this comprehensive approach.

Secondly, my study utilised data from the Botswana Demographic Survey, which is a nationally representative dataset with a large sample size. This allows for generalisability of the findings to the broader population. The inclusion of communicable diseases in the exploration of multimorbidity also provides a more holistic and contextually relevant perspective on this topic.

Thirdly, the inclusion of healthcare professionals with different roles within the healthcare system of Botswana, from four distinct health districts (urban and rural settings), provided valuable insights into the local issues surrounding this under-explored topic.

There are some important limitations to note when interpreting findings from this study. My epidemiological study relied on self-reported data of chronic conditions. The use of self-reported data in multimorbidity studies may introduce recall bias and accuracy issues. This might lead to underestimation of multimorbidity. Additionally, the selection of chronic conditions to include in the analysis was based on what was available in the dataset. For example, in the BDS, respondents were only allowed to select a maximum of three conditions. This has the potential to influence the prevalence and patterns observed

I focused my qualitative research on primary healthcare workers in public facilities which are funded by government and excluded private health sector. While over 90% of healthcare is provided by government, the growing private sector in Botswana is contributing significantly to the healthcare system of Botswana. Due to the limitations of public healthcare facilities, the use of private care in Botswana for treatment of NCDs and communicable diseases is recognised, with healthcare providers even admitting to sometimes recommending to patients to get medications from private pharmacies.

The study may have been impacted by the COVID-19 pandemic. I had to conduct telephone interviews instead of face-to-face interviews as I had initially planned, due to COVID-19 restrictions. While I am confident that I was still able to obtain good quality data, I am aware that telephone interviews presented limitations related to the quality of interactions, participant engagement, and the ability to gather non-verbal cues, which are important in qualitative research. Additionally, the pandemic disrupted services, and these disruptions and the shifts in priorities may have influenced healthcare providers' and policymakers' perspectives and experiences related to chronic disease multimorbidity.

7.4.7 Contribution to Knowledge

First, my systematic review on multimorbidity in SSA highlights both commonalities and differences in the definitions, measurements, and disease patterns of multimorbidity across different countries in the region. This regional perspective provides valuable insights that can inform interventions and future research directions.

Second, my prevalence study provides the first comprehensive assessment of chronic disease multimorbidity in Botswana, offering valuable data on the prevalence, patterns, and determinants among adults in Botswana. It is the first study to assess the burden of chronic disease multimorbidity, including NCDs and chronic communicable diseases (HIV and TB). Findings from nationally representative study can have impact on healthcare policies and planning in Botswana, filling a critical gap in the existing literature and serving as a foundational resource for addressing the growing burden of multimorbidity.

Additionally, my research has identified the most prevalent chronic conditions in Botswana, providing essential evidence for resource allocation, screening, and prevention efforts. Understanding the burden of specific diseases like hypertension, and HIV/AIDS in relation to multimorbidity is crucial for effective healthcare prioritisation.

Furthermore, my study revealed important associations between multimorbidity and demographic, socioeconomic and lifestyle factors, shedding light on vulnerable populations. This information can drive targeted interventions and initiatives aimed at achieving health equity within the Botswana population.

Finally, by exploring the perceptions and experiences of healthcare workers and policymakers in Botswana, my thesis has contextualised the issue of multimorbidity within the local healthcare system. This is vital for tailoring effective interventions and care strategies that address the unique need and challenges faced by the people of Botswana. In summary, my PhD thesis adds

to the limited multimorbidity literature in Botswana and in the SSA region and provides actionable insights for health policy and improved patient care.

7.4.8 Implications of Findings

7.4.8.1 Implications for practice

1. The study's identification of prevalent chronic conditions and common comorbidities underscores the importance of integrated care. Combining screening and care for both communicable diseases and noncommunicable diseases can optimise healthcare resources and enhance the efficiency of care delivery. It is quiet evident that most of the patients first point of contact are primary healthcare centres, it is therefore critical that access to screening and diagnostic services is improved to curb delays that patients may experience before they start receiving proper care.
2. To effectively manage patients with multimorbidity, healthcare professionals, particularly those in primary care, should receive comprehensive training and education. Special emphasis should be placed on equipping nurses and general practitioners with the skills and knowledge needed for effective multimorbidity care.
3. A patient-centered approach should be embraced by practitioners. This approach involves viewing individuals as holistic entities rather than focusing solely on their individual conditions. By doing so, healthcare providers can improve care coordination and ultimately enhance patient outcomes.
4. Encouraging community engagement in preventive efforts is a valuable strategy for chronic disease prevention. Healthcare professionals should collaborate with communities to promote healthier lifestyles and behaviours, fostering a proactive approach to healthcare.
5. In the qualitative interviews, participants acknowledged the difficulties they face when they encounter patients with complex conditions. This calls for the promotion of multidisciplinary teams where healthcare providers with their different levels of experience and expertise, can

come together to discuss and share clinical experiences, insights and skills. In some settings, collaborative work between Family Nurse Practitioners, Family Physicians and Pharmacy Technicians was highlighted to be bearing some fruits. In light of shortage of staff, building collaborative teams to leverage expertise is essential.

7.4.8.2 Implications for policy

1. Given the high prevalence of hypertension in Botswana and the broader SSA region, policymakers should prioritize hypertension prevention, early diagnosis, and management. This includes improving the effectiveness of hypertension screening in primary care settings and ensuring consistent access to treatment.
2. Policymakers should invest in comprehensive data collection on chronic conditions, including multimorbidity, to better understand the burden, disease patterns, as well as the social determinants associated with these conditions. This will enable decision-makers to develop evidence based policies and programmes, as well as allocate resources effectively.
3. Adequate funding for NCD and multimorbidity services is crucial. Healthcare financing should prioritise strengthening healthcare systems, prioritising primary and integrated care.
4. Policymakers should promote a holistic, integrated care approach for individuals with multiple chronic conditions. This includes comprehensive screening, care coordination, and bridging gaps in fragmented healthcare services.
5. Healthcare systems should develop resilient strategies to ensure the continued access to quality care for individuals with chronic conditions during health crises, such as the COVID-19 pandemic.
6. It is necessary to investigate the capabilities of digital health technologies, such as telemedicine, mobile health applications, and electronic health records, among other health technologies available. The COVID-19 pandemic has underscored the necessity of these

technologies for the uninterrupted provision of healthcare, among numerous other advantages.

7.4.8.3 Implications for research

1. Both the systematic review and the prevalence study have shed light on a crucial methodological challenge concerning the definition and measurement of multimorbidity. To advance our understanding in the sub Saharan African (SSA) context, it is imperative that future research focuses on establishing a consensus regarding the definition and measurement of multimorbidity among researchers, practitioners, policymakers, and other key stakeholders. This will create a consistent knowledge base that can inform health policy and public health interventions effectively.
2. Future research should further explore multimorbidity patterns in different settings, with a focus on understanding disease combinations and their implications for treatment and prevention strategies. The intersection of communicable and noncommunicable diseases, such as HIV and NCDs, should be studied in more depth to better understand the dynamics and challenges associated with these comorbidities. More advanced statistical approaches such as Latent Class Analysis should be adopted to explore these patterns.
3. Moreover, a comprehensive understanding of the social determinants and risk factors associated with multimorbidity is essential. To articulate opportunities for health policy and public health interventions, future studies should explore this area further. It's worth noting that a significant proportion of the studies included in the systematic review did not explore these correlates, and in the prevalence study, only a limited set of factors were examined within the BDS dataset. Therefore, there is a critical need to collect more data on socioeconomic and lifestyle factors to gain a fuller understanding of multimorbidity patterns.
4. Additionally, future research should extend its scope to include the experiences of patients with multimorbidity, their caregivers, and family members. This could encompass investigating the broader impact of

multimorbidity on families, including its economic burden on households and the responsibilities of caregivers.

5. Furthermore, the ongoing monitoring and research into the post-COVID complications in patients with chronic conditions are imperative. Such research is essential for making informed decisions and developing targeted interventions to address the long-term health consequences of COVID-19 in individuals with pre-existing chronic conditions.
6. Research should assess the preparedness of healthcare systems in LMICs and Botswana, to manage multimorbidity and the impact of policy interventions in improving healthcare delivery. There is a need to evaluate existing healthcare practices, available services as well as guidelines and policies to identify gaps in our healthcare system, and opportunities where we can improve care and management of people living with multiple chronic conditions.
7. While integration of services is seen as a solution to fragmented healthcare within the Botswana healthcare system, the evidence base is too little to come to such conclusions. It is therefore imperative to investigate NCDs and HIV integration models that may be useful in Botswana context.
8. Lastly, it is imperative to formulate a research agenda that specifically addresses the local requirements and priorities. This can also enhance cooperation and foster alliances among researchers, policymakers, and healthcare practitioners to focus efforts and exchange knowledge to advance research on multimorbidity. It is necessary to incorporate the collection of multimorbidity data into current health surveys and surveillance systems. My three studies have emphasised the potential of established research initiatives such as the BDS, the WHO STEPS survey, and BAIS for multimorbidity research. Additionally, it is necessary to investigate longitudinal approaches in order to gain a more comprehensive understanding of the patterns and progression of multimorbidity.

7.5 Chapter Summary

This chapter presents a comprehensive exploration of chronic disease multimorbidity in Botswana, offering insights into its epidemiology, determinants, and healthcare implications. The study reveals hypertension as the predominant chronic condition, alongside the persistent challenge of HIV/AIDS in the region. Multimorbidity is prevalent, with age, gender, lower educational attainment, and obesity emerging as significant determinants. Patterns of multimorbidity highlight the pivotal role of hypertension in co-occurring disease pairs, and the intersection of communicable and noncommunicable diseases, notably HIV with conditions such as hypertension and diabetes. Healthcare professionals and policymakers acknowledge the complexity of managing patient with multimorbidities, emphasizing the need for a holistic, patient-centered approach, primary care strengthening, and collaborative efforts among stakeholders. The study also underscores the impacts of COVID-19 on chronic disease management and the importance of resilient healthcare strategies. In summary, my study calls for a proactive, integrated, and community-centered healthcare approach in Botswana to address the challenges of multimorbidity effectively.

Chapter 8 Conclusion

Multimorbidity is a complex and multifaceted health phenomenon that presents unique challenges and implications in the context of Sub Saharan Africa (SSA) and Botswana in particular. The result of three empirical chapters has shed light on the prevalence, patterns, perceptions, and experiences surrounding multimorbidity, demonstrating the multifaceted nature of this phenomenon and its implications for healthcare systems in the region.

The systematic review of multimorbidity in SSA shed light on the heterogeneity in the definition and measurement of multimorbidity. This highlights the need for a nuanced understanding of multimorbidity that transcends a one-size-fits-all strategy. In terms of multimorbidity research, the review also revealed that SSA is an understudied region. While the global burden of multimorbidity continues to rise, especially in LMICs, there is a need for increased research efforts to address this escalating health problem.

The convergence of communicable and noncommunicable diseases is an outstanding aspect of multimorbidity in SSA. My research revealed that both disease categories contribute significantly to the multimorbidity landscape in this region. This multifaceted nature of multimorbidity necessitates healthcare approaches that bridge traditionally separate healthcare domains.

With no standard operational definition, multimorbidity research in SSA is difficult. The wide variety of chronic conditions, measurement methods, and definitions across studies makes it difficult to compare results and conduct meaningful meta-analyses. Establishing a cohesive body of evidence to inform policies and interventions requires addressing this challenge. Our studies also stressed the importance of data quality, especially when self-reported data may be underestimated due to stigma, low health literacy, and low awareness. Thus, improving data collection tools is essential for accurate assessments.

My research provides valuable insights that can significantly contribute to discussions on healthcare policy and treatment guidelines. Integrated

healthcare delivery that takes into account the convergence of communicable and NCDs emerges as a crucial necessity. The findings highlight the significance of recognising the complex patterns of disease co-occurrence, which can guide the development of individualised treatment protocols and interventions for individuals with multimorbidity. Furthermore, it is impossible to overstate the impact of the COVID-19 pandemic on multimorbidity care. The pandemic has taught us that we need to build resilient healthcare systems, that can withstand pressures and eventualities of this nature. As we rebuild back from COVID-19, this research brings us to a crossroads, with clear recommendations and avenues for future exploration. First and foremost, there is an urgent need for expanded and standardised multimorbidity research in SSA, with a focus on developing universally accepted definitions and measurement methodologies. Policymakers and healthcare stakeholders must recognise the gender, age, and urban-rural disparities in multimorbidity and tailor interventions accordingly. Integrated healthcare approaches that consider the convergence of communicable and noncommunicable diseases should be prioritised.

In conclusion, multimorbidity in SSA, including Botswana, is visibly a growing health challenge that demands nuanced solutions. As we navigate the evolving landscape of healthcare in the region, it is my hope that these findings will serve as a compass, guiding us toward more effective policies, interventions, and strategies to address the growing burden of multimorbidity In this effort, collaboration among researchers, policymakers, and healthcare providers will be pivotal in forging a healthier future for this country.

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Appendices

Appendix 1: Systematic Literature Review Protocol

Disang MR, Weller D, Campbell C. Prevalence and patterns of chronic communicable and non-communicable diseases multimorbidity in sub-Saharan Africa: protocol for a systematic review. *Journal of Global Health Reports*.:e2021011.

Research Articles

Prevalence and patterns of chronic communicable and non-communicable diseases multimorbidity in sub-Saharan Africa: protocol for a systematic review

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Keywords: sub-saharan africa, communicable diseases, non communicable diseases, multimorbidity, multiple chronic diseases

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Background

The burden of multimorbidity is rising globally. In sub-Saharan Africa (SSA), the growing prevalence of non-communicable diseases alongside the already existing high burden of chronic communicable diseases such as human immunodeficiency virus (HIV) presents a complex form of multimorbidity relative to patterns observed in high income countries. There is a gap in understanding the true burden of multimorbidity in SSA, in particular at interface of chronic communicable and non-communicable diseases (NCDs). The primary objective of this systematic review is to identify, evaluate and summarise the evidence on the prevalence and patterns of chronic communicable and NCDs multimorbidity in SSA.

Methods and analysis

This protocol was developed in compliance with the Preferred Reporting Items for Systematic Review and Meta-Analyses Protocols (PRISMA-P) guidelines. A comprehensive search will be conducted on selected electronic databases including Medline, Embase, African Journals Online, based on a predefined search strategy for observational studies reporting primary data on multimorbidity from any country in the SSA region. Additionally, we will explore grey literature databases and check reference lists of included studies. Study selection, assessment of quality of included studies and data extraction will be carried out independently by two reviewers. A narrative synthesis will be conducted and meta-analysis will be carried out where applicable.

Conclusion

The proposed systematic review will provide insights into the interface of chronic communicable diseases and NCDs in SSA. We expect this will provide additional insights into the true picture of multimorbidity in the region and assist policy makers to design appropriate prevention and management strategies. This review does not require ethical approval. Upon completion, it will be submitted for publication in peer-reviewed journals, and disseminated through relevant academic conferences.
Prospero registration: CRD42020183539

Global measures to reduce premature mortality have contributed to a rise in life expectancy: people live longer and a growing proportion live with more than one chronic condition, a phenomenon commonly referred to as multimorbidity.[1] Previous research has found that individuals with multiple chronic conditions have complex healthcare needs and are characterised by deteriorated physical, social and mental wellbeing, higher premature mortality, poor quality of life and increased utilisation of healthcare and social services.[2,3] One of the largest prevalence studies established that multimorbidity is associated with low socioeconomic status and that individuals from deprived areas were likely to develop multiple chronic conditions ten to fifteen years earlier than those from more affluent settings.[4]

Although most evidence comes from high income countries (HICs),[5] it is evident that the burden of multimorbidity is rising and putting pressure on health care systems and economies worldwide.[6] Prevalence estimates range from below 15% to above 95%.[7] A recent systematic review summarising global literature on the prevalence of multimorbidity based on seventy community based studies, estimated a prevalence of 37.9% for HICs and 29.7% in low- and middle-income countries (LMICs).[8] Understanding and mapping the magnitude of multimorbidity, as well as how diseases co-exist is critical in allocation of resources in healthcare and development of effective, efficient evidence-based management and prevention strategies.[8,9] The literature has pointed to the lack of international consensus on the operational definition of multimorbidity as well as the selection of conditions that meet the chronicity criteria as

the major reason behind varying results that are difficult to compare across different settings.[1,7,10]

MULTIMORBIDITY IN THE SUB-SAHARAN AFRICA CONTEXT

Although many countries especially HICs have managed to significantly reduce the prevalence of communicable diseases, in the sub-Saharan Africa region there remains a significant burden from diseases such as tuberculosis (TB), human immunodeficiency virus (HIV), malaria and these remain the leading causes of mortality and morbidity.[11,12] In parallel, the prevalence of NCDs in SSA is rising - primarily cardiovascular diseases, chronic respiratory disease, diabetes, mental disorders and cancers. Due to rapid urbanisation, adoption of risky lifestyles such as harmful use of tobacco and alcohol, lack of exercise and poor diet, the region has experienced a rise of approximately 67% in the burden of NCDs between 1990 and 2017.[13] Furthermore, due to the success of antiretroviral treatment (ART), survival in people living with HIV has significantly improved[14] and research shows that these individuals have an increased risk of developing chronic conditions such as cardiovascular diseases, depression, cancers among others.[15,16]

This increased prevalence of NCDs among people living with HIV has been linked to various factors including the nature of HIV infection, effects of certain antiretroviral drugs, ageing and other well-known NCD risk factors.[17] This interaction presents a complex form of multimorbidity that is different from the one observed in HICs. For example, SSA is likely to have a larger proportion of an ageing population on ART in the coming decades.[18] This highlights the importance of generating context-specific evidence for SSA, a region with the highest global burden of HIV infection which is, concurrently, experiencing a rapid increase in the burden of NCDs.

RATIONALE

Although there is clear evidence that the prevalence of multiple chronic conditions is rising in all regions of the world including sub-Saharan Africa (SSA), there is still limited evidence from the region to give a clear picture of the status or burden of multimorbidity. Most systematic reviews on prevalence and patterns of multimorbidity to date have focused on HICs and those that included SSA countries grouped them together with other countries in the 'LMIC' category. Evidence is needed specifically for this region due to the unique disease profile of a double burden of communicable diseases and NCDs. Given the rapid population growth in the region, an ageing HIV-positive population, the interaction of NCDs and communicable diseases, and already existing health care challenges, it is imperative to generate SSA-specific evidence.

The overall aim of this review is to identify and synthesise the evidence on the prevalence and patterns of chronic disease multimorbidity among adults in sub Saharan Africa by examining the interaction of chronic communicable diseases such as HIV, TB with the most prevalent NCDs in SSA. We will also evaluate the evidence on how multimorbidity in the region is typically measured, and how the differences in measurement might influence reported patterns of multimorbidity. With the advent of the COVID-19 pandemic, we will also incorporate emerging literature on the impact of this pandemic on chronic conditions. To the best our knowledge, this is the first systematic review that will map evidence on the combined burden of non-communicable and communicable disease multimorbidity specifically for SSA region.

METHODS

The development and reporting of this protocol was in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analyses Protocols (PRISMA-P) 2015 statement.[19] This protocol has been published with the International Prospective Register for Systematic Reviews (PROSPERO), registration number CRD42020183539.

ELIGIBILITY CRITERIA

The inclusion criteria is guided by the CoCoPop (condition, context and population) framework for reviews of prevalence studies recommended by the Joanna Briggs Institute.[20,21]

Condition: We will adopt the Academy of Medical Sciences definition of multimorbidity: the coexistence of two or more chronic conditions, each one of which is either; a physical non-communicable disease of long duration, such as a cardiovascular disease or cancer, a mental health condition of long duration, such as a mood disorder or dementia, or an infectious disease of long duration, such as HIV or hepatitis C.[22]

Context: We will consider studies from the sub-Saharan Africa region. Sub-Saharan Africa will be defined according to the World Bank country classification[23] as illustrated in Table 1.

Population: We will include multimorbidity studies involving adults aged 18 years and older.

Studies will be selected based on the following inclusion criteria;

1. Original studies aimed at estimating the prevalence of multimorbidity or documenting the frequent disease patterns conducted either at community or health facility level.
2. Observational studies including cross sectional and longitudinal studies. For longitudinal studies we will extract prevalence at baseline.
3. Government and non-governmental surveillance data/reports and theses that report original data on prevalence or patterns of multimorbidity.

Due to the paucity of research on multimorbidity in sub-Saharan Africa, studies that selected participants based on a specific condition (comorbidity studies) will not be excluded since it is important to understand how the two concepts have been defined and measured in the region. Distinctions on the characteristics of comorbidity and multimorbidity studies will be reported accordingly.

We will collect data from studies published between January 2000 through to December 2020. The rationale behind this date range selection is that global research on multi-

Table 1. Sub-Saharan Africa (World Bank country classification)

Angola	Ethiopia	Niger
Benin	Gabon	Nigeria
Botswana	Gambia, The	Rwanda
Burkina Faso	Ghana	São Tomé and Principe
Burundi	Guinea	Senegal
Cabo Verde	Guinea-Bissau	Seychelles
Cameroon	Kenya	Sierra Leone
Central African Republic	Lesotho	Somalia
Chad	Liberia	South Africa
Comoros	Madagascar	South Sudan
Congo, Dem. Rep.	Malawi	Sudan
Congo, Rep	Mali	Tanzania
Côte d'Ivoire	Mauritania	Togo
Equatorial Guinea	Mauritius	Uganda
Eritrea	Mozambique	Zambia
Eswatini / (Swaziland)	Namibia	Zimbabwe

morbidity only started increasing in the early 2000s, with 80% of studies published after 2010.[5,24] We therefore anticipate that before 2000 there were very few originating from sub-Saharan Africa, especially considering that even after 2010 only approximately 5% of research in this field comes from LMICs.[24] Furthermore, the availability of ART after 2000 changed the HIV situation in the region, making it a manageable chronic condition,[25] and considering the scope of research around HIV comorbidities and NCDs we deem this date range most appropriate for the sub-Saharan Africa context. We will apply no language limits on our literature search; studies in other languages will be translated to English.

We will exclude studies conducted among people below the age of 18 years and those from countries outside the sub-Saharan Africa region. Articles not reporting original peer-reviewed research such as abstracts, conference presentations, opinion reports and reviews will also not be included.

SEARCH STRATEGY

To identify appropriate and relevant studies for the review, the following databases will be searched; MEDLINE, Embase, Cumulative Index of Nursing and Allied Health Literature (CINAHL), Global Health, PsycINFO, African Journals Online and African Index Medicus. We will also hand search reference lists of relevant studies to identify further literature of interest. Additionally, we will use ProQuest Dissertation & Theses, Web of Science, Google Scholar and Google search engine to identify grey literature such as government and institutional reports, theses and dissertations, as well as to track citations. Key authors for studies that meet eligibility criteria will be contacted if there is some missing information or full texts of their studies cannot be accessed.

A comprehensive search strategy and terms was developed by the team in collaboration with the University of Edinburgh Medical Librarian. We will conduct a broad search, adopting some search terms from previous systematic reviews on the topic.[7,8,26] Search terms will include "multimorbidity", "comorbidity", "prevalence", "sub Saharan Africa" and their synonyms. Medical subject headings (MeSH) and key texts words will be developed and combined with Boolean operators "AND" and/ "OR" across and within categories. A full search strategy for MEDLINE (Ovid) database is provided in Table 2, and will be tested and adapted to other databases.

DATA COLLECTION AND ANALYSIS

SELECTION PROCESS

For the first stage of the review, titles and abstracts of potentially eligible studies identified through electronic database searches, will be extracted to Endnote Library (EndnoteX9). Duplicates will be removed (both via Endnote function, and manual checking). Two reviewers will then independently review the titles and abstracts of the remaining studies to identify studies that potentially meet the inclusion criteria. If any discrepancies arise the two reviewers will discuss them and reach an agreement, with a third reviewer providing input. Selection of full text studies against the eligibility criteria will be carried out independently by the two reviewers. The third reviewer will also randomly check 10% of selected studies to check for consistency. Reasons for excluding studies will be documented throughout the process. A PRISMA flow diagram (**Figure 1**)[27] will be used to outline the literature search and selection process.

DATA EXTRACTION

Data extraction from selected studies will be carried out independently by two reviewers. In the event that there are

Table 2. MEDLINE Search Strategy via Ovid

1. multimorbid*.mp.
2. multi$morbid*.mp.
3. multimorbidity.mp.
4. exp multimorbidity/
5. "multiple chronic condition*".mp]
6. "multiple disease*".mp.
7. multi$disease*.mp.
8. "multiple chronic disease*".mp
9. multi$patholog*.mp.
10. multipathology.mp.
11. polypatholog*.mp.
12. poly$patholog*.mp.
13. poly$morbid*.mp.
14. pluri$patholog*.mp.
15. . "chronic condition*".mp.
16. "chronic disease*".mp.
17. comorbid*.mp.
18. co$morbid*.mp.
19. exp Comorbidity/
20. poly$diagnos*.mp.
21. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
22. prevalence.mp.
23. exp Prevalence/
24. epidemiology.mp.
25. Epidemiology/
26. pattern*.mp.
27. cluster*.mp.
28. 22 or 23 or 24 or 25 or 26
29. "sub Saharan Africa".mp.
30. SSA.mp.
31. "Africa South of the Sahara"/
32. Angola OR Benin OR Botswana OR Burkina Faso OR Burundi OR Cameroon OR cape Verde OR Central African Republic OR Chad OR Comoros OR Congo Democratic Republic OR Cote d'ivoire OR Ivory Coast OR Djibouti OR Equatorial Guinea OR Eritrea OR Ethiopia OR Eswatini Gabon OR Gambia OR Ghana OR Guinea OR Guinea Bissau OR Kenya OR Lesotho OR Liberia OR Madagascar OR Malawi OR Mali OR Mauritania OR Mauritius OR Mozambique OR Namibia OR Niger OR Nigeria OR Rwanda OR Sao Tome and Principe OR Senegal OR Seychelles OR Sierra Leone OR Somalia OR South Africa OR South Sudan OR Sudan OR Swaziland OR Tanzania OR Togo OR Uganda OR Zambia OR Zimbabwe
33. 29 or 30 or 31 or 32
34. 21 and 28 and 33

disagreements, there will be discussions between the two reviewers and if a consensus is not reached the third reviewer will adjudicate. The team will develop a data extraction form which will be pre-tested. Key study characteristics are shown in Box 1.

QUALITY ASSESSMENT

We will evaluate the overall quality of individual studies using the Joanna Briggs Institute Prevalence Critical Appraisal Tool.[28] This tool appraises external and internal validity of each individual study by addressing issues of representativeness of sample, recruitment of participants, identification of the condition, its measurement and statistical analysis among others. Two reviewers will independently assess the quality of included studies and disagreements will be resolved through discussions with a third reviewer.

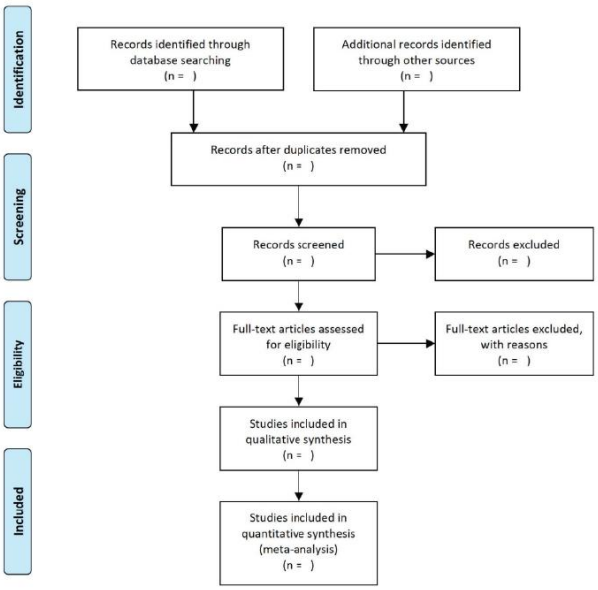

Figure 1. PRISMA flow diagram.

Box 1. Study characteristics

1. Authors, publication year and source of funding
2. Title and journal
3. Year of study
4. Country of study and location
5. Study design
6. Sample size
7. Study population characteristics (age, gender, any other measures such as rural/urban setting, education level)
8. Definition of multimorbidity
9. Measure of multimorbidity (simple diseases counts or weighted indices)
10. Source of multimorbidity data (self-reported, clinical records)
11. Number of conditions included in the study
12. Prevalence of multimorbidity
13. Disease combinations

DATA ANALYSIS

We will conduct a narrative synthesis of data from all included studies using "Guidance On The Conduct of Narrative Synthesis In Systematic Reviews".[29] Studies will be clustered according to multimorbidity definition (2 or more chronic diseases, or 3 or more chronic diseases), setting (population based and facility based). We will generate evidence tables to summarise, descriptively, study and participants' characteristics. Characteristics of comorbidity studies versus multimorbidity will also be captured in table format. We anticipate that potential studies that will meet the inclusion criteria, are likely to be heterogeneous in different features such as study population, settings and data sources hence we expect that meta-analysis might not be suitable.[30] However, if there are sufficient data that we are able to synthesise through meta-analysis, we will estimate a pooled prevalence of multimorbidity using random effects model together with their 95% confidence intervals (CI). Heterogeneity of studies will be assessed using the I^2 statistic. An I^2 value of 25%, 50% and 75% indicating low, medium and high heterogeneity, respectively.[31] For any data with substantial heterogeneity, we will consider sub group analysis using mean age, sex, study setting, World Health Organisation Region in Africa, definition of multimorbidity.

ETHICAL CONSIDERATIONS

This study does not require ethical approval as only sec-

ondary data will be assessed and does not involve interaction with the study subjects.

CONCLUSION

This review will identify and summarise evidence on the burden of multimorbidity in SSA taking into account the context of the region which is characterised by a double burden of communicable and non-communicable diseases. Results of this review will be published in peer reviewed journals and shared through relevant academic conferences.

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AUTHORSHIP CONTRIBUTIONS

MRD made substantial contribution to the conception of the protocol, drafting the manuscript and incorporated comments and suggestions from co-authors. DW and CC revised the drafts critically for important intellectual content and approved the final version for submission.

COMPETING INTERESTS

The authors completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available upon request from the corresponding author), and declare no conflicts of interest.

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Appendix 2: Data Extraction Form-Systematic Review

Date form completed	
Name of person extracting data	
Include/ Exclude	

General information

Study ID	
Author	
Title	
Year of publication	
Journal	
Source of funding	

Study Characteristics

Study aim	
Year of study	
Country & Location	
Design & setting	
Sample size recruited	

Sample size in analysis	
Sample characteristics *(age, gender, education)*	
Data source	
Survey instrument	

Findings

Definition of multimorbidity	
Measure of multimorbidity *(simple count/weighted index)*	
Ascertainment of multimorbidity *(self-reported, administrative records etc.)*	
Number of conditions studied	
List of conditions studied	
Prevalence of multimorbidity	
Disease combinations/ observed patterns	
Notes/ observations:	

Appendix 3: JBI Critical Appraisal Tool for Studies Reporting Prevalence Data

Reviewer	

Date	

Author	

Year	

Study ID	

Topics	**Yes**	**No**	**Unclear**	**Not applicable**
1. Was the sample representative of the target population?	☐	☐	☐	☐
2. Were the study population recruited in an appropriate way?	☐	☐	☐	☐
3. Was the sample adequate?	☐	☐	☐	☐
4. Were the study subjects and the setting described in detail?	☐	☐	☐	☐
5. Was the data analysis conducted with sufficient coverage of the identified sample?	☐	☐	☐	☐
6. Were objective, standard criteria used for the measurement of the condition?	☐	☐	☐	☐
7. Was the condition measured reliably?	☐	☐	☐	☐
8. Was there appropriate statistical analysis	☐	☐	☐	☐

9.	Are all important confounding factors/ subgroups/ differences identified and accounted for?	☐	☐	☐	☐
10.	Were subpopulations identified using objective criteria?	☐	☐	☐	☐

Comments:

Appendix 4: Prevalence of Multimorbidity by Urban/Rural Residence

Author (Year)	Country	Dataset	Sample Size	Age	No. of CC	Prevalence (%)	Prevalence (%) by Location
Agrawal (2016)	Multi country	WHO SAGE		≥18	9		
	Ghana		5571			23	Urban=10.6 Rural=5.1
	South Africa		4227			32	Urban=22.8 Rural=13.7
Alaba (2013)	South Africa	SA-NIDS	11638	≥18	6	4	Urban=4.3 Rural=3.7
Keetile (2020)	Botswana	Botswana NCD study	1178	≥15	10	5.4	Cities & Towns=3.4 Urban Villages=6.7 Rural=5.2
Kunna (2017)	Ghana	WHO SAGE	4050	≥50	8	30.2	Urban=32.31 Rural=28.04
Letamo (2017)	Botswana	Botswana AIDS Impact Survey	2153	≥10	3	2.6	Cities & Towns=2.6 Urban Villages=3.9 Rural=1.4
Morgan (2017)	Multi country	WHS		≥18	7		
	Ghana	WHO SAGE	5573			1.4	Urban=1.1 Rural=1.3
	South Africa		4227			4.7	Urban=4.6 Rural=3.4
Phaswana-Mafuya (2013)	South Africa	WHO SAGE	3638	≥50	8	22.5	Urban=24.9 Rural=18.2

Price (2018	Malawi	Community survey-Karonga Health & Demographic Surveillance Site	28891	≥18	3	3.4	Urban=5.9 Rural=2.7

Appendix 5: Prevalence of Multimorbidity by Sex

Author	Country	Study Setting	Sample Size	Age	Number of Conditions	Prevalence (%)	Male (%)	Female (%)
Chang (2019)	South Africa	community survey	3889	≥40	10	69.4	67.2	71.2
Gaziano (2017)	South Africa	community survey	5059	≥40	9	55.7	28.2	40.0
Hien (2014)	Burkina Faso	community survey	389	≥60	15	65.0	59.1	71.8
Price (2018)	Malawi	community survey	28891	≥18	3	3.4	2.5	5.4
Cadmus (2017)	Nigeria	facility based	4886	≥60	17	31.0	29.0	33.0
Gbeasor-Komlanvi (2020)	Togo	facility based	370	≥60	15	57.6	57.5	63.0
Nimako (2013)	Ghana	facility based	1399	≥18	13	38.8	33.3	41.3
Nwani (2015)	Nigeria	facility based	345	≥65	30	49.0	33.3	15.7
Petersen (2017)	South Africa	facility based	2549	≥18	5	35.0	36.0	35.0
Agrawal (2016)	Multi-country Ghana South Africa	national survey	 5571 4227	≥18	 9 9	 23.0 32.0	 5.4 14.5	 9.7 23.7
Alaba (2013)	South Africa	national survey	11638	≥18	6	4.0	2.6	4.9
Keetile (2020)	Botswana	national survey	1178	≥15	10	5.4	2.5	6.6
Kunna (2017)	Ghana	national survey	4050	≥50	8	30.2	25.7	34.3
Letamo (2017)	Botswana	national survey	2153	≥10	3	2.6	2.3	2.9
Morgan (2017)	Multi-country Ghana	national survey	 5573	≥18	6 7	 1.4	 1.1	 1.3

	South Africa		4227			4.7	2.4	11.1
Phaswana-Mafuya (2013)	South Africa	national survey	3638	≥50	8	22.5	17.6	26.4

Appendix 6: Prevalence of Multimorbidity by Age

Age Groups	Author	Country	Study Setting	Number of conditions	MM Prevalence (%)	Age Specific Prevalence
10-64	Letamo	Botswana	National survey	3	2.6	10-19=0.0 20-29=0.7 30-39=2.0 40-49=4.1 50-59=7.1
≥15	Keetile	Botswana	National survey	10	5.4	>24=0.7 25-34=1.3 35-44=3.6 45-54=6.9 55-64=18.7 65+=18.0
	Sharman	South Africa	Community survey	4	8.4	n/a
					13.2	n/a
	Weimann	South Africa	National survey	4	2.73	n/a
					2.84	n/a
≥18	Price	Malawi	Community survey	3	3.4	n/a
	Van Heerden	South Africa	Community survey	6	56	18-25=18.2 26-35=60.6 36-45=61.0 46-65=90.1 65+=70.7
	Isaacs	South Africa	Facility based	13	53.9	n/a
	Nimako	Ghana	Facility based	13	38.8	n/a
	Petersen	South Africa	Facility based	5	35	18-24=7.2 25-44=23.7 45-64=45.6 65== 43.4

Age Groups	Author	Country	Study Setting	Number of conditions	MM Prevalence (%)	Age Specific Prevalence
	Woldesemayat	Ethiopia	Facility based	18	17.8	18-29=3.4 30-44=3.6 44+=10.7
	Afshar	Multi country study	National survey	6		
		Burkina Faso			6.3	18-49=4.8 50-64=9.7 65+=13.0
		Ghana			3.6	18-49=2.0 50-64=4.4 65+=6.6
		Kenya			4.2	18-49=2.1 50-64=3.2 65+=11.5
		Namibia			7.9	18-49=4.5 50-64=11.9 65+=17.7
		South Africa			11.2	18-49=5.0 50-64=21.6 65+=30.1
	Agrawal	Multi country study	National survey	9		
		Ghana			23	18-29=1.6 30-39=1.0 40-49=3.8 50-59=7.6 60-69=14.1 70+=19.8
		South Africa			32	18-29=3.2 30-39=1.7 40-49=10.8 50-59=19.6 60-69=26.4 70+=26.7
	Alaba	South Africa	National Survey	6	4	n/a

Age Groups	Author	Country	Study Setting	Number of conditions	MM Prevalence (%)	Age Specific Prevalence
	Arokiasamy	Multi country study	National survey	8		
		Ghana			22	n/a
		South Africa			22.5	n/a
	Lee	Multi country study	National survey	9		
		Ghana			3.9	18-29=2.0 30-39= 0 40-49=3 50-59=5 60-69 =11 70+=16.3
		South Africa			9.2	18-29=0.5 30-39= 1.0 40-49=10 50-59=17 60-69 =26 70+=29
	Morgan Study 1	Multi country study	National survey	6		
		Burkina Faso			6.3 (5.6-7.0)	18-49=4.8 50-64=9.7 65+=13.0
		Ghana			3.6 (3.0-4.2)	18-49=2.0 50-64=4.4 65+=6.6
		Kenya			4.2 (3.6-4.8)	18-49=2.1 50-64=3.2 65+=11.5
		Namibia			7.9 (7.0-8.8)	18-49=4.5 50-64=11.9 65+=17.7
		South Africa			11.2 (9.8-12.5)	18-49=5.0 50-64=21.6 65+=30.1

Age Groups	Author	Country	Study Setting	Number of conditions	MM Prevalence (%)	Age Specific Prevalence
	Morgan Study 2	Multi country study	National survey	7		
		Ghana			1.4 (1.1-1.7)	18-49=0.1 50-64=2.3 60-69=4.4 70+=7.8
		South Africa			4.7 (4.0-5.4)	18-49=1.8 50-64=8.9 60-69=15.2 70+=14.2
	Sum	Multi country	National Survey	9		
		Ghana			17.18	n/a
		South Africa			17.72	n/a
≥40	Chang	South Africa	Community survey	10	69.4	40-49=62.8 50-59=70.2 60-69=71.4 70-79=68.7 80+=75.1
				4 categories	53.9	40-49=51.8 50-59=53.4 60-69=54.9 70-79=53.4 80+=57.5
	Gaziano	South Africa	Community survey	9	55.7	n/a
	Odland	Burkina Faso	Community survey	11	22.8 (21.4-24.2)	n/a
	Pengpid	South Africa	Community survey	13	56	n/a
≥50	Aboyade	South Africa	Community survey	9	39.2	n/a

Age Groups	Author	Country	Study Setting	Number of conditions	MM Prevalence (%)	Age Specific Prevalence
	Mugisha	Uganda	Community survey	9	37.4	50-59=38.1 60-69=26.5 70+=47.4
	Oduro	Ghana	Faciity based	13	52.2	n/a
	Garin	Multi country	National	12		
		Ghana			48.3	50-59=42 60-69=48 70-79=52 80+=54
		South Africa			63.44	50-59=60 60-69=68 70-79=62 80+=54
	Kunna	Ghana	8		30.2	50-59=25.38 60-69=31.26 70-79=33.10 80+=36.29
	Phaswana-Mafuya	South Africa	National survey	8	22.5	50-59=17.2 60-69=27.2 70-79=29.8 80+=26.1
	Stubbs	Multi country	National survey	13		
		Ghana			47.6	n/a
		South Africa			64.9	n/a
	Waterhouse	South Africa	National survey	9	12.9	n/a
≥60	Emeh	Cameroon	Community survey	7(+ others)	35.9	n/a

Age Groups	Author	Country	Study Setting	Number of conditions	MM Prevalence (%)	Age Specific Prevalence
	Hien	Burkina Faso	Community survey	15	65	60-69=59 70+=71.2
	Cadmus	Nigeria	Facility based	17	31	n/a
	Fakoya	Nigeria	Facility based	11	50.5	n/a
	Gbeasor-Komlavi	Togo	Facility based	15	57.6 (52.4-62.7)	n/a
65+	Nwani	Nigeria	Facility based	30	49	65-74=32.2 75+=16.8

Appendix 7: Studies Measuring Multimorbidity of NCDs and Communicable Diseases

Author (Year)	Country	Age	Number of Conditions Included	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
Alaba (2013)	South Africa	≥18	6	Diabetes (56) Asthma (23.4) Stroke (9.2) Cancer (5.8) High Blood Pressure (5.6) TB (n/a)	4
Odland (2020)	Burkina Faso	≥40	11	Hypertension (36.7) Diabetes (6.7) Hypercholesterolemia (10.9) Heart Disease (5.7) Stroke (1.2) Chronic Respiratory Disease (3.2) Cancer (0.5) HIV (0.6) Cognitive Impairment (7.1) Anxiety (12.4) Depression (7.9)	22.8 (21.4-24.2)
Weimann (2016)	South Africa	≥15	4		
	Wave 1			Hypertension (22.73) Diabetes (2.81)Tuberculosis (1.59) HIV (1.11)	2.73 (2.50-2.98)
	Wave 3			Hypertension (32.13) Diabetes (2.71)Tuberculosis (0.59) HIV (2.13)	2.84 (2.61-3.08)
Chang	South Africa	≥40	10	Hypertension(64) Dyslipidaemia (44) Anaemia(41) HIV (23) Depression(17) Diabetes(12) Angina (10) Post-Traumatic Stress Disorder (5) Alcohol Dependence (1) Chronic Bronchitis(1)	69.4 (68.0-70.9)

Author (Year)	Country	Age	Number of Conditions Included	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
Emeh	Cameroon	≥60	7(+)	Lung Diseases (4.23) Diabetes (7.75) Hypertension (29.58) Gastritis (38.73) Arthritis (38.73) HIV (1.41) Infectious Diseases (9.15) Others (59.86)	35.9
Gaziano	South Africa	≥40	9	Hypertension (58.4) Diabetes (11.1) Dyslipidaemia (43.6) Angina (2.35) Overweight/Obesity (n/a) HIV (n/a) Heart Failure (0.8) Myocardial Infarction (0.4) Stroke (3.0)	55.7
Mugisha	Uganda	≥50	9	HIV (51.8) Hypertension (34.6) Depression (8.7) Eye Problems (8.7) Arthritis (5.7) COPD (5.3) Diabetes (4.9) Angina (2.5) Stroke (2.1)	37.4
Pengpid	South Africa	≥40	13	Anaemia (17.3) Angina (2.4) Cataract (12.8) Chronic Bronchitis (1.5) Diabetes (12.0) Dyslipidaemia (43.8) Heart Failure (0.7) Hypertension (58.4) Kidney Disease (4.2) Myocardial Infarction (0.4) Stroke (2.9)HIV (12.4) Tuberculosis (8.8)	56
Sharman	South Africa	≥15			
	2009		4	HIV(25) Tuberculosis (4) Hypertension (18) Diabetes(4)	8.4

Author (Year)	Country	Age	Number of Conditions Included	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
	2015		4	HIV (32)Tuberculosis (3) Hypertension (31) Diabetes(8)	13.2
van Heedern	South Africa	≥18	5	HIV (33) Obesity (47) Hypertension (33) Hyperglycaemia (4) Hyperlipidaemia (20) Depression(12)	56
Cadmus	Nigeria	≥60	17	Hypertension (45.6) Osteoporosis (19.5) Diabetes (10.4) Eye problems (6.7) Spondylosis (6.5) Arthritis (5.9) Cataract (5.6) Malaria (3.2) Dementia (3.2) Hypertensive Heart Disease (2.7) Urinary Tract Infection (2.08), Peptic Ulcer Disease (2.0), Glaucoma (1.8) , Hearing Problems (n/a) Obesity (1.7) Pulmonary Tuberculosis (1.1) Asthma (1.1)	31

Author (Year)	Country	Age	Number of Conditions Included	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
Nwani	Nigeria	≥65	30	Hypertension (51.0) Cerebrovascular Accident (26) HHD with CCF (12.5) Cardiomyopathy (2.3) Valvular Heart Disease (1.2) Ischemic Heart Disease (0.6) Diabetes (42.9) Hypothyroidism (0.3) Chronic Liver Disease (4.3) Acid-related Disease (3.5) Chronic Gastritis (0.3) Hepatocellular Carcinoma (2.0) Cancer of Prostrate (1.7) Benign Prostatic Hyperplasia (2.0) Gastric Cancer (0.6) Cancer of the Lung (0.6) Non-Hodgkin Lymphoma (0.6) Brain Tumor (0.3) Multiple Myeloma (0.3) Seizure Disorder (2.3) Movement Disorder (Parkinsonism) (1.4) Spinal Cord Compression (0.6) Osteoarthritis/ Spondylopathies (4.9) Asthma (1.2) Chronic Obstructive Airway Disease (0.9) Dementia (1.2) Anxiety Disorder (0.3) Tuberculosis (2.9) HIV (0.6) Chronic Kidney Disease (0.9)	49

Author (Year)	Country	Age	Number of Conditions Included	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
Oduro	Ghana	≥50	13	Arthritis Asthma Liver Cirrhosis/ Hepatoma Diabetes Gastritis Congestive Heart Failure Peptic Ulcer Anxiety Migraine Hypertension Stroke Low Back Pain Kidney Stones ***Prevalence estimates for individual conditions n/a***	52.2
Petersen	South Africa	≥18	5	HIV (61.3) Hypertension(52.6) Diabetes (9.2) Depression(9.9) Alcohol Use Disorder(2.6)	35

Appendix 8: Prevalence of Individual Conditions Included in Multimorbidity Assessment

NO	Author (Year)	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
1	Afshar (2015)	Burkina Faso Ghana Kenya Namibia South Africa	4948 4165 4640 4379 2629	≥18	6	Arthritis Angina (pectoris) Asthma Depression Schizophrenia/ Psychosis Diabetes ***(Prevalence n/a)***	6.3 (5.6-7.0) 3.6 (3.0-4.2) 4.2 (3.6-4.8) 7.9 (7.0-8.8) 11.2 (9.8-12.5)
2	Agrawal (2016)	Ghana South Africa	5571 4227	≥18	9	Hypertension (37.4) Diabetes (3.5) Stroke (2.4) Angina pectoris (3.2) Arthritis (19.3) Asthma (3.2) Chronic Lung Disease (2.8) Depression (7.7) Low Visual Acuity (13.9) Hypertension (46.2) Diabetes (9.2) Stroke (3.6) Angina pectoris (4.9) Arthritis (23.1) Asthma (5.8) Chronic Lung Disease (6.1) Depression (4.7) Low Visual Acuity (16.8)	23 32
3	Alaba (2013)	South Africa	11638	≥18	6	Diabetes (56) Asthma (23.4) Stroke (9.2) Cancer (5.8) High Blood Pressure (5.6) TB (n/a)	4
4	Arokiasamy (2015)	Ghana South Africa	5108 4221	≥18	8	Angina pectoris, Arthritis Asthma, Chronic Lung Disease, Diabetes Mellitus, Hypertension Stroke Low Visual Acuity ***prevalence estimates n/a***	22.0 (19.3-25.1) 22.5 (18.2-27.4)

NO	Author (Year)	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
5	Garin (2016)	Ghana South Africa	4305 3836	≥50	12	Arthritis (26.16) Asthma (4.97) Cataract (18.07) COPD (1.21) Cognitive Impairment (12.58) Depression (7.89) Diabetes (3.80) Endetulism (2.96) Hypertension (59.64) Obesity (9.98) Stroke (3.75) Arthritis (30.60) Asthma (7.71) Cataract (6.38) COPD (4.26) Cognitive Impairment (11.29) Depression (4.79) Diabetes (9.20) Endetulism (8.45) Hypertension (78.29) Obesity (46.90) Stroke (4.94)	48.3 63.44
6	Keetile (2020)	Botswana	1178	≥15	10	Stroke, angina, diabetes, chronic lung disease, asthma, hypertension, eye/vision problem, nerves problem, skin problem and depression ***(prevalence estimates n/a)***	5.4
7	Kunna (2017)	Ghana	4050	≥50	8	Arthritis, diabetes, angina, stroke, asthma, depression, hypertension and chronic lung disease ***Prevalence estimates n/a***	30.2
8	Lee (2015)	Ghana South Africa	4873 3243	≥18	9	Angina, arthritis, asthma, cataracts, diabetes, stroke, chronic lung disease, hypertension and depression ***Prevalence estimates n/a***	3.9 (3.0-4.9) 9.2 (6.7-11.7)
9	Letamo (2017)	Botswana	2153	10-64	3	Hypertension (14.2) Asthma (5.3) Diabetes (3.3)	2.6

NO	Author (Year)	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
10	Mall (2014)	South Africa	4351	≥18	10	Depression (5.5) any Anxiety disorder (8.4) any Substance Abuse Disorder (5.7) Headaches/Migraines (32.6) Arthritis (10.1) Chronic Pain (31.5) Cardiovascular Diseases (19.7) Respiratory Diseases (19.3) Diabetes (5.6) Digestive Disorders (5.5)	42.1
11	Morgan (2017) Study 1	Burkina Faso	4948	≥18	6	Angina (11.8) Arthritis (12.7) Asthma (2.4) Diabetes (0.5) Depression (2.6) Schizophrenia (1.1)	6.3 (5.6-7.0)
		Ghana	4165			Angina (4.6) Arthritis (7.0) Asthma (4.2) Diabetes (0.9) Depression (1.5) Schizophrenia (0.7)	3.6 (3.0-4.2)
		Kenya	4640			Angina (2.5) Arthritis (4.1) Asthma (2.9) Diabetes (1.3) Depression (5.5) Schizophrenia (0.7)	4.2 (3.6-4.8)
		Namibia	4379			Angina (7.7) Arthritis (10.1) Asthma (3.6) Diabetes (2.1) Depression (7.7) Schizophrenia (3.0)	7.9 (7.0-8.8)
		South Africa	2629			Angina (4.7) Arthritis (10.0) Asthma (6.3) Diabetes (8.6) Depression (9.0) Schizophrenia (1.2)	11.2 (9.8-12.5)
	Study 2	Ghana	5573	≥18	7	Angina (M=0.5, F=1.1) Arthritis (M=2.2, F=3.2) Asthma (M=0.9, F=1) Chronic Lung Disease (M=0.06, F=0.3) Depression (M=0.5, F=0.3) Diabetes (M=0.7, F=1.6) Stroke (M=0.8, F=0.5)	1.4 (1.1-1.7)

NO	Author (Year)	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
		South Africa	4227			Angina (M=0.6, F=2.3) Arthritis (M=2.4, F=6.1) Asthma (M=0.7, F=1.4) Chronic Lung Disease (M=1.9, F=0.7) Depression (M=0.4, F=4.5) Diabetes (M=1.1, F=2.2) Stroke (M=0.4, F=1.0)	4.7 (4.0-5.4)
12	Phaswana-Mafuya (2013)	South Africa	3836	≥50	8	Arthritis (24.7) Stroke (4.0) Angina (5.2) diabetes (9.2) Chronic Lung Disease (2.9) Asthma (4.9) Depression (2.9) Hypertension (30.3)	22.5
13	Stubbs (2018)	Ghana	4305	≥50	13	Angina (12.8) Arthritis (26.2) Asthma (5.0) Cataract (18.1) Chronic Back Pain (7.5) COPD (3.7) Depression (8.0) Diabetes (3.8) Edentulism (3.0) Hearing Problems (2.9) Hypertension (59.6) Obesity (10.5) Stroke (2.8)	47.6
		South Africa	3838			Angina (8.9) Arthritis (30.6) Asthma (7.7) Cataract (6.4) Chronic Back Pain (5.7) COPD (7.4) Depression (4.8) Diabetes (9.2) Edentulism (8.5) Hearing Problems (5.0) Hypertension (78.3) Obesity (47.1) Stroke (4.0)	64.9

NO	Author (Year)	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
14	Sum (2019)	Ghana	5067	≥18	9	Hypertension (55.18) Angina (12.67) Arthritis (20.74) Asthma (3.09) Chronic Lung Disease (2.30) Diabetes (2.15) Cataracts (2.27) Depression (5.13) Stroke (1.38)	17.18
		South Africa	3477			Hypertension (75.44) Angina (8.04) Arthritis (15.81) Asthma (4.60) Chronic Lung Disease (4.75) Diabetes (3.41) Cataracts (2.02) Depression (6.61) Stroke (1.58)	17.72
15	Waterhouse (2017)	South Africa	3055	≥50	9	Cataracts Depression Asthma Chronic Lung Disease Diabetes Angina Stroke Arthritis Hypertension ***Prevalence estimates n/a***	12.9
16	Weimann (2016)	South Africa Wave 1	18526	≥15	4	Hypertension (22.73) Diabetes (2.81) Tuberculosis (1.59) HIV (1.11)	2.73 (2.50-2.98)
		Wave 3	20015			Hypertension (32.13) Diabetes (2.71) Tuberculosis (0.59) HIV (2.13)	2.84 (2.61-3.08)

No	Author	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (prevalence, %)	Prevalence of multimorbidity % (95% CI)
1	Aboyade (2019)	South Africa	250	≥50	9	Hypertension, Diabetes, Arthritis, Cancer, Heart/ Cardiovascular Disease, Stroke, Depression, Hypercholesterolemia, Asthma *prevalence n/a*	39.2
2	Chang (2019)	South Africa	3889	≥40	10	Hypertension (64) Dyslipidaemia (44) Anaemia (41) HIV (23) Depression(17) Diabetes(12) Angina (10) Post-Traumatic Stress Disorder (5) Alcohol Dependence (1) Chronic Bronchitis(1)	69.4 (68.0-70.9)
3	Emeh (2020)	Cameroon	142	≥60	7 (and others not stated)	Lung Diseases (4.23) Diabetes (7.75) Hypertension (29.58) Gastritis (38.73) Arthritis (38.73) HIV (1.41) Infectious Diseases (9.15) Others (59.86)	35.9
4	Gaziano (2017)	South Africa	5059	≥40	9	Hypertension (58.4) Diabetes (11.1) Dyslipidaemia (43.6) Angina (2.35) Overweight/Obesity (n/a) HIV (n/a) Heart Failure (0.8) Myocardial Infarction (0.4) Stroke (3.0)	55.7

No	Author	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (prevalence, %)	Prevalence of multimorbidity % (95% CI)
5	Hien (2014)	Burkina Faso	389	≥60	15	Hypertension (82.3) Malnutrition (39.2) Visual Impairment (28.3) Diabetes (26.5) Ischaemic CVD (6.9) Abnormal Heart Rhythm (5.7) Osteoarthritis (4.9) Parkinson's Disease (2.6) Dementia (1.5) COPD (1.3) Hearing Impairment (1.3) Peripheral Arterial Disease (0.8) Heart Failure (0.8) Thyroid Dysfunction (0.8) Cancer (0.5)	65
6	Mugisha (2016)	Uganda	471	≥50	9	HIV (51.8) Hypertension (34.6) Depression (8.7) Eye Problems (8.7) Arthritis (5.7) COPD (5.3) Diabetes (4.9) Angina (2.5) Stroke (2.1)	37.4
8	Odland (2020)	Burkina Faso	2604	≥40	11	Hypertension (36.7) Diabetes (6.7) Hypercholesterolemia (10.9) Heart Disease (5.7) Stroke (1.2) Chronic Respiratory Disease (3.2) Cancer (0.5) HIV (0.6) Cognitive Impairment (7.1) Anxiety (12.4) Depression (7.9)	22.8 (21.4-24.2)

No	Author	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (prevalence, %)	Prevalence of multimorbidity % (95% CI)
9	Pengpid (2020)	South Africa	5059	≥40	13	Anaemia (17.3) Angina (2.4) Cataract (12.8) Chronic Bronchitis (1.5) Diabetes (12.0) Dyslipidaemia (43.8) Heart Failure (0.7) Hypertension (58.4) Kidney Disease (4.2) Myocardial Infarction (0.4) Stroke (2.9) HIV (12.4) Tuberculosis (8.8)	56
10	Price (2018)	Malawi	28891	≥18	3	Overweight /Obesity (23.1) Hypertension (15.8) Diabetes (2.6)	3.4
11	Sharman (2019)	South Africa 2009 2015	47334	≥15	4	HIV (25) Tuberculosis (4) Hypertension (18) Diabetes (4) HIV (32) Tuberculosis (3) Hypertension (31) Diabetes (8)	8.4 13.2
12	van Heerden (2017)	South Africa	570	≥18	5	HIV (33) Obesity (47) Hypertension (33) Hyperglycaemia (4) Hyperlipidaemia (20) Depression (12)	56

No	Author	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
1	Cadmus (2017)	Nigeria	4886	≥60	17	Hypertension (45.6) Osteoporosis (19.5) Diabetes (10.4) Eye problems (6.7) Spondylosis (6.5) Arthritis (5.9) Cataract (5.6) Malaria (3.2) Dementia (3.2) Hypertensive Heart Disease (2.7) Urinary Tract Infection (2.08), Peptic Ulcer Disease (2.0), Glaucoma (1.8), Hearing Problems (n/a) Obesity (1.7) Pulmonary Tuberculosis (1.1) Asthma (1.1)	31
2	Fakoya (2018)	Nigeria	216	≥60	11	Hypertension, diabetes mellitus, visual impairment, urinary problems, hearing difficulty, stroke, sleep problems, immobility, arthritis, chronic back pains, dementia (n/a)	50.5
3	Gbeasor-Komlanvi (2020)	Togo	370	≥60	15	Hypertension (50.5) Diabetes (18.1) other CVD (13.5) Osteoarthritis (59.2) Visual impairment (12.4) Gastrointestinal disease (8.7)	57.6 (52.4-62.7)

No	Author	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
						Dyslipidaemia (11.4)	
4	Isaacs 2014)	South Africa	4184	≥18	13	Diabetes (19.67) Hypertension (58.96) Asthma/COPD (12.14) Epilepsy (5.47) Arthritis (rheumatoid, osteoarthritis or gout) (21.8) , mental health (schizophrenia, depression, anxiety and psychosis) (6.67), miscellaneous (any other condition, e.g. eczema, systemic lupus erythematosus and glaucoma)(40. 03)	53.9
5	Lalkhen (2015)	South Africa	5793	Unclear	6	Hypertension (55.6) Diabetes (17.3) Osteoarthritis (9.1) Asthma (8.4) Epilepsy (6.5) COPD (2.4)	48.4
6	Nimako (2013)	Ghana	1399	≥18	13	Hypertension (52.8) Diabetes (25.4) Musculoskeletal Conditions (17.9) Asthma Sickle Cell Disease Occupational Injuries Malnutrition Intestinal Worms other Cardiovascular Conditions Chronic Eye	38.8 (36.3-41.4)

No	Author	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
						Diseases Skin Diseases & Ulcers Gastrointestinal Diseases Anaemia (n/a)	
7	Nwani (2015)	Nigeria	345	≥65	30	Hypertension (51.0) Cerebrovascular Accident (26) HHD with CCF (12.5) Cardiomyopathy (2.3) Valvular Heart Disease (1.2) Ischemic Heart Disease (0.6) Diabetes (42.9) Hypothyroidism (0.3) Chronic Liver Disease (4.3) Acid-related Disease (3.5) Chronic Gastritis (0.3) Hepatocellular Carcinoma (2.0) Cancer of Prostrate (1.7) Benign Prostatic Hyperplasia (2.0) Gastric Cancer (0.6) Cancer of the Lung (0.6) Non-Hodgkin Lymphoma (0.6) Brain Tumor (0.3) Multiple Myeloma (0.3) Seizure Disorder (2.3) Movement Disorder (Parkinsonism) (1.4) Spinal	49

No	Author	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
						Cord Compression (0.6) Osteoarthritis/ Spondylopathies (4.9) Asthma (1.2) Chronic Obstructive Airway Disease (0.9) Dementia (1.2) Anxiety Disorder (0.3) Tuberculosis (2.9) HIV (0.6) Chronic Kidney Disease (0.9)	
8	Oduro (2012)	Ghana	984	≥50	13	Arthritis Asthma Liver Cirrhosis/ Hepatoma Diabetes Gastritis Congestive Heart Failure Peptic Ulcer Anxiety Migraine Hypertension Stroke Low Back Pain Kidney Stones (n/a)	52.2
9	Petersen (2017)	South Africa	2549	≥18	5	HIV (61.3) Hypertension (52.6) Diabetes (9.2) Depression(9.9) Alcohol Use Disorder(2.6)	35

No	Author	Country	Sample Size	Age	Number of Conditions	Prevalence of Individual Conditions (%)	Prevalence of multimorbidity % (95% CI)
10	Woldesemayat (2018)	Ethiopia	411	≥18	18	Musculoskeletal: Arthritis, Gauty Arthrisis (16.8) Endocrine System: Goiter, Diabetes (16.3) Cardiovascular System: Hypertension, Congestive Heart Failure Haemorrhoid (14.6) Nervous System: Epilepsy Alzheimer Migraine (11.2) Genitourinary System: Benign Prostatic Hypertrophy Nephrolithiasis Nephritis (7.3) Respiratory System: COPD (4.6) Malignant Cancer: Cancer (4.6) Gastrointestinal System: Liver Diseases Cholelithiasis (1.5)	17.8

Appendix 9: EMREC Ethics Clearance

Edinburgh Medical School
Research Ethics Committee (EMREC)

emrec@ed.ac.uk

Mpho Disang
PhD Student
Usher Institute

20 January 2022

Dear Mpho

Study Title: Prevalence and patterns of chronic disease multimorbidity and response of primary care in Botswana

REC Reference: 21-EMREC-048

The Research Ethics Committee has now reviewed the above application.

Ethical opinion

The Committee can give a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation. There are no conditions on this opinion.

Amendments and Reporting Requirements

Now that you have a favourable ethical opinion from EMREC you are bound to the protocol, informed consent and data collection materials reviewed by us. Small changes like updating contact details, fixing typos, or adding a partner's logo do not require an amendment. However, you must re-contact us if you wish to make substantive changes that affect the protocol or answers to any of the questions on the EMREC form.

You should also contact EMREC to notify us about:

- Serious breaches of the protocol
- Safety reports and any adverse events
- The end of the study, including early termination of the study
- Final report

Favourable opinion from EMREC is not the only requirement to ensure integrity in research conduct, so in parallel with this stage, you will also want to satisfy yourself that you have considered other governance issues.

Documents reviewed

THE UNIVERSITY of EDINBURGH

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

21-EMREC-048 Please quote this number on all correspondence		
Document	*Version*	*Date*
EMREC form	3.0	14/01/22
Protocol	2.0	14/01/22
Response to EMREC Letter	1.0	10/01/22
Oral Consent Form Script	2.0	14/01/22
PIS	2.0	14/01/22
Budget (Fieldwork)	2.0	14/01/22
Consent Form	2.0	14/01/22
UB Ethics clearance letter	1.0	18/11/21
DHMT Coordinators Stakeholder Interviews Permission	1.0	12/11/21
Recruitment Email for Stakeholder Interviews	1.0	12/11/21
Interview Guide (Healthcare Providers)	1.0	12/11/21
Interview Guide (Policy Makers)	1.0	12/11/21
DPIA	1.0	12/11/21
Recruitment Flyer	1.0	12/11/21

With the Committee's best wishes for the success of this project.

Yours sincerely,

Sue Fletcher-Watson
Co-Chair, EMREC

Christine Campbell
Co-Chair, EMREC

Appendix 10University of Botswana Ethics Clearance

UNIVERSITY of BOTSWANA

Office of the Deputy Vice Chancellor (Academic Affairs)

Office of Research and Development

Corner of Notwane and Mobuto Road, Gaborone, Botswana

Pvt Bag 00708 Gaborone Botswana

Tel: [267] 355 2900
Fax: [267] 395 7573
E-mail: research@mopipi.ub.bw

UBR/RES/IRB/BIO/292

16th November 2021

Permanent Secretary
Ministry of Health and Wellness
Private Bag 0038
Gaborone, Botswana

RE: REQUEST FOR EXPEDITED REVIEW OF A RESEARCH PROPOSAL

TITLE: "Prevalence and Patterns of Chronic Disease Multimorbidity and Response of Primary Care in Botswana."

RESEARCHER(S): Mpho Refilwe Disang

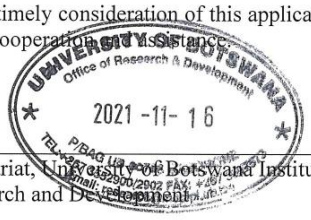
Since it is a requirement that everyone undertaking research in Botswana should obtain a Research Permit from the relevant arm of Government, The Office of Research and Development at the University of Botswana has been tasked with the responsibility of overseeing research at UB including facilitating the issuance of Research Permits for all UB Researchers inclusive of students and staff.

I am writing this letter in support of an application for a Research Permit by the above-mentioned Principal Investigator who is pursuing a PhD from the Centre for Population Health Sciences Department at the University of Edinburgh. The proposed study aims to explore the epidemiology of multimorbidity in Botswana, as well as increase understanding on strategies that can be adopted to improve care for patients with multimorbidity at primary care level. It is hoped that the findings of this study will provide evidence on the magnitude of multimorbidity in Sub-Saharan Africa and in Botswana as well as reveal the common chronic diseases combinations observed in the population. This evidence may be crucial for facilitating the development of guidelines and policies that will ensure proper management and care for people with multimorbidity. Furthermore, the study findings may further deepen our understanding on the patterns of multimorbidity in the country, how the healthcare providers perceive and experience managing individuals with multimorbidity and the policy response to this public issue. This is also hoped to give an opportunity to understand the opportunities and challenges that exists within Botswana's primary care system and ways in which care can be improved in the future.

The Office of Research and Development is satisfied with the process for data collection, analysis and the intended utilization of findings from this research and is confident that the project will be conducted effectively and in accordance with local and international ethical norms and guidelines.

Your kind and timely consideration of this application will be highly appreciated and we thank you for your usual cooperation and assistance.

Sincerely,



For/The Secretariat, University of Botswana Institutional Review Board
Office of Research and Development

Appendix 11: Ministry of Health-Botswana Study Approval

PRIVATE BAG 0038
GABORONE
BOTSWANA
REFERENCE:

REPUBLIC OF BOTSWANA
MINISTRY OF HEALTH AND WELLNESS

TEL: (+267) 363 2500
FAX: (+267) 391 0647
TELEGRAMS: RABONGAKA
TELEX: 2818 CARE BD

REFERENCE NO: HPDME: 13/18/1 **26 November 2021**

Health Research and Development Division

Mpho Refilwe Disang
University of Botswana
Private Bag 00708
Gaborone

Dear Mpho Refilwe Disang

PERMIT: PREVALENCE AND PATTERNS OF CHRONIC DISEASE MULTIMORBIDITY AND RESPONSE OF PRIMARY CARE IN BOTSWANA

Your application for a research permit for the above stated research protocol refers. We note that your proposal has been reviewed and approved by University of Botswana Review Board.

Permission is therefore granted to conduct the above mentioned study. This approval is valid for a period of 1 year effective 26th November 2021.

This permit does not however give you authority to collect data from the selected site(s) without prior approval from the management. Consent from the identified individuals should be obtained at all times.

The research should be conducted as outlined in the approved proposal. Any changes to the approved proposal must be submitted to the Health Research and Development Division in the Ministry of Health and Wellness for consideration and approval.

Furthermore, you are requested to submit at least one hardcopy and an electronic copy of the report to the Health Research, Ministry of Health Wellness within 3 months of completion of the study. Approval is for academic fulfillment only. Copies should also be submitted to all other relevant authorities.

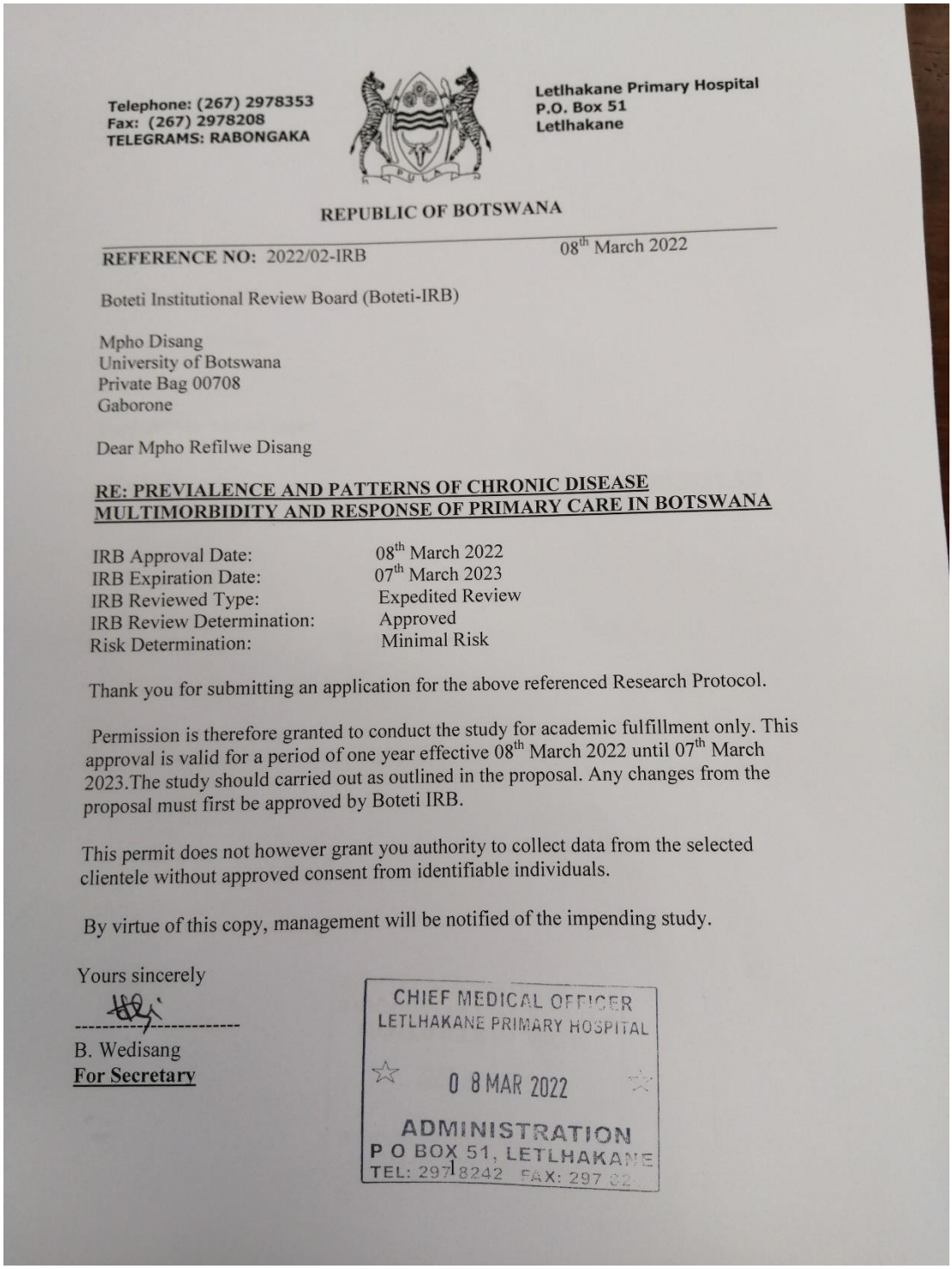
Thank you for your cooperation and your commitment to the protection of human subjects in research.

Yours faithfully

Dr. P. Masokwane
for /PERMANENT SECRETARY

MINISTRY OF HEALTH AND WELLNESS
RESEARCH DIVISION
26 NOV 2021
P/BAG 0038
GABORONE
REPUBLIC OF BOTSWANA

Appendix 12: Districts Health Management Team Study Approval



Telephone: (267) 2978353
Fax: (267) 2978208
TELEGRAMS: RABONGAKA

Letlhakane Primary Hospital
P.O. Box 51
Letlhakane

REPUBLIC OF BOTSWANA

REFERENCE NO: 2022/02-IRB

08th March 2022

Boteti Institutional Review Board (Boteti-IRB)

Mpho Disang
University of Botswana
Private Bag 00708
Gaborone

Dear Mpho Refilwe Disang

RE: PREVIALENCE AND PATTERNS OF CHRONIC DISEASE MULTIMORBIDITY AND RESPONSE OF PRIMARY CARE IN BOTSWANA

IRB Approval Date:	08th March 2022
IRB Expiration Date:	07th March 2023
IRB Reviewed Type:	Expedited Review
IRB Review Determination:	Approved
Risk Determination:	Minimal Risk

Thank you for submitting an application for the above referenced Research Protocol.

Permission is therefore granted to conduct the study for academic fulfillment only. This approval is valid for a period of one year effective 08th March 2022 until 07th March 2023.The study should carried out as outlined in the proposal. Any changes from the proposal must first be approved by Boteti IRB.

This permit does not however grant you authority to collect data from the selected clientele without approved consent from identifiable individuals.

By virtue of this copy, management will be notified of the impending study.

Yours sincerely

B. Wedisang
For Secretary

CHIEF MEDICAL OFFICER
LETLHAKANE PRIMARY HOSPITAL
08 MAR 2022
ADMINISTRATION
P O BOX 51, LETLHAKANE
TEL: 297 8242 FAX: 297 82

TELEPHONE: 6540235
FAX: 6540242
TELEGRAMS: NGAKA

ALAGADI SOUTH DHMT
P.O. BOX 5
GABONG

REPUBLIC OF BOTSWANA

KSDHMT 1/12/8 I (1)

2nd March 2022

Mpho Refilwe Disang
P O Box 660 ABF
Gaborone

Dear Madam,

AUTHORITY TO COLLECT DATA IN KGALAGADI SOUTH DHMT FOR PURPOSES OF A RESEARCH STUDY- YOURSELF

Reference is made to be above subject matter. The contents of your letter herein are acknowledged.

The purpose of this communication is to kindly inform you that your request to collect data for the research study at Kgalagadi South DHMT has been acceded to. This is in line with the permission awarded by the University of Botswana Ethics Committee and the Ministry of Health and Wellness - HRDC. Kgalagadi South DHMT will give support in any way possible for the successful completion of the research study.

The DHMT kindly request that you share the study results with the district.

We wish you success in the project.

Thank you.

Yours faithfully

G. Rammekwa

Gaboelwe Rammekwa
DHM COORDINATOR

Tel. No. 5315600
Fax No. 5330719

Greater Lobatse DHMT
Private Bag 20
LOBATSE
BOTSWANA

REPUBLIC OF BOTSWANA

REFERENCE NO: GLRHMT 6/17/1 I

25th February 2022

Mrs. Mpho Refilwe Disang
University of Botswana
Private Bag 00708
Gaborone

Dear Madam,

PERMISSION TO CONDUCT RESEARCH STUDY – YOURSELF

Reference is made to your letter dated 1st February 2022 regarding the above subject matter.

Permission is hereby granted for you to conduct a study titled ***"Prevalence and patterns of chronic disease multimorbidity and response of Primary Care in Botswana"***.

You are expected to report to hospital management upon your arrival.

Thank you.

Yours faithfully

Dr. B. Kgosiemang
/for **RHMT Coordinator**

Tel. No. 5315600
Fax No. 5330719

Greater Lobatse DHMT
Private Bag 20
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You are expected to report to hospital management upon your arrival.

Thank you.

Yours faithfully

Dr. B. Kgosiemang
/for **RHMT Coordinator**

Appendix 13: Statistics Botswana Approval-BDS Dataset

STATISTICS BOTSWANA
Private Bag 0024, Gaborone, Botswana
Tel: (+267) 367 1300. Fax: (+267) 395 2201

REF: STB 24/14 III (16)

26th April 2021

The University of Edingnurg
NINE Edingburg, BioQuarter
9 Little France Road
Edingburg EH16 4UX

Attention: Mpho Disang

REQUEST TO USE DATA FROM THE BOTSWANA DEMOGRAPHIC SURVEY (2017)

1. The above matter refers.
2. Statistics Botswana hereby grants authority to use data from the 2017 Botswana Demographic Survey for the purpose of fulfilling the academic requirement stated in your letter.
3. Please note that data should not be shared with any third party or transmitted to other parties without the authority of Statistics Botswana. You are therefore, requested to contact our resource centre to access the final data. However, the same data can be accessed from the Statistics Botswana data portals. Please visit Statistics Botswana website for more details on the portals.
4. We are available to avail more information if required.
5. Thank you

T. B. Baakile
FOR/ STATISTICIAN GENERAL

REGIONAL OFFICE. Private Bag F193., Francistown . **Tel:** (+267) 241 5848. **Fax:** (+267) 241 7540

All correspondence should be addressed to Statistician General
Email.info@statsbots.org.bw **Website:** www.statsbots.org.bw

Appendix 14: Recruitment Email-Qualitative Interviews

RECRUITMENT EMAIL

Research Participants Needed for A Multimorbidity Study

Hello (name of potential participant),

My name is Mpho Refilwe Disang. I am a PhD student working under the supervision of Dr Christine Campbell & Professor David Weller in the Centre for Population Health Sciences at the University of Edinburgh. As part of my PhD project, I am conducting a study to learn about healthcare professionals' experiences and views regarding care and management of people with multiple chronic conditions in primary care settings in Botswana. Given your role as a healthcare provider/ your role in health policy formulation and your expertise on the primary care system of Botswana, I feel that you can provide valuable insight into this issue and I would like to invite you to participate in this study.

Participating in this study involves a semi-structured telephone interview that will last about 30-60 minutes at a time most suitable for you. The telephone interview will be more like a conversation with me where you will be sharing your perspectives on this issue. I will be asking a few questions to assist you express your own understanding of multimorbidity, your perspectives regarding how care for patients with multimorbidity is organised at primary healthcare level, the challenges and recommendations for improvement of care.

There are no known risks associated with this study and participation is completely voluntary. This study has been reviewed and has received ethical clearance from University of Edinburgh through the Edinburgh Medicine Research Ethics Committee, the University of Botswana Institutional Review Board and has been granted permission by the Ministry of Health and Wellness, Botswana.

If you are interested in participating or learning more about this study, kindly contact me at (+267) 75580728 or email I will then get in touch with further details.

Yours sincerely,

Mpho Disang (Mrs)

Appendix 15: Introduction Letter-Qualitative Interviews

Mpho Refilwe Disang

Old Medical School

Teviot Place

Edinburgh EH8 9AG

University of Edinburgh

Scotland, United Kingdom

District Health Management Team Coordinator

Greater Lobatse DHMT

Private Bag

(Date)

Dear Sir/Madam

RE: PERMISSION TO CONDUCT RESEARCH STUDY

I am writing to seek permission to conduct a study in your health district. My name is Mpho Refilwe Disang. I am studying for a PhD in the Centre for Population Health Sciences, Usher Institute at the University of Edinburgh.

I am conducting a research to explore the views and experiences of healthcare providers in Botswana regarding multimorbidity. This is part of a larger study which is aimed at investigating the extent and patterns of multimorbidity in Botswana and how the primary healthcare system is responding to this growing public health issue. This study is part of my PhD project and is funded by the University of Botswana.

The study entails collecting data from healthcare workers in primary care facilities in the Greater Lobatse health district, particularly nurses, doctors and other professionals who have experience caring for and managing patients with multiple chronic conditions. I hope to recruit and interview five (5) healthcare workers from your district, with different portfolio or clinical responsibilities and who are willing to share their experiences in caring for patients with multimorbidity. Interested participants will be invited to take part in a telephone interview expected to last about 30-60 minutes. The interviews will be conducted at a time most suitable to the participant.

Participants who are interested in participating will be sent an information pack prior to the interview, with detailed information about the study and a consent form. After confirmation of participation, they will be asked to give their verbal consent before the interview begins. participation is entirely voluntary and participants have their right to withdraw from the study without giving any reasons. We do not anticipate any risk in participating in this study. Your organisation and individual participants will not incur any costs related to this study.

Your approval to conduct this study will be greatly appreciated. I will follow up with a telephone call in a week, and will be happy to answer any questions or address any concerns that you may have at the time. Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

Appendix 16: Recruitment Flyer-Qualitative Interviews

Appendix 17: Information Sheet: Qualitative Interviews

Participant Information Sheet

Project Title: Prevalence and patterns of chronic disease multimorbidity and response of primary health care in Botswana

Principal Investigator: Ms Mpho Refilwe Disang

Name of Sponsor: University of Edinburgh

Name of Funder: University of Botswana

You are being invited to take part in a research project. To help you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Talk to others about the study if you wish. Feel free to ask any questions if anything is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this information sheet.

What is the purpose of the study?

The number of people living with more than one chronic condition is rising globally, a problem commonly referred to as multimorbidity. Multimorbidity is defined as the co-occurrence of multiple chronic or long-term conditions in an individual. Patients with multiple chronic conditions visit healthcare facilities more frequently, are more likely to be hospitalised, use multiple medications and their care is usually long-term and spread across different healthcare settings and between professionals. Due to the complexity of multimorbidity and its consequences, healthcare systems are challenged to reorganise and re-think their traditional single diseases and acute care approaches, and develop comprehensive health services that can facilitate proper management and care for people with multimorbidity.

Botswana like other countries in the sub Saharan Africa region, is experiencing a rapid increase of noncommunicable diseases alongside an already high burden of HIV and other infectious diseases such as TB and Malaria. Despite the growing number of people with

chronic conditions in Botswana and the recognition of the coexistence of HIV, TB and NCDs, there is limited evidence on the magnitude of multimorbidity and how healthcare providers in the country manage patients suffering from this issue, particularly at primary care level where most of these patients are seen.

This study aims to explore healthcare professionals' views and experiences regarding multimorbidity burden and care in Botswana's primary healthcare system. Understanding what is understood by multimorbidity in the local context, and the management of multiple chronic conditions from healthcare professionals' perspectives, will potentially bring valuable information for policymakers, government and healthcare providers to develop practical and context specific strategies to organise and deliver quality care for people living with multimorbidity. This is a qualitative component of a mixed methods study which aims to investigate the epidemiology of multimorbidity in Botswana, and the role of primary care. This study plans to recruit twenty (20) healthcare workers in public primary healthcare facilities from Francistown, Lobatse, Boteti and Kgalagadi Health Districts and ten (10) national and district level policymakers in Botswana.

Why have I been invited to take part?

You have been invited to participate in this study because we are looking for healthcare professionals who are regularly involved in the care of people with multiple chronic conditions. We believe you are familiar with the local healthcare system and you have experiences and expertise of how chronic care is delivered in the country especially at primary healthcare level.

Do I have to take part?

No, participation in this study is entirely VOLUNTARY. You will be given this information sheet to keep and read before the interview. You can ask questions about the study before deciding whether or not to participate. If you agree with the statements in the consent form

and you decide to take part, contact me at or call +267 75580728, to express your interest. You may decide not to take part without giving reasons. Your choice will not have any negative impact on your job or position.

What will happen if I take part?

If you decide to take part in this research, I will contact you to confirm eligibility, answer any questions you might have about the study and we will schedule an appointment for a telephone interview at a date and time most suitable for you. The phone interview will be more like a conversation with me where you will be sharing your views and experiences regarding multimorbidity in primary healthcare, and I will be asking a few questions to assist you express your experiences and views in your own words.

Prior to the interview you will have to provide informed consent to confirm that you have voluntarily decided to participate in this study. If it is practical and feasible for you, you may email a signed scanned copy or photograph of the consent form. Alternatively, at the start of the interview, I will go over the consent form with you, and your oral consent will be audio recorded. The interview will last from 30-60 minutes depending on how much you have to say. It will be very helpful if you agree for the interview to be audio-recorded. The recording allows for me to capture all the important information said during the interview, which is vital during analysis. If you are happy to do so, I will use an encrypted audio recorder to record our conversation. But if you prefer not to be audio-recorded, I will take notes of our conversation by hand. After the interview, your audio recording together with those of other participants, will be stored using a code number and will be securely transferred to a third party transcription service. The transcriber who will type up what you said in the interview, will sign an agreement prior to receiving the audio files to keep everything said in the interview confidential. The audio recording and the typed up record, only identifiable by code numbers will not have any identifiable information, would be stored securely at the University of Edinburgh DataStore. During the interview you can choose not to answer some questions, if you prefer, and you may stop the interview at any time.

Is there anything I need to do or avoid?

You may wish to be in a quiet room if possible.

What are the possible benefits of taking part?

There are no direct benefits to you taking part in this study. We hope that your valuable experiences and perspectives, alongside those of others who will be interviewed, might help policymakers, researchers and healthcare providers in Botswana reflect on their current understanding of multimorbidity, how they deliver care and inform future policy to improve healthcare for people with multiple chronic conditions.

There will be no payment for taking part in this study. However, to appreciate your time and effort, a token of an airtime voucher of fifty Pula (P50.00) will be extended to you.

What are the possible disadvantages of taking part?

There are no particular disadvantages to participating in this research. However, we acknowledge that you may find it distressing to talk about your experiences and challenges in the healthcare system particularly given the current COVID-19 situation. If you feel uncomfortable or distressed, you can ask for the interview to be paused or stopped at any time. Additionally, you may also feel inconvenienced by the time required for the interview which we estimate to last between 30-60 minutes.

What if there are any problems?

Given the nature of this study, we do not anticipate any problems. However, if you have any concerns about the study, kindly contact me at or call (+267)

75580728. Alternatively, you can also Office of Research and Development, University of Botswana, Phone: Ms Dimpho Ralefala on (+267) 355-2432/2900, E-mail: / research.ethics@ub.ac.bw.

What will happen if I don't want to carry on with the study

You are under no obligation to participate in this research. If you want to withdraw from the study at any time, you are free to do so without giving an explanation. Your decision will be respected and there will be no loss of good feeling or consequences. You can notify me of your decision using the contact details provided.

If you decide to withdraw, you will have the option of withdrawal from either:

a) All aspects of the study but continued use of the data collected up to that point
b) All aspects of the study with removal of all previously collected data.

What happens when the study is finished?

The results of this study will be summarised in a University doctoral thesis, articles, reports and presentations. At the end of the study the electronic anonymised information will be kept in secure University of Edinburgh DataShare storage platform for preservation and further analysis

Will my taking part be kept confidential?

All the information we collect during the course of the research will be kept confidential and there are strict laws which safeguard your privacy at every stage. We will ask for only the minimum personal information we need for the study.

How I will use information about you?

I will need to collect the following personal identifiable information from you for this research project in order to allow me to ensure I speak with a broad sample of healthcare providers:

- Full name
- Email address
- Telephone number
- Gender

- Age
- Work Area
- Occupation
- Length of service
- Qualifications
- Interview data
- Interview audio recordings

The information collected from you in paper copies (i.e. consent forms) will be stored in a locked cabinet in a secure office at the University of Botswana. These documents will later be scanned and saved electronically on DataStore and it will be kept for 3years.

We will keep all information about you safe and secure in a password protected computer. Your interview will be audio recorded in an encrypted audio-recorder. Upon completion of the interview, the recording will be uploaded in a secure platform and deleted from the recorder. The recorded interviews will be accessed by the interviewer (myself) and a designated transcriber. The audio recording will be coded and anonymised- all identifying information will be removed so that no one identifies you or links you or your institution to the information. Once I have checked the transcript for accuracy the digital recording will be deleted from our records. The anonymised transcripts will be password protected and stored securely at the University of Edinburgh Data Store which is a secure platform in line with ethical and legal practices. Fully anonymised data will be analysed to produce original research results and will be used in reports and peer reviewed journal articles which will be shared with other researchers and the public. Your anonymity will be preserved during the write-up and publication of results.

At the end of fieldwork all paper records will be shredded and disposed of securely and electronic records will be permanently erased after 3 years.

What will happen to the results of the study?

The results of this study will be summarised in reports and will be shared with you and other stakeholders who wish to receive a summary of the findings, through emails or other platforms you would have indicated. I also intend to hold a stakeholder workshop at the end of my PhD to share my findings with the wider stakeholders in Botswana who might be interested in this research. Additionally, the results will be disseminated through peer-

reviewed journals and presented in academic conferences. Finally, this study is part of my PhD project, therefore the results will form part of my PhD thesis. The results will be totally anonymous, and all the individuals who participated will not be identifiable in all these reports and articles.

Who is organising and funding the research?

This is a PhD study which is being funded by the University of Botswana and is being conducted by Mpho Disang a PhD student at the University of Edinburgh, Scotland, UK. The study is sponsored by the University of Edinburgh, Scotland, UK. Dr Christine Campbell based at the University of Edinburgh, is the Principal Supervisor of the PhD Project.

Who has reviewed the study?

The study has received a favourable ethical opinion from the local ethics committees in Botswana through the Office of Research and Development at the University of Botswana and Ministry of Health & Wellness. Approval was also granted by the University of Edinburgh through the Edinburgh Medicine Research Ethics Committee.

Researcher Contact Details

If you have any further questions about the study please contact Ms Mpho Refilwe Disang on +267 75580728 or email

Independent Contact Details

If you would like to discuss this study with someone independent of the study, please contact

Office of Research and Development, University of Botswana, Phone: Ms Dimpho Ralefala on (+267) 355-2432/2900, E-mail: research.ethics@ub.ac.bw.

Complaints

1. Office of Research and Development, University of Botswana, Phone: 3552900, Email research.ethics@ub.ac.bw.
2. Ministry of Health and Wellness, Head of Health Research Unit, Phone: (+267) 3914467, Email: hhealthresearch@gov.bw/ botshealthresearch@gmail.com.

Privacy Notice

The University of Edinburgh is the sponsor for this study based in the United Kingdom but this study is being conducted in Botswana. The Sponsor has overall responsibility for the running of the study. To follow the United Kingdom's data protection regulations, we must inform you of how we will use and store your personal data.

As a university, we use personally-identifiable information to conduct research to improve health, care and services. As a publicly-funded organisation, we have to ensure that it is in the public interest when we use personally-identifiable information from people who have agreed to take part in research. This means that when you agree to take part in a research study, we will use your data in the ways needed to conduct and analyse the research study.

We will use information from you and/or your medical records in order to undertake this study. The sponsor will keep identifiable information about you for 3 years after the study has finished.

The University of Edinburgh will act as the data controller for this study. This means that they are responsible for looking after your information and using it properly.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

Non-identifiable data from this project may be stored in a research data repository at the University of Edinburgh to allow knowledge sharing and learnings about this study. The University of Edinburgh provides its researchers (and their collaborators) two services for sharing and archiving of

data which will be used for your information. There is an open access repository for anonymised data, which means that all non-identifiable data is freely available. For sensitive information a secure repository is used which can only be accessed by approved researchers who have undergone a rigorous application and review process.

Appendix 18: Oral Consent-Qualitative Interviews

ORAL CONSENT SCRIPT

Study Title: **Prevalence and patterns of chronic disease multimorbidity and response of primary health care in Botswana**

Hello. My name is Mpho Disang. I am a PhD student at the University of Edinburgh, in the Centre for Population Health sciences. I am contacting you because you have volunteered to take part in a study that is investigating healthcare professionals' perceptions and experiences regarding multimorbidity in Botswana. This study aims to get a deeper understanding of how healthcare professional understand and view multimorbidity, how care for patients with multiple long-term conditions are organised and what can be done to improve care for these patients.

Before we begin our interview, I will have to make sure that you have made an informed decision about taking part in this study. I will obtain your consent orally, and this process will be audio recorded to keep a formal record that you agreed to be interviewed.

Do you agree to your consent being audio recorded?

Yes (Proceed)

No (End Conversation)

I will now switch on the audio recorder to begin the consent process

Can you please state you name in full?

Please indicate Yes/No

1. Have you read and understood the information sheet (29 October 2021 Version 2.0) for the above study? Have you had the opportunity to consider the information, ask questions and have had these questions answered satisfactorily? ☐
2. Do you understand that your participation is voluntary and that you are free to withdraw at any time, without giving any reason and without your medical care and/or legal rights being affected? ☐
3. Do you understand that the information you provide including personal data, will be kept confidential, stored securely and only accessed by those carrying out the study? Do you understand that relevant sections of the data collected during the study may be looked at by individuals from the Sponsor (University of Edinburgh), from regulatory authorities where it is relevant to your taking part in this research? Do you give permission for these individuals to have access to your data? ☐
4. Do you give permission for your personal information (including name, address, telephone number and consent form) to be passed to the University of Edinburgh for administration of the study? ☐
5. Do you understand that data collected about you during the study may be converted to anonymised data? ☐
6. Do you understand that your personal data collected in this study will be transferred to the University of Edinburgh's OneDrive and DataStore platform? Do you understand that these servers are based in the United Kingdom, where the Data Protection laws may be different to those of your home country? ☐
7. Do you agree to your anonymised data being used in future studies. Yes ☐ No ☐
8. Do you agree to your interview being audio recorded? Yes ☐ No ☐
9. Do you agree to your audio recorded interview being transcribed by a third party contractor. Yes ☐ No ☐
10. Do you understand that the results of this study will be written up in a thesis and only the de-identified data may be used in future studies or future publications and presentations? Do you understand you will not be personally identified from any of the results of the study . Yes ☐ No ☐
11. Do you agree to take part in the above study. ☐

Do you have any questions about the study?

If there are no questions, then we have come to the end of our consent process. I will then switch of the recording and proceed with the next stage of our interview.

Name of Person Giving Consent	Date	Signature

Name of Person Receiving Consent	Date	Signature

1x original – to Investigator; 1x copy – to Participant

Appendix 19: Interview Guide-Healthcare Workers

STUDY TITLE: EXPERIENCES AND PERCEPTIONS OF HEALTHCARE PROVIDERS AND POLICYMAKERS ON THE CARE OF PATIENTS WITH MULTIMORBIDITY IN BOTSWANA

Topic Guide – Health Care Providers

1. Introduction

Thank you for offering to take part in this study and agreeing to be interviewed today. You have been invited to participate in this study because you are regularly involved in the care of people with multiple chronic conditions. We are conducting this study to learn from healthcare providers their perceptions of multimorbidity, how services for people with multiple chronic conditions are organised and delivered, the challenges they meet in providing care for these patients and areas that need to be improved to achieve quality care.

The information you share with us today will be treated with utmost confidentiality. Your responses will not have any identifying information and will be compiled with other responses from other professionals like yourself.

- Before we start the interview I would like to ask you to give us your consent. Please be advised that your participation is voluntary and you can withdraw at anytime from the study without giving reason why you are dropping out.
- This interview will last from 30-60 minutes depending on how much you have to say. There are no right or wrong answers, your experiences and views will bring valuable contribution to our understanding of multimorbidity in the local context and will guide policy responses regarding multimorbidity.
- In addition, it will be very helpful if you agree for the interview to be audio-recorded. The recording allows for me to capture all the important information said during the interview, which is vital during analysis. If you are happy to do so, I will use an audio

recorder to record our conversation. Do you allow me to record this conversation?

- Do you have any questions or any concerns about the interview before we start?
- If you agree to take part and be recorded, I would like to start with the socio-demographic characteristics.

2. Demographic Details

Name (confidential)	
Sex	
Age	
Place	
Institution	
Designation	
Education	
Years of Experience	

3. Topic Guide

1. Knowledge and Understanding of multimorbidity
▪ Can you tell me of your understanding of multimorbidity, and if you perceive it as a major problem in your daily work? **Probes:** Concept used for multiple conditions; comorbidity/ multimorbidity. Examples of patients with multimorbidity that you currently support? Is it a big issue in your daily work?

- How do you feel about your level of knowledge regarding multimorbidity?

2. Experiences in Managing Multimorbidity

- Tell me about your experiences in providing care to people with multiple chronic conditions and how services are organised on the ground?

Probes: available services in the facility, care/ treatment guidelines.

- What is your role or main responsibilities in caring for these patients?
- What processes are in place to link patients with other healthcare providers (in secondary/ tertiary care) for multiple conditions?
- In your opinion do you think the available services adequately address the problem of multimorbidity?
- Do you think your patients have encountered any problems with medication availability or financial costs in accessing care?
- How do you ensure there is equity in access to multimorbidity care?

3. Impacts of COVID-19 on Multimorbidity Care

- How has the COVID-19 pandemic affected your local provision of services relevant to patients with multimorbidity?

Prompt: How has COVID-19 affected you? How has it affected your daily routine? How has it affected services for people with multiple conditions?

- In your view, how has COVID-19 influenced the way you perceive multimorbidity and how you extend care to people with multiple chronic conditions going forward?

4. Barriers, Opportunities and Recommendations

- Are there any strengths/opportunities within your system that facilitate better management of people with coexisting chronic conditions?
- What challenges or difficulties do you face in providing care to people with multimorbidity?
- How could these challenges be handled efficiently?

- What are your recommendations or suggestions to improve care and support for people with multimorbidity at primary care level?

Lastly, do you have any final comments, questions or ideas you would like to share with me on this issue?

Thank you for your time and participation.

If you have any further questions about today's interview or overall study, please feel free to contact us.

Appendix 20: Interview Guide-Policymakers

STUDY TITLE: EXPERIENCES AND PERCEPTIONS OF HEALTHCARE PROVIDERS AND POLICYMAKERS ON THE CARE OF PATIENTS WITH MULTIMORBIDITY IN BOTSWANA

Topic Guide – Policymakers

1. INTRODUCTION

Thank you for offering to take part in this study and agreeing to be interviewed today. You have been invited to participate in this study because you have responsibility in oversight and development of healthcare policy in Botswana. We believe you are familiar with the local healthcare system, and you have experiences and expertise of how chronic care is delivered in the country especially for people with multiple conditions at primary healthcare level. We are conducting this study to learn more on your perspectives regarding management of multimorbidity, the policy response, challenges and recommendations to improve care in primary care settings in the country.

The information you share with us today will be treated with utmost confidentiality. Your responses will not have any identifying information and will be compiled with other responses from other professionals like yourself.

- Before we start the interview I would like to ask you to give us your consent. Please be advised that your participation is voluntary and you can withdraw at any time from the study without giving reason why you are dropping out.
- This interview will last from 30-60 minutes depending on how much you have to say. There are no right or wrong answers, your experiences and views will bring valuable contribution to our understanding of multimorbidity in the local context and will guide policy responses regarding multimorbidity.
- In addition, it will be very helpful if you agree for the interview to be audio-recorded. The recording allows for me to capture all the important

information said during the interview, which is vital during analysis. If you are happy to do so, I will use an audio recorder to record our conversation. Do you allow me to record this conversation?

- Do you have any questions or any concerns about the interview before we start?
- If you agree to take part and be recorded, I would like to start with the socio-demographic characteristics.

2. DEMOGRAPHIC DETAILS

Name (confidential)	
Sex	
Age	
Place	
Institution	
Designation	
Education	
Years of Experience	

3. Topic Guide

1. Knowledge and Understanding of Multimorbidity
▪ In your own words, what is your understanding of multimorbidity? ▪ Which concept do you use to describe the occurrence of multiple chronic conditions; multimorbidity/comorbidity? ▪ What is its relevance in the context of Botswana's primary care/ healthcare system?
2. Organisation of Services

▪ At policy level, what guidelines /strategies/ regulations are in place to guide chronic care and management in Botswana? ▪ Do you perceive these policies or strategies adequate to address the current disease burden e.g. the intersection of HIV/TB with NCDs? ▪ What are your views on the current organization of care for people with multiple chronic conditions at primary care level? ▪ Is primary care currently equipped to provide care for people with multimorbidity-- in terms of financing, human resources and service organisation? ▪ Are there any disparities between rural and urban areas?
3. Barriers and Challenges
▪ What are the strength/opportunities of Botswana's primary care for multimorbidity care? ▪ What are the difficulties/ challenges that the health system has in managing multimorbidity? ▪ From a policy perspective what are the outstanding issues and concerns regarding primary care response to multimorbidity care? ▪ In your opinion how should health policy respond to the NCDs and chronic communicable disease intersection in Botswana?
4. Impact of COVID-19 pandemic
▪ What is your opinion on the current COVID-19 pandemic? ▪ How has it affected you? How has it affected healthcare provision in the country? ▪ How do you think the COVID-19 pandemic has influenced policy discussions around multimorbidity?

Lastly, do you have any final comments, questions or ideas you would like to share with me on this issue?

Thank you for your time and participation. If you have any further questions about today's interview or overall study, please feel free to contact us.