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IMPACT OF COVID-19 PANDEMIC ON HEALTH SERVICE UTILIZATION AMONG NON-COMMUNICABLE DISEASE (NCD) PATIENTS IN GHANA: AN INTERRUPTED TIME SERIES ANALYSIS

BY

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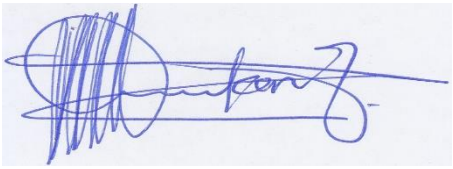
DECLARATION

I, JOHN-KENNEDY DEKU, thus certify that, except for citations to works on this subject by other authors that I have formally acknowledged, this work was completed by me under the supervision of Professor Duah Dwomoh. I also declare that this work has not been submitted for any degree awards at this University or anywhere else.



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DEDICATION

I dedicate this dissertation to the LORD, God almighty for his amazing grace and rich mercies toward me throughout this journey. He is good and his mercy endures forever. I also dedicate this work to my precious wife, Mrs. Anita Aseye Deku, and our glorious children for their unflinching support and the superb atmosphere of peace they provided me during this study period. Finally, I dedicate this work also to my biological parents and my spiritual father, especially my mother for her incessant words of encouragement and prayers.

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I would like to duly acknowledge the LORD, God almighty, the ALPHA, and OMEGA for his faithfulness endures forever. I would also like to acknowledge my able supervisor, the apple of God's eyes, Prof. Duah Dwomoh. God bless you for inspiring me to work hard. Thank you.

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LIST OF ABBREVIATIONS

SARS-CoV-2 - Severe Acute Respiratory Syndrome Coronavirus 2

Interrupted Time Series Analysis – ITSA

Acute ST-segment elevation myocardial infarction – STEMI

Regression Discontinuity Design - RDD

Non-Communicable Disease – NCD

WHO – World Health Organization

Ministry of Health – MOH

Ghana Health Service – GHS

National Diabetes Association - NDA

Disability-Adjusted Life Years – DALYs

Intensive Care Unit – ICU

Lower Quartile – LQ

Upper Quartile – UQ

Confidence Interval – CI

Out-patient Department – OPD

District Health Information System 2 – DHIMS-I

Frontline Health Workers – FLHCW

Acute Ischemic Stroke – AIS

ABSTRACT

Background

The COVID-19 pandemic has interrupted the world's healthcare systems, causing a substantial disruption in routine healthcare services. Non-communicable Diseases (NCDs) are the leading cause of morbidity and mortality in Ghana. In Ghana, accessing care for NCDs has been difficult, especially in rural regions. This already-existing challenge has been aggravated by the COVID-19 pandemic. This study seeks to estimate the impact of the COVID-19 pandemic on the utilization of healthcare services among non-communicable disease patients in Ghana

Method

The study employed a retrospective longitudinal study using routine time series data on non-communicable (NCD) care visits from January 2018 to December 2022. Interrupted time series analysis was used to compare the number of NCD care visits before and during the COVID-19 pandemic, and to quantify the impact of COVID-19 on NCDs of interest.

Results

The results are presented under two main headings. One is the immediate impact of the COVID-19 pandemic on NCD care visits and the second is the sustained impact of the pandemic on NCD care visits. The analysis showed that the COVID-19 pandemic had no immediate, and sustained impact on asthma care visits nationally. However, the pandemic had a significant immediate impact [1.22, (p-value=0.003; CI=0.45, 1.98)], and a significant sustained impact [-0.061, (p-value=0.008; CI=-0.11, -0.017)] on diabetes care visits nationally. Also, hypertension care visits experienced significant immediate impacts [2.05, (p-value=0.023; CI=0.29, 3.81)] nationally. Lastly, the pandemic also had a significant sustained impact [-1.05, (p-value=0.004; CI=-1.75, -

0.35)] on stroke care visits nationally. Across the sixteen administrative regions, the pandemic affected NCD care visits differently. NCD care visits in some regions were significantly interrupted while in other regions there was no significant impact.

Conclusion

The study has provided evidence of some significant immediate and sustained effect of the COVID-19 outbreak on most Non-Communicable Disease (NCD) care visits in Ghana. The findings underscore the need for policymakers and health practitioners to prioritize NCD care during pandemics and develop innovative strategies to mitigate the impact

CHAPTER ONE

INTRODUCTION

1.0 Background

The outbreak of coronavirus disease 2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has significantly impacted the health, economy, education, and security of people all over the world. The World Health Organization (WHO) officially declared the COVID-19 pandemic on March 11, 2020, due to its fast spread around the globe (Bouba *et al*., 2021). Predictive models have been used to propose that COVID-19 will have negative effects in South Saharan Africa on disease transmission, disease severity, and death due to our weak healthcare systems, the current burden of comorbidities like tuberculosis and chronic non-communicable diseases, and poor socioeconomic factors (Okonji *et al*., 2021).

According to a study conducted by Clark *et al*., (2020) using modelling techniques, approximately 20% of the global population may be at a heightened risk of experiencing severe COVID-19 symptoms if they contract the virus. This increased risk is primarily attributed to pre-existing non-communicable diseases (NCDs). The prevalence of non-communicable diseases (NCDs) such as hypertension, diabetes, asthma, cardiovascular disease, and cerebrovascular disease is on the rise in Sub-Saharan Africa (SSA) and has become a significant risk factor for severe illness and mortality among COVID-19 patients (Wang *et al*., 2020). The World Health Organization (WHO) reports that the percentage of deaths in the WHO Africa region caused by NCDs has increased from 22.8% (2.2 million) in 2000 to 34.2% (3 million) in 2016 (WHO, 2018). This trend has been seen in the region since 1980, with NCDs becoming more prevalent. From 1990 to 2017, the number of disability-adjusted life years (DALYs) attributable to NCDs increased by 67%; cardiovascular disease and cancer were the leading causes of death in the African area (Gouda *et*

al, 2019). According to global estimates, one or more of these comorbidities contributed to the elevated mortality risk associated with Covid-19 patients (World Obesity Federation, 2020). The presence of non-communicable diseases such as hypertension, diabetes, respiratory diseases, and heart disease in individuals increases their vulnerability to the Covid-19 virus (WHO, 2020). Risk factors like smoking and excessive alcohol consumption, which contribute to NCDs, also increase the likelihood of contracting the virus (Guan *et al*., 2020). A study by Pal and Bhadada (2020) found that 72.2% of patients requiring intensive care treatment had chronic comorbidities, compared to only 37.3% of those who did not require ICU care. A study conducted by Guan *et al*. (2020) in China reported that of 1,099 confirmed Covid-19 patients, 173 had severe symptoms, and a higher prevalence of hypertension (23.75%), diabetes mellitus (16.2%), coronary artery disease (5.8%), and chronic obstructive pulmonary disease (3.5%) was found among them compared to those with mild symptoms. The most common pre-existing non-communicable comorbidities among the 32 non-surviving ICU patients out of a group of 52 were cerebrovascular disorders (22%) and diabetes (Pal & Bhadada, 2020).

The COVID-19 pandemic has had far-reaching effects on the global population, including Ghana. NCDs such as hypertension, diabetes, asthma, cardiovascular disease, and cerebrovascular disease are known to increase the risk of severe illness and death among COVID-19 patients (Wang *et al*, 2020). The rise in NCDs in Sub-Saharan Africa has only exacerbated this problem, putting those with these comorbidities at an even higher risk of complications from COVID-19. The elderly, in particular, are more susceptible to COVID-19 due to underlying NCDs like diabetes and hypertension (WHO, 2020).

In Ghana, the situation is no different, as NCDs are becoming more widespread, and the number of disability-adjusted life years (DALYs) attributable to NCDs has increased from 22.8% in 2000

to 34.2% in 2016 (WHO, 2018). The impact of the pandemic on non-communicable disease care visits in Ghana is yet to be fully understood, but the lockdown measures and reduced access to healthcare facilities may have resulted in a reduction in the number of NCD care visits. The health system in Ghana, like many other developing countries, is already strained, and the pandemic has added an extra burden to the healthcare system, making it challenging to provide adequate care to NCD patients.

In nutshell, the COVID-19 pandemic has highlighted the need to address NCDs in the context of communicable diseases, as NCDs and communicable diseases reinforce each other and disproportionately affect the poorest segment of society and the most vulnerable people worldwide

It is crucial to understand the impact of the COVID-19 pandemic on NCD care visits in Ghana to inform policy and guide resource allocation to ensure that NCD patients receive the care they need during and after the pandemic.

1.1 Problem Statement

The World Health Organization announced a pandemic caused by the global spread of coronavirus disease (COVID-19), which is a new infection caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (WHO, 2020). The high level of contagiousness of COVID-19 has put a significant strain on healthcare systems due to its high mortality rate (Toner & Waldhorn, 2020). The COVID-19 pandemic has significantly impacted individuals with non-communicable diseases (NCDs) due to the increased pressure on healthcare systems. NCDs require specialized screening, treatment, and care from a team of healthcare professionals, but access to outpatient services has been restricted in 59% of countries, with rehabilitation services being the most

impacted (50% partial disruption and 12% complete disruption), according to a report by the World Health Organization (WHO, 2020).

Older age, being a man, and having chronic noncommunicable diseases as a background have all been linked to increased COVID-19 severity and mortality since the outbreak. With the rapid spread of COVID-19 around the globe, there were extensive and unanticipated disruptions to health services, primarily because of restrictions on public transportation preventing patient access to medical facilities, a lack of personal protective equipment (PPE), a shortage of clinical staff due to redeployment to COVID-19 units, as well as the absence of necessary medications and services (WHO, 2021). Patients with NCDs who are particularly vulnerable and need ongoing or long-term care may have suffered long-term effects as a result of these healthcare disruptions. Bullen *et al.*, (2021), also reported that, the public health restriction measures implemented across different healthcare centers negatively affected the willingness of NCD patients to visit healthcare centers. Seventy-nine percent of European nations reported a disruption in the provision of rehabilitation services (Pécout *et al.*, 2021). Additionally, it has been determined that patients who already have NCDs are more likely to suffer a serious illness or pass away from a coronavirus infection (WHO, 2021). A study conducted among NCD patients in Ghana also identified heightened knowledge of being more susceptible to the COVID-19 pandemic and the fear of certainly contracting it should they endeavor to go for healthcare in the health facilities as some main barriers to seeking health care during the COVID-19 pandemic (Abraham et al., 2023). However, this study was limited to only the Cape Coast Metropolis of Ghana. NCD patients frequently require long-term access to essential healthcare or rehabilitation services due to the chronic nature of their pathology.

Formenti et al., (2022) also projected in a study they conducted in Africa that the COVID-19 would severely impact people living with comorbidities such as NCDs, HIV, Tuberculosis etc. in terms

of severity, and mortality. These were due to less developed healthcare systems, along with difficult socioeconomic conditions. According to the WHO, (2020), it is very difficult to ensure that patients with NCDs receive the right care, an early diagnosis, and prevention in an environment with inadequate resources and health-care infrastructures such as in the Sub-Saharan African. Thus, the vulnerabilities that were always present have been made worse by the COVID-19 pandemic. However, all these studies did not focus mainly on the impact of the pandemic on health service utilization among NCD patients in Ghana.

There is limited research on the impact of COVID-19 on NCD care in low- and middle-income countries such as Ghana, where poverty and limited access to healthcare exacerbate underlying medical conditions. The purpose of this research is to examine the impact of COVID-19 on NCD care visits in Ghana, including the disruptions to access to care and the consequences for NCD patients.

1.2 Justification

Covid-19 was a global nightmare that plagued most countries, including Ghana. The disease's impact was limitless, weakening the economy, security, systems, and NCDs in a variety of ways, including an increased proclivity to contract the disease with a high affinity for poor clinical outcomes. The efforts to combat covid-19 have caused disruptions in the health system, affecting the attention and care required by patients with NCDs (Haileamlak, 2022).

This study, however, seeks to contribute to the ongoing discussion to explore the impact of the Covid-19 pandemic on non-communicable disease care visits with a focus on the context of Ghana. This study may provide valuable insights into the barriers to NCD care during the pandemic, as well as opportunities for improvement in the future, particularly in low- and middle-income settings. Understanding the impact of COVID-19 on NCD care visits in Ghana can provide

important insights into the challenges faced by people with NCDs during a pandemic and inform policy decisions to improve healthcare access. In terms of policy, the results of this study may inform decision-makers on the need for improved access to NCD care services in Ghana and may highlight the importance of considering the needs of NCD patients during pandemic responses. The findings may also guide the development of policies and programs aimed at improving NCD care delivery in low- and middle-income settings and will inform the design of more effective NCD care delivery systems that are better equipped to respond to future pandemics.

Overall, this study may provide important insights into the impact of COVID-19 on NCD care visits in Ghana and contribute to developing more effective and equitable NCD care delivery systems that are better equipped to respond to future pandemics.

The study is important because the context of Ghana has received less attention in empirical studies. This will fill the gap in the literature.

1.3 Research Questions

1.3.1 Main Research Question

- What is the impact of COVID-19 on non-communicable disease care visits in all 16 administrative regions of Ghana?

Specifically, the study seeks to answer the following research questions:

1. What is the immediate effect of the COVID-19 pandemic on NCD care visits in Ghana?
2. What is the sustained effect of the COVID-19 disease on NCD care visits at the health facilities in each of the 16 administrative regions of Ghana?

1.4 General Objective

- To determine the impact of COVID-19 on non-communicable disease care visits in all 16 administrative regions of Ghana

1.4.1 Specific Objectives

1. To determine the immediate effect of COVID-19 on NCD care visits at the facilities in each of the 16 administrative regions and Ghana as a whole.
2. To examine the sustained impact of the NCD care visit at the facilities in each of the 16 administrative regions of Ghana.

1.5 Organization of Study

For this study on the impact of COVID-19 on NCDs care visits in Ghana, it would be organized as follows:

Chapter 1: Introduction: In this chapter, the background of the study would be introduced, including the rationale for the study, the research problem, the research objectives and questions, and the significance of the study.

Chapter 2: Literature Review: The literature review chapter would summarize and critically analyse the existing research and theories relevant to the impact of COVID-19 on NCD care visits in Ghana. The chapter would also provide vivid information on the gap in the existing research.

Chapter 3: Methodology: In this chapter, the study's research design, sampling method, data collection procedures, and data analysis plan will be discussed in detail. The research design chosen for this study will provide a comprehensive overview of the impact of COVID-19 on NCD care visits in Ghana. The study's population and sample will be defined, and the inclusion and exclusion criteria used to sample will be explained.

Chapter 4: Results

This chapter will present the results of the study. The results will be presented in tables, and graphs, and will be discussed in detail to provide a comprehensive understanding of the impact of COVID-19 on NCD care visits in Ghana.

Chapter 5: Discussion

In this section, the findings will be compared with existing literature and previous research in the field to validate the study's results. The results will be interpreted in light of the research questions.

Chapter 6: Conclusion, and Recommendations

In this chapter, the researcher will summarize the study's main findings and conclude, and also propose recommendations for theory, practice, and policy.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter is for the review of related literature for this study. It critically evaluates various concepts, definitions, and studies that have been done about the study's topic. Again, it presents and discusses the relevant theories that underpin the study.

2.1 Theoretical Review

For a very long time, there has been an unprecedentedly growing interest in academia to investigate and receive clarity on factors that determine health-related behaviours, hence many academic reports and articles have been published to that effect. As a result, many models or frameworks have been designed and proposed to predict and explain health-related behaviours. Every model or theory has some underlying constructs or variables, propositions, assumptions, and logic that underpin it when they are critically examined. This section will look at the Health Belief Model and the Predictive Model.

2.1.1 The Health Belief Model

The health-belief model was propounded by Rosenstock in 1966. According to Ajzen (2002), this model is a health-specific social cognition model, and it was first proposed to respond to the free tuberculosis health screening program which failed. According to its proponents, the hypothesis for this model is that individuals would naturally not seek preventive health care or screening unless they have, at least, some level of motivation and knowledge concerning how susceptible they are and how severe the condition can be, and how the health interventions present themselves convincingly before they commit to the entire health program (Becker *et al*., 1977).

In the context wherein it was originally used, it was established that individuals who believed that they were prone to the infection and the perceived benefits of the health screening, accepted the chest X-ray (Coulson *et al*., 2016). Subsequently, and based on the results of its first use, the health belief model was applied to other health screening activities and immunization and compliance with treatments for a variety of medical situations (Coulson *et al*., 2016). Recently, it has even been applied to hearing health behaviours (Saunders *et al*., 2013).

As already established, every model has some constructs, and this model is no exception. The constructs in this model are five in number, which include: 1) Perceived susceptibility, 2) Perceived severity, 3) Perceived benefits, 4) Perceived barriers, and finally 5) Cues to action (Coulson *et al*., 2016). Perceived susceptibility simply refers to how the individual believes that he or she is prone to developing an ill-health condition. This is the perception of that individual; hence it is subjective in perspective. Perceived severity also refers to when an individual assesses his or her ill-health condition and its undesirable consequences. Again, since this is from the individual's point of view, it is also subjective. Perceived benefits refer to when an individual decides to take an action to compensate or counterbalance his or her perception of risk. Perceived barriers also refer to when an individual puts some barriers in place to offset his or her perception of health risk. Finally, cues to action simply refer to cues that necessitate that an individual should act (Coulson *et al*., 2016).

Hence, the first assumption or logic for this model is that individuals would be encouraged to practice a healthy lifestyle if they believe that they are prone to health risks and outcomes. The second is that, if an individual's perception of the severity of an ill-health condition is strong, he or she would also be strongly motivated to prevent it. Next, a person must reckon that the target behaviour would present strong and positive benefits and that if there be any barriers to that effect,

they could be overcome. Then, finally, the health belief model inoculates into its framework cues to action whereby a person could be motivated to act (Coulson *et al*., 2016).

Indeed, many researchers have used the health belief model in their studies, some confirming some variables and some disconfirming and proposing either an introduction or removal of some constructs or variables. For example, in the study of Janz and Becker (1984), it was established that susceptibility, benefits, and barriers were good regressors of human behaviour, however, severity was not. In more recent studies, Carpenter (2010) also revealed empirically that benefits and barriers were good regressors of human behaviour, but susceptibility and severity were poorly correlated.

This theory is important for this study because it seeks to explain the impact of the Covid-19 pandemic on non-communicable disease care visits in Ghana. This is because the Health Belief Model (HBM) focuses on the individual's perceptions and attitudes towards health and illness, and how these perceptions influence health behaviors, such as seeking health care services. HBM could be used to understand why individuals with non-communicable diseases may have reduced visits to healthcare facilities during the COVID-19 pandemic.

2.1.2 Predictive Model

Predictive modeling is a statistical approach that involves the analysis of data and the use of algorithms to make predictions about future events. It aims to identify patterns and relationships in data that can be used to forecast future outcomes accurately. The theory of predictive modeling can be traced back to the early days of statistics and data analysis, and it has evolved with the advancement of new algorithms, computational methods, and data sources (Lemeshow *et al.*, 2013). Predictive modelling is a statistical method that involves the use of algorithms and data analysis to make predictions about future outcomes based on past and current data. The goal of

predictive modelling is to identify patterns and relationships in data that can be used to make accurate predictions about future events.

Predictive modelling has been widely used in various fields, including healthcare, to understand and forecast patterns of disease, health behaviours, and utilization of health services. Regarding the research topic of "Impact of Covid-19 pandemic on non-communicable disease care visits in Ghana", predictive modelling could be used to identify patterns and trends in non-communicable disease care visits before, during, and after the COVID-19 pandemic. This information could be used to make predictions about future trends in healthcare utilization and to understand the factors that are associated with reduced or increased visits to healthcare facilities during the pandemic.

2.2 Non-communicable Diseases and COVID-19 Pandemic

2.2.1 Non-Communicable Diseases

With their significant impact on mortality and morbidity, non-communicable diseases (NCDs) continue to be the main global public health concern. The move away from a scenario dominated by communicable diseases is primarily driven by changes in the environment, economy, and demographics (Habib & Saha, 2010). Chronic NCDs are diseases or ailments that affect people for a long time and for which no known causal factors are passed from one person to the next. NCDs are defined by the World Health Organization (WHO) as cardiovascular diseases, primarily heart disease, and stroke; cancers; chronic respiratory diseases; diabetes; and others, including mental disorders, vision and hearing impairment, oral diseases, bone and joint disorders, and genetic disorders (Ministry of Health [MoH], 2012). NCDs are the world's leading cause of death and disability. The global rate of disease caused by these diseases is increasing, and it is spreading across regions and social classes (WHO, 2018). As the population ages, more cancer, heart disease, diabetes, and mental health issues develop, which leads to a high prevalence of chronic disability.

Cardiovascular disease (CVD), cancer, chronic obstructive pulmonary disease (COPD), and diabetes are the four most prevalent NCDs, and they all have similar preventable risk factors like smoking, eating poorly, and not exercising enough (Habib & Saha, 2010).

2.2.2 Risk Factors of Non-Communicable Diseases

A risk factor could be defined as "a characteristic of human behavior or lifestyle, an environmental exposure, or a hereditary attribute that is related to an increase in the occurrence of a particular disease, accident, or other health condition" (Centers for Disease Control and Prevention, 2022). Modifiable risk factors, the main causes of the global epidemic in NCD are smoking, a poor diet, alcohol, and physical inactivity characterized as diabetes, elevated blood pressure (BP) obesity, and high fats. Although the proportional impact of these factors varies by population, these risk factors may explain 70 % of chronic diseases (Nathan *et al*., 2017).

2.2.2.1 Obesity

Obesity is a risk factor for all four main NCDs: cardiovascular disease, cancer, diabetes, and chronic lung disease (Kim & Oh, 2013). Obesity and overweight can cause negative metabolic changes such as increased blood pressure, high cholesterol, and insulin resistance. They increase the risk of coronary heart disease, stroke, type 2 diabetes, atherosclerosis, gallbladder disease, hypertension, kidney failure, and many types of cancer, especially breast cancer (Aune *et al.*, 2016).

Obesity and chronic lung illness are also becoming increasingly linked, according to research (Kim & Oh, 2013). In multiple observational studies in Western and Asian populations, adiposity and excess body weight have been related to increased total mortality as well as higher odds of acquiring or dying from illnesses like diabetes, cancer, chronic kidney disease, and osteoarthritis. The risk of getting diabetes and ischemic heart disease grows steadily with increasing body mass

index starting in the low 20s (BMI; weight in kilograms divided by height in meters squared). Ezzati and Riboli (2013) claim that a portion of the burden of obesity, which presently accounts for 3.4 million annual deaths and 3.8 percent of all diseases in the globe, is borne by diseases with low mortality and lengthy durations of impairment, such as diabetes and musculoskeletal problems.

2.2.2.2 Smoking

For many years, the relationship between smoking and increased mortality from cancer, cardiovascular disease, and respiratory illness has been well documented. Other significant diseases such as diabetes and tuberculosis have also been linked to smoking. The dangerous impact of smoking is not limited to just certain regions but is a global issue (Ezzati & Riboli, 2013). In South Korea, smoking has long been the leading cause of non-communicable diseases (NCDs)—it has been estimated that 73% of lung cancer deaths and 32% of stomach cancer deaths are attributed to smoking (Kim & Oh, 2013). Additionally, smoking has been linked to 15% of liver cancer deaths and 24% of pancreas cancer deaths (Kim & Oh, 2013). Research also shows that smoking is a major risk factor for type 2 diabetes, both in terms of incidence and mortality. Quitting smoking has been proven to reduce the risk of developing diabetes for smokers (Kim & Oh, 2013). Moreover, smoking is a crucial factor in the development and progression of chronic lung disease (Kim & Oh, 2013). In South Asia, using oral tobacco and chewing betel nut, in addition to smoking, are common practices that lead to a significant number of oral cancer cases and related deaths (Ezzati & Riboli, 2013).

2.2.2.3 Unhealthy Diet

Studies in nutritional epidemiology have shown connections between certain foods, nutrients, and dietary patterns to cancer, cardiovascular disease, and diabetes, as well as intermediate conditions

like weight gain, high blood pressure, insulin resistance, and high blood sugar levels. A lack of fruits, vegetables, whole grains, nuts, and seeds, combined with excessive salt consumption, contributes to the global health crisis (Ezzati & Riboli, 2013). Low fruit and vegetable intake are known to play a role in the development of roughly 31% of coronary heart disease and 11% of ischemic stroke globally (Aune *et al.*, 2016). Many countries have increased the prevalence of cardiovascular diseases and some malignancies due to a lack of fruits and vegetables (Khatib, 2004).

2.2.2.4 Alcohol

The use of alcohol has been linked to an increased likelihood of chronic liver disease, heart failure, and some forms of cancer (Kim & Oh, 2013). Moderate drinking may lower the risk of cardiovascular disease and diabetes, though the benefits may be greater for those with existing cardiovascular risk factors. Excessive or binge drinking increases the likelihood of injury, exacerbates cardiovascular disease and liver disease, and is associated with high blood pressure and subsequent hemorrhagic stroke (Kim & Oh, 2013). Alcohol is a leading contributor to worldwide health problems, causing approximately 3 million deaths each year and accounting for 5.3% of the total global disease burden (WHO, 2018). The disease burden caused by alcohol is largely due to cancer, chronic liver disease, unintentional injuries, alcohol-related crime, neuropsychiatric conditions, and in some areas, particularly Eastern Europe where binge drinking is prevalent, a high death toll from cardiovascular diseases (Ezzati & Riboli, 2013).

2.2.2.5 Physical Inactivity

Globally, type 2 diabetes, breast and colon cancers, coronary heart disease, and other major non-communicable diseases are thought to be caused by 6-10 percent of people being inactive (Katzmarzyk, 2022). More than 53 percent of the 57 million deaths in 2008 were attributable to

this unhealthy behavior, which also caused 9% of all premature deaths (Lee *et al*., 2022). The fourth leading cause of death is physical inactivity, which has been linked to all-cause, cancer, and cardiovascular deaths (WHO, 2019). Physical inactivity has also been linked to obesity, metabolic syndrome, and cardiovascular disease (Powell-Wiley, 2021). Also, physical activity and the prevalence or incidence of arterial hypertension have been found to have an inverse association (Mills *et al.*, 2020). In Finnish population research, low leisure-time physical activity increased the risk of hypertension; the relative risk of hypertension for the lowest versus the highest level of physical activity was 1.73 (Kim & Oh, 2013).

2.2.2.6 High Blood Pressure and Cholesterol

High levels of cholesterol and other blood lipids encourage plaque formation in the arteries. Plaque builds up and can obstruct blood flow, resulting in ischemia and tissue damage, which is especially dangerous when the heart and brain vessels are involved (Academy of Nutrition and Dietetics, 2015). Hypercholesterolemia, or high blood cholesterol, is a crucial factor in the emergence of atherosclerotic cardiovascular disorders like peripheral artery disease, coronary heart disease, and ischemic stroke. Although a link has been found between high cholesterol levels and certain types of cancer, including breast, colon, and prostate cancer, this connection is still poorly understood (Han *et al.*, 2022). Although there is some evidence to support a link between high blood cholesterol and diabetes, it is still unknown if hypercholesterolemia contributes to the onset of diabetes (Kim & Oh, 2013).

2.2.3 Types of Non-Communicable Diseases

Cardiovascular illnesses, malignancies, chronic lung diseases, and diabetes are the four primary categories of non-communicable diseases (NCDs) (WHO, 2019). In 2008, these disorders caused

1.3 million deaths from diabetes, 7.6 million deaths from cancer, 17 million deaths from cardiovascular disease, and 4.2 million deaths from chronic lung diseases (Kim & Oh, 2013).

2.2.3.1 Hypertension

High blood pressure, often known as hypertension, is a common public health issue that has a major impact on cardiovascular disease, kidney failure, early mortality, and disability (Sanuade *et al*., 2018). It is a long-term disorder that causes high blood pressure (Akoko *et al*., 2017). One-third of all worldwide premature deaths that could have been avoided each year are brought on by hypertension. Normal blood pressure is described by the Joint National Committee 7 (JNC7) as having a systolic pressure of 120 mmHg and a diastolic pressure of 80 mmHg, while hypertension is described as having a systolic pressure of 140 mmHg or a diastolic pressure of 90 mmHg (Singh *et al*., 2017). As well as being a major factor in cardiovascular disease, high blood pressure is one of the main causes of stroke. Although the relationship between hypertension and diabetes is not well understood, there is evidence suggesting a close link between the two conditions. Hypertension has also been linked to an increased risk of certain cancers (Kim & Oh, 2013). The prevalence of hypertension is rising in both economically developing and developed countries, due to factors such as increased life expectancy, obesity, physical inactivity, and unhealthy diets. In many developing countries, particularly in urban societies, the current prevalence of hypertension is comparable to that in developed countries. Without effective preventive measures, the prevalence of hypertension is expected to increase further in the future (Addo *et al*., 2012). Hypertension is responsible for over 7.5 million deaths worldwide each year, accounting for 12.8% of global mortality and contributing more than any other individual risk factor (WHO, 2013). Hypertension is known as "the silent killer" because it often has no warning signs or symptoms, and most people with high blood pressure are unaware of their condition. Food and weight-related

issues, such as excess body weight, high sodium intake, and excessive alcohol consumption, can contribute to hypertension (WHO, 2013).

2.2.3.2 Diabetes

Diabetes mellitus is a metabolic and/or hormonal condition characterized by persistent hyperglycemia caused by deficiencies in pancreatic-cell insulin secretion, decreased insulin sensitivity of cell surface receptors, or both. Type 1 diabetes, type 2 diabetes, gestational diabetes, and "other specific types of diabetes mellitus" are the four main types of diabetes mellitus (Adinortey, 2019). Acute complications are marked by symptoms and are brought on by improper management or uncontrolled hyperglycemia. Serious consequences can result if these warning signs and symptoms are disregarded or missed (Adinortey *et al*., 2019). In numerous studies, it has been found that diabetes mellitus (DM), which accounts for more than 8% of diseases worldwide, is the main cause of endocrine disorders (Narh *et al*., 2022). Other non-communicable diseases (NCDs) like cardiovascular disease (CVD), renal disease, and communicable diseases like tuberculosis all have diabetes mellitus as a significant comorbidity. Type 2 diabetes is the most prevalent type (Narh *et al*., 2022)

According to recent estimates, there are over 422 million adults in the world who have diabetes, and the disease is thought to be responsible for 1 point 5 million deaths annually (WHO, 2014). With more than 600 million people on the planet by 2030, diabetes is predicted to be the 7th most common cause of death. According to Cappuccio & Miller (2016), Sub-Saharan Africa will likely experience more than two-thirds of the global increase in diabetes prevalence. Asamoah-boaheng *et al*., (2019) estimate that by 2030, there will be 18 point 6 million people living with the disease in Africa, up from an estimated 7 point 1 million in the early 2000s. It was determined that between 0 and 1 percent of people in Sub-Saharan Africa had diabetes. The disease may now be more

prevalent than previously believed in Sub-Saharan Africa, according to recent studies from urban Cameroon, Nigeria, and Tanzania (A. G. B. Amoah *et al*. 2002). A growing body of research is showing that Ghana's population and health system face a significant challenge due to the rising prevalence of diabetes mellitus (DM) (Narh *et al*., 2022). According to Boutayeb *et al.*, (2014) from different nations, diabetes is an expensive disease that accounts for between 2 and 15% of total healthcare spending. More than $153 billion is estimated to be the annual direct cost globally for people aged 20 to 79, and by 2025, this amount is expected to have doubled (WHO, 2017). Diabetes was the sixth most common cause of death in 1999, according to the National Institute of Diabetes and Digestive Kidney Disease (NIDDK) and the American Diabetes Association, with a direct cost of $44 billion and an indirect cost of $54 billion per year (Boutayeb & Boutayeb, 2005).

2.2.3.3 Asthma

Asthma is a persistent respiratory disease with a wide range of symptoms. According to Narh *et al*. (2021), it is caused by inflammation in the airways, which restricts airflow into the lungs and causes symptoms such as wheezing, coughing, and shortness of breath. The disease can be diagnosed through a patient's medical history, physical examination, and spirometry results. Effective management of asthma aims to prevent attacks from occurring.

The cause of asthma is complex and multi-faceted, with no single biological marker. It is believed to arise from a combination of genetic and environmental factors (Amoah *et al*., 2012). One important aspect of asthma is atopy, which refers to a genetic tendency to produce immunoglobulin E (IgE) antibodies in response to allergens. Early exposure to common allergens like pet dander, pollen, or house dust mites can increase the likelihood of developing asthma in individuals who are genetically predisposed to the disease. Other risk factors include having a family history of

asthma, maternal smoking during pregnancy, low antioxidant consumption, obesity, living in urban areas, having a large family size, and reduced exposure to childhood infections (Amoah *et al*., 2012).

Asthma is a complex disease that has numerous factors contributing to its development. These factors can be both genetic and environmental, with atopy being a major component. Atopy refers to a genetic predisposition towards the production of immunoglobulin E (IgE) antibodies in response to allergens (Vaillant *et al*., 2022). Children and young adults are at a higher risk of developing asthma, particularly if they are exposed to common allergens like animal dander, house dust mites, or pollen during infancy. Other risk factors for asthma include maternal smoking during pregnancy, low antioxidant intake, a family history of the disease, obesity, living in inner-city urban areas, reduced exposure to childhood infections, and large family size (Amoah *et al*., 2012).

Asthma is a leading cause of non-communicable diseases globally and is responsible for increased deaths, disability, and decreased quality of life for sufferers. The World Health Organization (WHO, 2019) estimates that 300 million people are suffering from asthma worldwide, with 250,000 deaths being reported each year. Although the prevalence of asthma has been rising in industrialized countries, the national burden of asthma in Ghana remains poorly understood due to the lack of comprehensive data. The 2005 annual report from the W.H.O. Ghana Country Office states that data on non-communicable diseases, including asthma, is dispersed and unrepresentative (De-Graft Aikins, 2012). The asthma incidence rate in Ghana was reported as 1.5/1000 people per year, which is higher than the rates in Greece (0.3/1000 people per year) but lower than in Wales and New Zealand (2.8/1000 people per year) (Amoah *et al*., 2012).

2.2.3.4 Upper Respiratory Tract Infection

Upper respiratory tract infections (URTIs) are illnesses that affect the upper airways and encompass a range of diseases, including the common cold, influenza, pharyngitis, otitis media, tonsillitis, and sinusitis, but the common cold is the most frequent type. These infections are mainly caused by viruses and are treated mainly by relieving symptoms, such as reducing fever, increasing fluid intake, and using nasal decongestants, with 90% of cases resolving without any medical intervention (Sumaila *et al*., 2018). Acute respiratory infections (ARI) are a significant public health issue and a leading cause of death among children under the age of five (Kwofie *et al*., 2012).

2.2.4 Prevention of Non-Communicable Diseases

The majority of non-communicable diseases (NCDs) described above can be prevented through low-cost measures such as behaviour changes that target common and controllable risk factors. The reduction of risk factors such as tobacco consumption, an unhealthy diet, lack of physical activity, and excessive alcohol intake has the potential to prevent the majority of heart disease, strokes, and type 2 diabetes, as well as a significant portion of cancers. It is estimated that nearly 80% of these non-communicable diseases can be prevented through the elimination or reduction of these risk factors (WHO, 2021). Promoting health education and enacting supporting legislation also has a substantial effect on reducing NCDs (Opare *et al*., 2020). To tackle NCDs, it is crucial to shift from harmful lifestyle habits. Lifestyle is deeply ingrained in communities, so a systematic community-wide approach is necessary, including well-designed interventions that target lifestyle-related risk factors and are integrated into the community. All evidence shows that preventive measures, particularly those that focus on changing lifestyles and risk factors at the community level and tackle the underlying determinants of NCDs, are effective (Diseases & Health, n.d.).

2.2.5 Prevalence of Non-Communicable Disease in Ghana

Chronic non-communicable diseases (NCDs) in Ghana have been a growing concern for over half a century but have only recently become a matter of national attention. In a 1950 survey, 5.5% of 255 individuals aged 0-75 years were found to have cardiovascular disease (Bosu, 2012). Strokes have been a major cause of death and hospitalization for adults in Ghana. The number of stroke-related deaths increased from 6-10% between 1960 and 1968 to 17% between 1990 and 1993 (Bosu, 2012). The first comprehensive study on cardiovascular diseases in Mamprobi, Accra was conducted by the University of Ghana Medical School between 1974 and 1976, with funding from the World Health Organization. The study found that a quarter of the urban population aged 15 to 64 had abnormal cardiovascular conditions, and 48% of adult deaths were due to cardiovascular diseases. The burden of non-communicable diseases, including hypertension and diabetes, is growing in Ghana, both in absolute and relative terms (Bosu, 2012). Outpatient cases of hypertension increased from 60,000 in 1990 to 700,000 in 2010. Among adults diagnosed with hypertension, 19% to 48% have the disease and up to 70% are not receiving treatment, with only 0% to 13% having their blood pressure under control. Diabetes affects 6% to 9% of the population in Accra and Kumasi. The prevalence of asthma in school children aged 9-16 years in and around Kumasi increased from 3.1% in 1993 to 5.2% in 2003, based on exercise-induced bronchospasm. Meanwhile, the prevalence of skin sensitization to at least one allergen rose from 7.6% to 13.6%. The adult population in Accra has a 3% prevalence of asthma. (Bosu, 2012; Ministry of Health, 2012).

2.2.6 Impact of Non-Communicable Diseases in Ghana

In Ghana, non-communicable diseases (NCDs) cause 34% of all deaths and 31% of the overall disease burden (Ministry of Health, 2012). Each year, an estimated 86,200 people in Ghana die from NCDs, with 55.5% of those being under 70 years old and 58% being men ((Ministry of Health, 2012). The age-standardized death rate from NCDs is 817 per 100,000 for men and 595 per 100,000 for women. NCDs lead to the loss of 10.500 DALYs per 100,000 people, which equates to 2.32 million DALYs (Ministry of Health, 2012). Cardiovascular diseases (CVDs) were responsible for 8.9% of deaths in institutions (excluding teaching hospitals) in 2003, as compared to malaria, which accounted for 17.1% of deaths (Ministry of Health [MoH], 2012). In 2008, CVD surpassed malaria as the leading cause of institutional deaths, accounting for 14.5% of all deaths, compared to 13.4% for malaria (Nsiah-Asare, 2017).

2.2.7 Non-Communicable Health Care in Ghana

It has been noted that despite the high impact of NCDs in Ghana, decision-makers tend to view them as infrequent and therefore do not give the necessary attention to their management (Yawson *et al*, 2016). Although there have been many studies on NCDs in Ghana, there is limited research on how patients with NCDs receive healthcare in the country (Amu *et al*, 2021). A study by De-Graft Aikins *et al*. (2012) found that people in Ghana turn to both biomedical and spiritual methods to deal with NCDs. In 2012, the Ministry of Health in Ghana implemented a national policy aimed at managing, treating, and controlling NCDs (MoH, 2012). Despite efforts to address the issue of non-communicable diseases (NCDs) in Ghana, current policies tend to focus primarily on primary prevention and clinical care. This includes early detection, access to treatment services, and strengthening the capabilities of healthcare professionals. However, the policy seems to neglect the management of patients who have already been diagnosed with NCDs.

2.2.7.1 Impact of Non-Communicable Diseases on the Health System

Infectious diseases and noncommunicable diseases (NCDs) are contributing to a dual burden of disease in Africa (Gouda et al., 2019). Healthcare systems in many African countries face numerous difficulties in addressing NCDs. These difficulties include a lack of adequate funding, a shortage of qualified medical professionals, and a limited healthcare infrastructure (Formenti et al., 2022). The lack of early detection, economical treatment choices, and preventative measures exacerbates the impact of NCDs on African healthcare systems (WHO, 2020). Research conducted by Abraham et al., (2023), acknowledged that NCDs have become a leading cause of illness and death in Ghana. Similar to other African countries, Ghana's healthcare system faces significant obstacles in managing the burden of non-communicable diseases. According to de-Graft Aikins et al. (2012), these difficulties include a lack of healthcare personnel, an inadequate infrastructure for providing healthcare, and restricted financial resources. According to the World Health Organization, NCD patients frequently require long-term access to essential healthcare or rehabilitation services due to the chronic nature of their pathology (WHO, 2021). In order to prevent and control NCDs, the government has put policies and initiatives into place (Ministry of Health, 2012). However, there are still issues that need to be resolved, such as restricted access to necessary NCD drugs, poor public knowledge, and an urgent need for more comprehensive primary healthcare services (Ministry of Health, 2012).

2.2.8 Covid-19 Outbreak

In December 2019, the Coronavirus Disease (COVID-19) pandemic, which was caused by the severe acute respiratory syndrome coronavirus (SARS-CoV-2), an enveloped positive sense RNA virus with about 80% similarity to the 2002 SARS-CoV (Oduro-Mensah *et al*., 2020), broke out

in Wuhan, China. The majority of the cases initially had a common exposure to seafood and live animal markets, and it presented as severe pneumonia of unknown cause. The pandemic continued to spread from town to town, country to country, and the World Health Organization (WHO) declared it a pandemic in March after establishing person-to-person transmission (Oduro-Mensah *et al*., 2020). The global spread of COVID-19 has resulted in a widespread response from governments and health organizations to curb the spread of the virus. This response has included a range of measures such as physical distancing, wearing face masks, increased hygiene practices, and a range of restrictions on movement and economic activity. These measures have been put in place to slow the spread of the virus and help bring the pandemic under control. The rapid spread of COVID-19 has resulted in over 106.7 million confirmed cases and over 2.3 million deaths globally as of February 7, 2021 (Saah *et al*., 2021).

2.2.9 Global Impact of Covid-19

The global pandemic of coronavirus disease 2019 (COVID-19), caused by the SARS-CoV-2 coronavirus, had a greater impact on human health, the economy, and security all over the world (Formenti *et al*., 2022). The emergence of COVID-19 increased the strain on health systems worldwide, particularly in resource-limited countries, with 90 percent of countries in five WHO regions experiencing disruptions to their health services (Saah *et al*., 2021). Initial predictive models predicted a disastrous impact of COVID-19 in Africa in terms of transmission, the severity of disease, and deaths due to weaker healthcare systems, existing comorbidity burden (HIV, tuberculosis, and non-infectious chronic conditions), and poor socioeconomic determinants (Formenti *et al*., 2022). However, current epidemiological data appear to have fallen short of expectations, with lower SARS-CoV-2 infection and fatality rates than in Europe, the Americas, and Asia (Formenti *et al*., 2022).

The pandemic of COVID-19 had a widespread impact on healthcare services globally, including cancer services. Cancer services, particularly in low-resource settings such as many African countries and other low- and middle-income countries, were heavily affected by the pandemic (Nnaji & Moodley, 2020). The impact of COVID-19 on cancer care was wide-ranging, from prevention to screening and diagnosis, treatment, palliative care, patient follow-up, as well as logistics and supplies of cancer drugs and other critical commodities (Nnaji & Moodley, 2020).

2.3 Impact of Covid-19 in Ghana

The COVID-19 pandemic had a devastating impact on low and middle-income countries due to their inadequate healthcare capacity. In Sub-Saharan Africa (SSA), for instance, many people lack access to necessities such as clean water for hand washing and adequate sanitation, as well as technology such as the Internet for schooling and work. Healthcare and public health systems in SSA, including Ghana, were further strained by the lack of essential equipment and supplies for treating COVID-19 patients, including ICU beds, oxygen supply, ventilators, pulse oximeters, and personal protective equipment. Despite the challenges posed by the pandemic, it also provided an opportunity for health systems to redirect resources to neglected areas of health promotion and education. The Ghana Health Service (GHS) has taken advantage of this opportunity by increasing public health education through various media (Saah *et al*., 2021).

2.4 Covid-19 and Non-Communicable Disease

Studies have revealed that a substantial percentage of hospitalized COVID-19 patients have pre-existing medical conditions, with 20-51% of them having at least one comorbidity (Guan, 2020). According to Williamson *et al.*, (2020), more than 90% of the fatalities linked to COVID-19 in the United Kingdom (UK) were reported in individuals aged 60 years and above, while 60% of the deaths were recorded in men. A meta-analysis conducted by Sanyaolu *et al*. (2020) showed that

hypertension was the most prevalent comorbidity among COVID-19 cases, accounting for around 16% of the co-morbid conditions. Cardiovascular conditions and diabetes were found in 11.7% and 9.4% of the participants, respectively. Those with diabetes face a higher risk of morbidity and mortality, which often leads to prolonged hospitalization and ICU admission. Individuals with COPD and asthma are also susceptible to severe illness from COVID-19. Other conditions like obesity, chronic kidney disease, and liver disease raise the risk of contracting and developing severe forms of COVID-19. Patients with pre-existing medical conditions are four times more likely to contract COVID-19, and males appear to have a higher mortality risk. The presence of co-morbid conditions has a significant impact on the severity of symptoms and fatalities in Ghana. Regardless of age, individuals with conditions such as hypertension or diabetes have a less favorable prognosis.

2.5 Effect of Covid-19 on Patients with Non-Communicable Diseases

Sub-Saharan Africa's weak healthcare systems and limited resources make it challenging to ensure adequate prevention, diagnosis, and treatment for non-communicable diseases (NCDs). The impact of COVID-19 has made the situation even more severe, exacerbating the existing vulnerabilities. There is growing evidence that NCDs, such as cardiovascular diseases, obesity, and type 2 diabetes, are risk factors for severe COVID-19 and death. This highlights the risk of disrupting NCD control mechanisms in the region. A World Health Organization WHO (2021) study found that only 22% of 41 Sub-Saharan African countries provided emergency inpatient care for chronic conditions, while 37% had limited outpatient care. In the study, nearly 59% of countries reported an impact on the management of hypertension, while 56% reported a disruption in the management of diabetic complications. A study in South Africa showed a sharp decrease in HbA1c tests and a higher proportion of uncontrolled diabetes cases due to the disruption caused by

COVID-19 (Delobelle, 2022). Nearly 89 of WHO African region countries reported a significant reduction in immunization campaigns, including cancer-preventive vaccines, in June 2020 (Formenti *et al*., 2022). Most Sub-Saharan African countries are heavily dependent on international production and import of drugs, which has been disrupted by lockdowns and reallocation of resources, leading to drug shortages, especially in rural areas. According to a survey in Zimbabwe, over half of the respondents reported difficulty accessing medication. Lockdowns and patients' fears of contracting COVID-19 have disrupted follow-up visits and delayed diagnoses, resulting in the progression of advanced-stage NCDs and an increased risk of severe complications, including COVID-19 (Formenti *et al*., 2022). The closure of public transportation and fear of infection has led to a significant drop in breast cancer consultations in Tunisia and a 40% reduction in new outpatient cases was observed at a Moroccan oncology center (Nnaji, 2021).

2.6 Empirical Evidence

Tagoe *et al*, (2023) conducted a study on the challenges to the delivery of clinical diabetes services in Ghana created by the COVID-19 pandemic. The study examines the changes in diabetes service delivery due to COVID-19 and considers policy responses for future outbreaks in low- and middle-income countries (LMICs), using Ghana as a case study. To conduct the study, health professionals and administrators from primary, secondary, and tertiary facilities within the Ghana Health Service were interviewed between November 2020 and February 2021. The analysis was performed using deductive and inductive methods. Interviewees' responses revealed six general themes. Firstly, COVID-19 had worsened the problems of high medicine and service costs as well as medicine shortages. Secondly, the pandemic had exacerbated problems with poor patient record-keeping. Thirdly, COVID-19 had reduced the availability of suitably trained health providers. Fourthly, staff morale had been negatively affected by management's lack of willingness to make innovative

changes to cope with the pandemic. Fifthly, COVID-19 had led to a reorganization of diabetes services. Finally, the country's national health insurance scheme lacked flexibility in dealing with the pandemic. It is important to note that access to resources in LMICs is limited. However, the study identifies practical policy responses that can improve health providers' response to COVID-19 and future pandemics.

Delobelle *et al*., (2022) investigated non-communicable disease care and management in two sites of the Cape Town Metro during the first wave of COVID-19. This study aimed to evaluate the impact of COVID-19 on facility and community-based non-communicable disease (NCD) care and management in South Africa, specifically type-2 diabetes and hypertension, during the first COVID-19 wave. There is limited data on the effect of COVID-19 on NCD care in South Africa, and it is crucial to ensure quality care for these conditions. The study was conducted at two public health sector primary care sites in the Cape Town Metro, including a Community Orientated Primary Care (COPC) learning site. A rapid appraisal with convergent mixed-methods design was used, including semi-structured interviews with facility and community health workers (CHWs) (n = 20) and patients living with NCDs (n = 8). The interviews were conducted in English and Afrikaans, and transcripts were analysed using thematic content analysis. Quantitative data on health facility attendance, chronic dispensing unit (CDU) prescriptions, and routine diabetes control were sourced from the Provincial Health Data Centre and analysed descriptively. The qualitative analysis revealed three themes: disruption (cancellation of services, fear of infection, stress, and anxiety), service reorganisation (communication, home delivery of medication, CHW scope of work, risk stratification, and change management), and outcomes (workload and morale, stigma, appreciation, and impact on NCD control). Primary care attendance decreased, and CDU prescriptions and uncontrolled diabetes increased. In conclusion, service reorganisation was also

necessary to ensure quality NCD care and management, including communication, home delivery of medication, CHW scope of work, risk stratification, and change management. The COPC foundation in one of the study sites strengthened the changes. Further investigation is needed to assess the impact of COVID-19 on primary-level NCD care and management.

Devi *et al*., (2021) investigated the impact of covid-19 on the care of patients with non-communicable diseases in low- and middle-income countries. An online survey was conducted during the COVID-19 pandemic to investigate the impacts of COVID-19 and associated control measures on patients from low- and middle-income countries with cardiovascular disease, diabetes, and mental health conditions. The survey revealed that the participants' main concern was contracting COVID-19 during healthcare visits. Among those who contracted COVID-19, half reported a deterioration in their health status. Most participants experienced increased stress and loneliness. The COVID-19 pandemic has led to various healthcare impacts on patients with noncommunicable diseases, including restricted access to care and adverse health effects, particularly on mental well-being.

Formenti *et al*., (2021) also studied the impact of COVID-19 on communicable and non-communicable diseases in Africa. Available evidence suggests that the COVID-19 pandemic has severely impacted the control and prevention programs, diagnosis capacity, and adherence to treatment of major infectious diseases (HIV, TB, and Malaria) - including neglected diseases - and non-communicable diseases. Future research and efforts are necessary to assess the medium- and long-term impact of the pandemic and implement tailored interventions to mitigate the standstill on decades of improvement in public health programs.

Miller *et al*, (2022) looked at the adaptation of care for non-communicable diseases during the COVID-19 pandemic. The case study examines how humanitarian health programs in five

countries adapted to reduce exposure risks for people living with non-communicable diseases (PLWNCDs) during the COVID-19 pandemic. Adaptations included administrative and engineering controls, improved triaging, changes in prescribing practices, decreased frequency of stable patient visits, shift to remote consultations, and expanded responsibility for existing community health workers. Despite concerns about health service utilization, PLWNCDs continued to seek services, and changes in utilization rates were attributed to factors such as population changes, COVID-19 travel restrictions, closure of other health services, and enhanced health education and community engagement. This study highlights the resilience and creativity of frontline health staff and managers in responding to changes in risk for client groups. By targeting specific groups that are most at risk, such as those in humanitarian settings, access to sustained services can be ensured even during infectious disease outbreaks, conflicts, and natural disasters.

Luciani *et al.*, (2023) recently looked at Non-Communicable Diseases service capacity and disruptions due to COVID-19. This study presents results from the WHO non-communicable diseases (NCDs) Country Capacity Survey in the Americas region from 2019 to 2021, assessing NCD service capacity and disruptions due to the COVID-19 pandemic. The study included Ministry of Health officials managing a national NCD program from 35 countries in the region. The availability of evidence-based NCD guidelines, essential medicines, and basic technologies in primary care, as well as cardiovascular disease risk stratification, cancer screening, and palliative care services, were measured. Results showed that more than 50% of countries reported a lack of comprehensive NCD guidelines and essential medicines. Extensive disruptions in NCD services resulted from the pandemic, with only 12 out of 35 countries (34%) reporting that outpatient NCD services were functioning normally. Ministry of Health staff were redirected to work on the

COVID-19 response, reducing human resources for NCD services. Six out of 24 countries (25%) reported stock out of essential NCD medicines and/or diagnostics at health facilities, affecting service continuity. Mitigation strategies included telemedicine, triaging patients, and novel prescribing practices. These findings suggest significant and sustained disruptions to NCD services, affecting all countries in the region.

Bullen *et al* (2021) also looked at the impact of COVID-19 on the care of people living with non-communicable diseases in low- and middle-income countries. The study aimed to gather insights directly from frontline healthcare workers (FLHCWs) in high NCD burden countries to identify opportunities for improving healthcare provision during the COVID-19 pandemic and future healthcare emergencies. The researchers recruited FLHCWs, including general practitioners, pharmacists, and other medical specialists, from nine countries to complete an online survey, which focused on the impact of the pandemic on clinical practice and NCDs, barriers to clinical care, and innovative responses to the challenges presented by the pandemic. The majority of FLHCWs reported that their care of patients had been both adversely and positively impacted by public health measures imposed due to the pandemic. The study highlights the need for continuity of care for NCDs as part of pandemic preparedness to prevent exacerbation of chronic conditions by public health measures and direct impacts of the pandemic, and to prioritize the mental health of patients.

Last but not least, Mekonnen *et al*., (2022) investigated the impact of COVID-19 on non-communicable disease management services at selected government health centers in Addis Ababa, Ethiopia. The objective of this study was to identify the impact of COVID-19 on non-communicable disease (NCD) management services at government health centers in Addis Ababa, Ethiopia. The study was conducted using a health facility-based cross-sectional design from

August to September 2020, with 30 health centers included in the study. The results showed that the COVID-19 pandemic severely disrupted NCD management services, with 80% of the study participants perceiving this impact. The study also found a significant association between the occurrence of the COVID-19 pandemic and the decrease in outpatient volume at NCD management services, closure of population-level screening programs of NCDs, and closure of disease-specific NCD clinics. The study highlights the need for policymakers to ensure the continuation of critical clinical services during public health emergencies and to inform the public about proper service utilization.

2.7 Impact evaluation

The Impact evaluation design is a crucial aspect of research that helps to determine the effectiveness of a program or intervention. It involves identifying the causal relationship between an intervention and the outcomes it produces, and it has gained significant attention in recent years (Gertler *et al.*, 2016). There are different impact evaluation designs and their applications in various fields. The most widely used impact evaluation design is the experimental design, which is known as the gold standard for impact evaluation. It involves randomly assigning individuals or groups to either a treatment or control group and measuring the differences in outcomes between the two groups. This design is useful for establishing causality, but it may not be feasible or ethical in some cases. Secondly, a quasi-experimental design is also used. It is similar to experimental design, but it involves the non-random assignment of individuals or groups to treatment or control groups. This design is useful when randomization is not possible or ethical, and it can provide valuable insights into the effectiveness of an intervention. Also, Regression Discontinuity Design (RDD), which involves using a cutoff score to determine who receives the treatment and who does not is another type of impact evaluation design. It is a quasi-experimental design that allows for

causal inference when the assignment to treatment is based on a continuous measure. This design is useful when the treatment assignment is not random and provides a valid estimate of treatment effects near the cutoff. Another impact evaluation design is Difference-in-Differences Design. It is a quasi-experimental design that compares the change in outcomes before and after the intervention between the treatment and control groups. It is useful when randomization is not possible or feasible, and it can provide valuable insights into the effectiveness of an intervention (Gertler *et al.,* 2016). Interrupted Time Series Design is also another impact evaluation design. It is a quasi-experimental design that involves collecting data before and after the intervention. The design involves modeling the trends in the outcome variable before the intervention and comparing it with the trend after the intervention. This design is useful for evaluating the effectiveness of policies or programs that have a known start and end date (Penfold & Zhang, 2013). Lastly, Matching design which involves matching individuals or groups in the treatment group with individuals or groups in the control group who have similar characteristics is another form of impact evaluation design. This design is useful when randomization is not possible, and it can improve the precision of the estimate of the treatment effect (Rogers, 2009).

2.8 Interrupted Time Series Analysis (ITSA)

Interrupted time series (ITS) analysis is a highly effective research design that can be utilized when it is not possible or ethical to conduct randomized trials (Penfold & Zhang, 2013). According to Soumerai *et al.,* (2015), the use of ITS is becoming more common in assessing the efficacy of various interventions, including clinical therapies and public health policies at a national level. ITS has been employed to assess the impact of numerous public health interventions, such as the introduction of new vaccines, helmet laws for cyclists, modifications to paracetamol packaging, implementation of traffic speed zones, and measures to prevent nosocomial infections.

Additionally, it has been utilized to evaluate the health consequences of unforeseen events, like the global financial crisis (Bernal *et al.,* 2017).

According to Bernal *et al.,* (2017), the method involves analyzing population-level rates over some time and evaluating if there is a change in the outcome rate before and after a policy/program is implemented to improve the outcome.

ITS has numerous strengths, including the capacity to control for secular trends, the use of population-level data, the clear presentation of results, the ease of conducting stratified analyses, and the ability to evaluate both intended and unintended consequences of interventions (Wagner *et al.,* 2002). Wagner *et al.,* (2002) again added that there are some limitations, such as the requirement for a minimum of 8 time periods before and after an intervention, challenges in analyzing the independent impact of distinct components of a program implemented close together in time, and the need for a suitable control population.

2.9 Gaps in Literature

Despite the existing literature on the impact of the COVID-19 pandemic on NCD care visits in Ghana, there are several gaps in the literature there need to be addressed:

There is limited data on the actual impact: Although some studies have reported a decrease in NCD care visits during the pandemic, there is limited data on the actual impact of the pandemic on NCD care visits in Ghana. More research is needed to quantify the extent of the impact and the specific NCDs affected.

There is also limited research on the perspectives of patients: Most of the existing literature focuses on the healthcare provider's perspective, and there is limited research on the perspectives of patients with NCDs during the pandemic. Understanding the experiences and perceptions of

patients is crucial to developing appropriate interventions to address their needs during the pandemic.

There is limited research on the effectiveness of telemedicine: While some studies have reported positive outcomes in the use of telemedicine for NCD care during the pandemic, there is a need for more research on the effectiveness and sustainability of these interventions in Ghana. Factors such as accessibility, affordability, and acceptability of telemedicine need to be explored.

There is also limited research on the long-term impact: Most of the existing literature focuses on the immediate impact of the pandemic on NCD care visits. However, there is a need for more research on the long-term impact of the pandemic on NCD management and outcomes in Ghana.

There is also limited research on vulnerable populations: Vulnerable populations, such as older adults, individuals with disabilities, and those living in rural areas, may face unique challenges in accessing NCD care during the pandemic. However, there is limited research on the impact of the pandemic on these populations in Ghana.

Addressing these gaps in the literature is crucial to developing appropriate interventions to ensure that patients with NCDs continue to receive quality care during the pandemic and beyond.

CHAPTER THREE

METHODS

3.0 Introduction

This chapter describes the strategies that were in the study, including the study design, the methods for obtaining and managing data, the techniques for analyzing the data, the methods for presenting the results, and the study's limitations.

3.1 Study design

The study employed a retrospective longitudinal study using routine time series data on non-communicable (NCD) care visits from January 2018 to December 2022. The NCD care visits data, which were taken repeatedly over equal monthly intervals, were obtained for the Ghanaian population as a whole and the 16 administrative regions.

This design was appropriate because we were interested in investigating the effect of a phenomenon that had occurred in the past using secondary data. An interrupted time series analysis was performed, where the time series of the outcome variables (non-communicable diseases of interest) were used to generate an underlying pattern, which was presumptively going to be interrupted on the 12th of March, 2020 by the COVID-19 pandemic. A hypothetical counterfactual scenario was modeled using the interrupted time series. In this scenario, it was presumed that the non-communicable disease care visits trend would have been unchanged, had COVID-19 not occurred. Post-COVID (i.e., after March 12, 2020) is defined as the period after the first infections. Hence, by investigating any changes that occurred during the post-COVID period, the counterfactual usually offers a comparison for determining the impact of COVID-19 on non-communicable disease care visits.

3.2 Study Variables

The independent variables in this study were COVID-19 pandemic, Time and Month.

COVID-19 variable was measured as a binary outcome, Time variable was measured in months, and Month variable was also measure in months.

The outcome variables examined in the study were four different non-communicable diseases namely Asthma, Diabetes, Hypertension, and Stroke. The variables are defined in Table 1 below.

Table 1: Outcome Variables

Indicator	Definition	Numerator	Denominator	Source of denominator	Measurement scale
Asthma rate	The proportion of asthma cases reported at the OPD	Number of asthma patients reported at the OPD	OPD cases	District Health Information System 2	Continuous variable
Diabetes rate	The proportion of diabetes cases reported at the OPD	Number of diabetes cases reported at the OPD	OPD cases	District Health Information System 2	Continuous variable
Hypertension rate	The proportion of hypertension cases reported at the OPD	Number of diabetes cases reported at the OPD	OPD cases	District Health Information System 2	Continuous variable
Stroke rate	The proportion of stroke cases reported at the OPD	Number of stroke cases reported at the OPD	OPD cases	District Health Information System 2	Continuous variable

3.3 Study setting

Ghana is a central West African country on the Gulf of Guinea. Its entire land area is 238,537 square kilometers, and it is situated between latitudes 5°33'North and 0°12'West and longitudes 5.550°North and 0.200°West. As shown in Fig. 1 below, the neighbors of Ghana are Côte d'Ivoire,

to the west, Burkina Faso, which lies north, and Togo, to the east. The Gulf of Guinea also lies to the South and stretches across the 560-kilometer coastline.

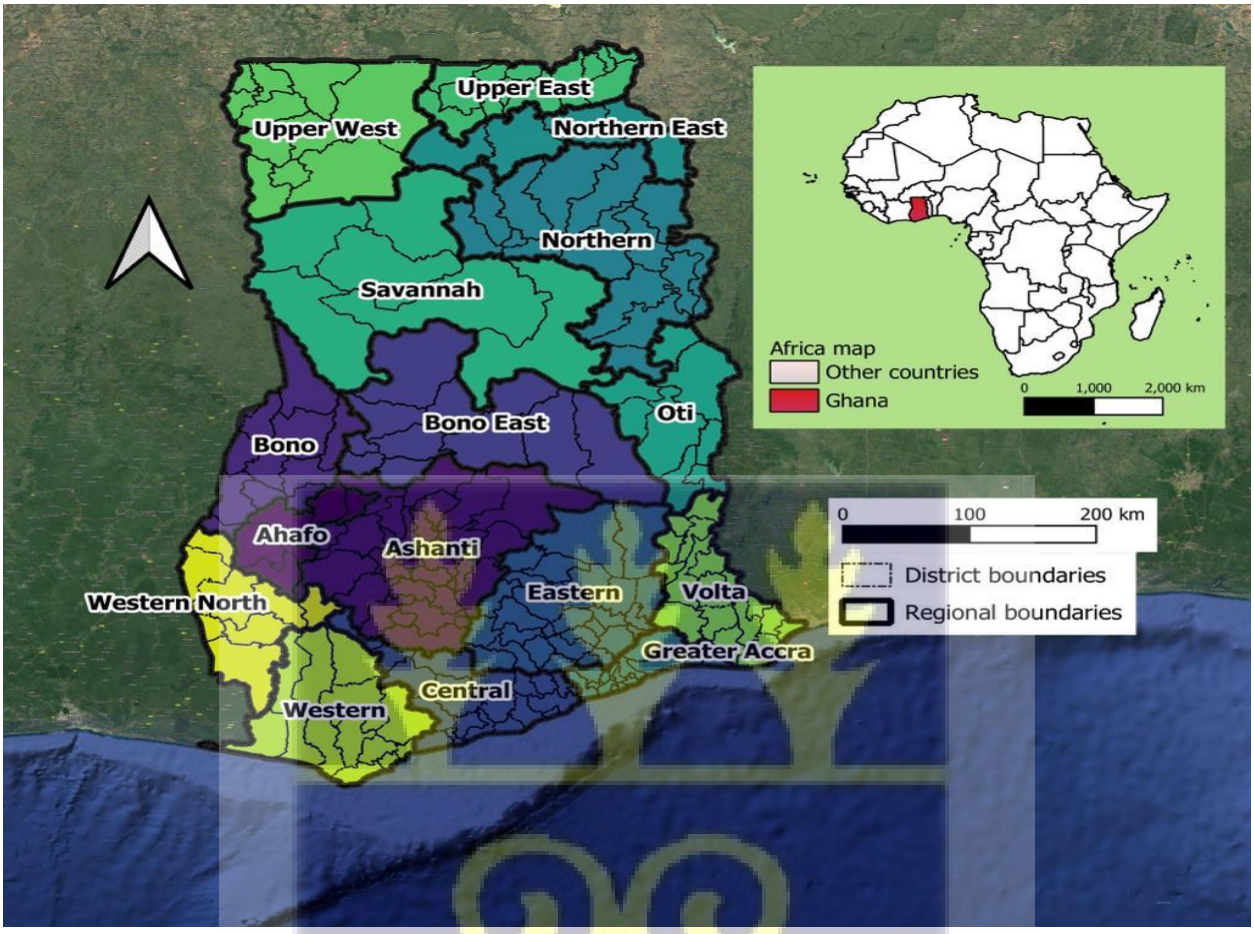

Figure 1: Showing Ghana on the African map and the map of Ghana showing the sixteen administrative regions

The nation has an estimated population of 32,511,465 as of Thursday, September 22, 2022, based on the World meter elaboration of the latest United Nations data. As shown in fig. 1 above, the country has sixteen (16) administrative regions and the study was conducted in all of these sixteen (16) administrative regions namely: Northern Region, Ashanti Region, Western Region, Volta Region, Eastern Region, UPPER West Region, Upper East Region, Central Region, Bono East Region, Greater Accra Region Savannah Region, North-East Region, Oti Region, Western Region, Ahafo Region, and Bono Region.

In Ghana, the government body in charge of meeting the general public's healthcare needs is the Ministry of Health (MoH). The MoH is responsible for providing public health services, regulating the Ghanaian healthcare sector, building service delivery centers, and educating competent healthcare workers to provide healthcare to the well-meaning citizens of Ghana. Some sectors under the MoH are the Ghana Health Service (GHS), the Christian Health Association of Ghana (CHAG), teaching hospitals, faith-based service providers, and private health practitioners. However, GHS is the major health service agency, implementing authorized national policies for health service delivery in the country, increasing access to high-quality health services, and managing resources available for the provision of healthcare services (Asamani *et al*, 2021). The GHS strives to promote and restore health as well as to build efficient systems for disease surveillance, prevention, and control. It also offers in-service training and continuing education. The National, Regional, and District levels are the three (3) administrative levels of the GHS. The teaching hospitals (tertiary hospitals), which offer specialist healthcare and are the final point of referral in the Ghanaian health delivery system, are the highest level of health service providers. The district hospitals located throughout the nation are principal referral sites for primary health care facilities, such as health centers, polyclinics, and community-based health promotion services (CHPS).

3.4 Study population

The study population were aggregate cases of non-communicable diseases specifically diabetes, hypertension, stroke, and asthma recorded on monthly bases from January 2018 to December 2022 across the sixteen (16) administrative regions in Ghana.

3.4.1 Inclusion criteria

- All healthcare facilities in Ghana that provided NCD care for patients diagnosed with Asthma, Hypertension, Stroke, and Diabetes from January 2018 to December 2022 and received NCD care.

3.5 Data Source

Data for the study were obtained from the District Health Information System 2 (DHIMS-II). The DHIMS was established in 2008 and is the data repository of all health service provisions in Ghana. Except for the teaching hospitals, DHIMS covers all hospitals nationwide that submit patient- and disease-specific information.

3.5.1 Data Processing and Management

Data for this study was retrieved from the District Health Information Management System version 2 (DHIMS2), the main data repository of the Ghana Health Service of the Ministry of Health. The DHIMS 2 is an online data repository where service delivery and health outcome data are stored from the various health facilities across Ghana. Data in the DHIMS2 is organized by date, organizational unit or service delivery level and data category. The criteria or parameters for data retrieval were selected from the DHIMMS 2 website (https://chimgh.org/). Data were then downloaded in spreadsheet form. Data were cleaned and converted to appropriate format. Data were imported into Stata 17 for statistical analysis

3.6 Data analysis

Descriptive statistics using median, minimum and maximum observations, that is, 25th and 75th percentiles respectively, and tools from time series were used to measure the distribution of the outcome measures of interest and observed underlying patterns and seasonal trends in the NCD care visit data. Quantile regression and bivariate analyses were also conducted to estimate the

difference in the median for NCD outcomes before-and-after COVID-19. The median was used as the data were not normally distributed and the presence of any outliers could bias our results. The NCD indicators investigated were: Asthma, Diabetes, Hypertension, and Stroke. COVID-19 was hypothesized to have interrupted NCD care visits both at the national and regional levels. This interruption is believed to have had both an immediate and sustained impact on NCD care visits.

The immediate effect (regression coefficient for before and after COVID) was measured one month after the index case, whereas the sustained effect was recorded after one month (the coefficient of the interaction term between COVID and time trend). Any effect requires a significant regression coefficient. COVID's sustained and immediate effects require statistically significant regression coefficients. ***p<0.001, **p<0.01, *p<0.05. All models were adjusted for seasonality.

To measure the impact of COVID-19 on the NCD care visits in Ghana, Interrupted Time Series (ITS) analysis was performed. A single-group ITSA design was used to measure the extent to which COVID-19 disrupted NCD care visits nationally, regionally, and across the three different regional belts. Observed trends of NCD care visits before COVID-19 were compared with predicted trends and the counterfactual (what the trend would have been in the absence of COVID-19) for all the four different NCDs of interest namely: Asthma, Diabetes, Hypertension, and Stroke. The purpose of this comparison was to determine whether there were any variations in the coverage and trend of NCD care visits.

ITS is a quasi-experimental study design with a potentially high level of internal validity (Wagner et al., 2002). We fitted quantile regression in our ITS analysis to quantify the effect of COVID-19 on NCD care visits. This model was fitted to NCD care visits outcome measures of interest.

To transform the care visit values for each dependent variable into a rate and account for any potential population changes over time for the count outcome measures, monthly care visits for asthma, diabetes, and hypertension were divided by 1,000 population while monthly care visits for stroke were divided by 100,000 population. We also used models stratified by calendar month as a technique to adjust for seasonality and other long-term patterns in the data Linden (2017).

To account for seasonality in NCD care visit time-series dependent outcomes, the following ITS regression model was applied: $\boldsymbol{Y_{ti} = \beta_0 + \beta_1 T + \beta_2 C + \beta_3 CT + \varepsilon_{ti}}$

Where:

- Y_{ti} is the count or rate of NCD care visits in the t_{th} month of the i_{th} year.
- t values range from 1 to 12 for months January through December respectively
- i values range from 1 to K,
- K is the number of observational years (2018-2022).
- C is a dummy variable that indicates whether an observation was obtained before COVID (C=0) or after (C=1).
- T is a continuous numeric variable indicating the number of months that have transpired since the observational period began (2018-2022).
- $\boldsymbol{\beta_0}$ represents the baseline level of NCD at time zero (T = 0),
- $\boldsymbol{\beta_1}$ is interpreted as the change in NCD care visits associated with an increase in time and it represents the underlying pre-COVID-19 trend),
- $\boldsymbol{\beta_2}$ is the level change in NCD care visits following the detection of the index COVID-19 case on March 12, 2020.
- $\boldsymbol{\beta_3}$ indicates the slope change following the COVID-19 pandemic.

To transform the NCD care visits into a rate and account for anticipated variations in OPD attendance over time, we incorporated the total number of cases at the OPD as an offset variable. The counterfactual was what the NCD care visits trend would have been in the absence of COVID-19 and by assuming there were no COVID-19 cases reported in Ghana and that the pandemic had neither an immediate nor a long-lasting impact, we assessed the counterfactual.

Stata BE 17.0 (Stata Corp, College Station, USA) and MS Excel were deployed for the statistical analysis and presentations of the outcomes.

3.7 Key Assumptions

This study relied on key assumptions that were important to the validity of our findings. These assumptions covered both the data and the analytical technique employed in this study. This section explored these assumptions and their relevance to the study.

- Independence: The data points in the time series should be independent of each other, meaning that the number of visits in one period should not be influenced by the number of visits in another period.
- Stationarity: The trend in the number of non-communicable disease care visits before the outbreak of COVID-19 should be stable and not change in any systematic way over time.
- Linearity: The relationship between time and the number of non-communicable disease care visits should be linear before and after the COVID-19 outbreak.
- Normality: The residuals of the ITS analysis should follow a normal distribution, meaning that the errors should have constant variance and be normally distributed around zero.

- Homoscedasticity: The variance of the residuals should be constant across time, meaning that the spread of the residuals should be the same before and after the COVID-19 outbreak.
- No autocorrelation: The residuals should not be correlated with each other over time, meaning that there should be no patterns or trends in the residuals that persist over time.

3.8 Study Limitations

The study had several limitations, including the use of secondary data, which may have limitations in terms of data quality and completeness. The study also assumed that the COVID-19 pandemic is the only intervention that may have affected non-communicable disease care visits in Ghana. Finally, the study is limited to the sixteen administrative regions of Ghana and may not be generalizable to other regions or countries.

3.9 Ethical Issues/Considerations

The study complied with ethical standards for research involving human subjects. The study did not involve direct contact with study participants, and all data were anonymized to ensure confidentiality. The study complied with the relevant data protection laws in Ghana.

CHAPTER FOUR

RESULTS

4.0 Introduction

This section presents the findings of this research in a clear and organized manner. It also provides a detailed description of the data collected and the statistical analyses conducted to answer the research questions.

4.1 Country and Regional belt levels analysis

4.1.1 Asthma care visits before and after the Pandemic

The results in Table 2 revealed that, after the pandemic, the highest significant decline in asthma care visits was in the Central region [-257.0 (p<0.001, CI=-356.1, -157.9)], followed by the Eastern region [-189 (p=0.002, CI=-306.4, -71.6)] and the Volta region [-141.0 (p<0.001, CI=-202.0, -80.0)]. The Ahafo [-35 (p=0.006, CI=-59.57, -10.43)] and the Upper West regions [-44 (p=0.001, CI=-70.1, -17.9)] also reported a significant decline in asthma care visits after the pandemic. The Bono region, on the contrary, reported a significant rise in asthma care visits [75.0 (p=0.011, CI=17.8, 132.2)] after the COVID-19 pandemic. Asthma care visits in the Northern belt declined significantly by 42 (p=0.002, CI=-69.0, -15.0) after the COVID-19 pandemic

Table 2: Reported asthma care visits before and after COVID-19

Regions	Asthma			
	Before COVID Median [LQ, UQ]	**After COVID Median [LQ, UQ]**	**Change in Median [95% CI]**	**p-value**
National	237.5[117.0, 679.0]	235.5 [93.0, 506.5]	-3.0 [-53.9, 47.9]	0.910
Regions				
Ahafo	139.5 [126.0, 162.0]	104.0 [88.0, 143.0]	-35.0 [-59.6, -10.4]	**0.006**
Ashanti	1451.5 [1300.0, 1563.0]	1483.0 [1320.0, 1666.0]	48.0 [-114.9, 210.9]	0.558
Bono	265.5 [236.0, 311.0]	277.5 [231.0, 332.0]	11.0 [-36.0, 58.1]	0.642
Bono East	197.5 [175.0, 251.0]	272.5 [222.0, 356.0]	75.0 [17.8, 132.2]	**0.011**
Central	762.5 [699.0, 878.0]	498.5 [418.0, 614.0]	-257.0 [-356.1, -157.9]	**<0.001**
Eastern	987.0 [987.0, 1094.0]	791.0 [715.0, 880.0]	-189.0 [-306.4, -71.6]	**0.002**
Greater Accra	1220.5 [1021.0, 1359.0]	1255.0 [970.0, 1452.0]	33.0 [-187.4, -253.4]	0.766
North East	53.0 [30.0, 100.0]	54.5 [39.0, 71.0]	0.0 [-25.4, 25.4]	1.000
Northern	192.5 [147.0, 210.0]	164.5 [129.0, 191.0]	-26.0 [-58.8, 6.8]	0.118
Oti	81.5 [68.0, 89.0]	72.0 [61.0, 87.0]	-8.0 [-20.5, 4.5]	0.206
Savannah	72.0 [62.0, 83.0]	59.5 [52.0, 75.0]	-11.0 [-22.6, 0.6]	0.063
Upper East	305.5 [251.0, 372.0]	252.5 [197.0, 370.0]	-54.0 [-133.0, 25.0]	0.177
Upper West	129.5 [101.0, 174.0]	85.5 [76.0, 108.0]	-44.0 [-70.1, -17.9]	**0.001**
Volta	490.0 [457.0, 589.0]	350.0 [333.0, 437.0]	-141.0 [-202.0, -80.0]	**<0.001**
Western	470.0 [387.0, 509.0]	493.0 [414.0, 536.0]	26.0 [-32.1, 90.1]	0.420
Western North	111.5 [97.0, 161.0]	113.5 [95.0, 150.0]	3.0 [-27.9, 33.9]	0.847
Regional Belts				
Northern Belt	127.5 [73.0, 210.0]	86.5 [60.0, 183.0]	-42.0 [-69.0, -15.0]	**0.002**
Middle Belt	243.5 [138.5, 962.5]	275.5 [113.0,791.0]	25.0 [-50.6, 100.6]	0.516
Southern Belt	541.5 [379.0, 870.0]	455.0 [294.0, 617.0]	-86.0 [-167.0, -5.1]	0.037

4.1.3 Diabetes care visits before and after the Pandemic

From Table 3, the Central region reported the highest decline in diabetes care visits [-798.0 (p<0.001, CI=- 1044.5, 537.5], followed by the Volta region [-300 (p=0.002, CI=-487.35, 112.64)] and these changes were all statistically significant. Four regions also recorded a statistically significant rise in diabetes care visits after the COVID-19 pandemic. The Greater Accra Region reported the highest rise in diabetes care visits [489.0 (p=0.002, CI=180.7, -797.3)] after the pandemic, followed by the Ashanti region [412.0 (p=0.025, CI=54.3, 7690.0)], the Bono region [288.0 (p<0.001, CI=178.0, 398.0)], the Western region [282 (p=0.001, CI=118.37, 445.6)] and the Western North region [165.0 (p=0.001, CI=75.4, 254.6)].

Table 3: Reported Diabetes care visits before and after COVID-19

Regions	Diabetes			
	Before COVID Median [LQ, UQ]	**After COVID Median [LQ, UQ]**	**Change in Median [95% CI]**	**p-value**
National	462.5 [193.5, 1168.5]	510.0 [174, 1166.5]	46 [-44.4, 136.4]	0.310
Regions				
Ahafo	231.0 [165.0, 324.0]	188.0 [169.0, 363.0]	-52.0 [-145.9, 41.9]	0.272
Ashanti	3328.5 [2941.0, 3521.0]	3742.5[3419.0, 4177.0]	412.0 [54.3, 7690.0]	**0.025**
Bono	329.5 [301.0,481.0]	598.0 [509.0, 741.0]	288.0 [178.0, 398.0]	**<0.001**
Bono East	591.5 [510.0, 650.0]	575.0 [474.0, 692.0]	-18.0[-114.8, 78.8]	0.711
Central	1985.0 [1639.0, 2264.0]	1191.5[1002.0, 1352.0]	-798.0 [- 1044.5, 537.5]	**<0.001**
Eastern	1511.5 [1287.0, 2063.0]	1723.5[1368.0, 2118.0]	223.0 [-176.9, 622.9]	0.269
Greater Accra	3294.0 [3003.0, 3446.0]	3753.5[3491.0, 4188.0]	489.0 [180.7, -797.3]	**0.002**
North East	117.0 [6.0, 150.0]	51.0 [35.0, 148.0]	-63.0 [-129.4, 3.4]	0.063
Northern	536.0 [444.0, 601.0]	496.0 [375.0, 576.0]	-38.0 [-133.6, 58.0]	0.429
Oti	174.5 [132.0, 254.0]	157.0 [99.0, 201.0]	-24.0 [-21.0, 34.1]	0.412
Savannah	65.0 [48.0, 90.0]	56.0 [50.0, 68.0]	-10.0 [-24.9, 4.9]	0.185
Upper East	302.0 [256.0, 365.0]	281.0 [204.0, 344.0]	-37.0 [-103.5, 29.5]	0.270
Upper West	98.5 [73.0, 116.0]	109.5 [91.0, 119.0]	9.0 [-9.1, 27.1]	0.324
Volta	899.0 [710.0, 1108.0]	600.0 [465.0, 790.0]	-300.0 [-487.4, 112.6]	**0.002**
Western	903.5 [824.0, 1106.0]	1169.0[1031.0, 1365.0]	282.0 [118.4, 445.6]	**0.001**
Western North	279.5 [210.0, 384.0]	443.0 [389.0, 557.0]	165.0 [75.4, 254.6]	**0.001**
Regional Belts				
Northern Belt	143.0 [70 0, 331.0]	128.5 [58.0, 317.0]	-13.0 [-64.1, 38.1]	0.617
Middle Belt	515.5 [253.0, 1511.5]	586.5 [218.0, 1673.0]	68.0 [-94.8, 230.1]	0.412
Southern Belt	1071.5 [695.0, 2063.0]	1033.0 [580.0, 1713.0]	-71.0 [-298.2, 156.2]	0.539

4.1.4 Hypertension care visits before and after the Pandemic

After the pandemic, hypertension care visits decreased most significantly in the Northern region [-1728 (p<0.001, CI=-2212.8, -1243.0)], followed by the Volta region [-1661, (p<0.001, CI=-2327.7, 994.3)], the Central region [-1100 (p=0.004, CI=-1841.3, -358.7)], the Upper West region [-195.0 (p<0.001, CI=-257.4, 132.6)], and the Savannah region [-104 (p=0.048, CI=-206.8, 1.2)]. There were some significant rises in hypertension care visits in some regions. The highest care visits were recorded for the Western region [825 (p<0.001, CI=404.8, 1245.2)], followed by the Bono region [588.0 (p<0.001, CI=306.1, 869.9)], the Western North region [335.0 (p<0.001, CI=161.0, 509.0)] and the Bono East region [290 (p=0.016, CI=56.71, 523.28)]. The Middle belts recorded a significant decline of 409 (p=0.028, CI=44.2, 773.8) in hypertension care visits after the pandemic. All the results are presented in table 4 below.

Table 4: Reported hypertension care visits before and after COVID-19

Area	Hypertension			
	Before COVID Median [LQ, UQ]	**After COVID Median [LQ, UQ]**	**Change in Median [95% CI]**	**p-value**
National	1945.0 [849.5, 4810.0]	1874.5[811.0, 3824.5.0]	-76.0 [-1645.4, 2282.6]	0.730
Regions				
Ahafo	610.5 [531.0, 788.0]	579.0 [487.0, 802.0]	-19.0 [-171.3, 133.3]	0.804
Ashanti	9120.0 [8528.0, 9120.0]	9838.0 [8854.0, 9838.0]	661.0 [-143.4, 1465.4]	1.105
Bono	1048.0 [925.0, 1146.0]	1605.0 [1274.0, 2052.0]	588.0 [306.1, 869.9]	**<0.001**
Bono East	1407.5 [1232.0, 1633.0]	1706.0 [1478.0, 1955.0]	290.0 [56.7, 523.3]	**0.016**
Central	5322.0 [4742.0, 6165.0]	4306.5 [3560.0, 4962.0]	-1100.0 [-1841.3, -358.7]	**0.004**
Eastern	5562.0 [4556.0, 6310.0]	6293.0 [5309.0, 7390.0]	757.0[-261.8, 1775.8]	0.142
Greater Accra	10903.5[10339.0, 12251.0]	10747.0[10111.0, 11683.0]	-64.0 [-967.2, -839.2]	0.888
North East	721.0 [261.0, 952.0]	678.0 [551.0, 883.0]	40.0[-216.1, 296.1]	0.756
Northern	3892.5 [3387.0, 4719.0]	2174.5 [1861.0, 2471.0]	-1728.0 [-2212.8, -1243.0]	**<0.001**
Oti	961.5 [561.0, 1107.0]	819.0 [588.0, 996.0]	-144.0 [-389.8, 101.8]	0.246
Savannah	497.0 [405.0, 709.0]	404.5 [357.0, 470.0]	-104.0 [-206.8, 1.2]	**0.048**
Upper East	2425.5 [2156.0, 2859.0]	2234.5[1850.0, 2430.0]	-237.0 [-569.7, 95.7]	0.159
Upper West	828.5 [776.0, 905.0]	634.0 [591.0, 702.0]	-195.0 [-257.4, 132.6]	**<0.001**
Volta	4449.0 [3985.0, 5305.0]	2866.5 [2173.0, 3403.0]	-1661.0 [-2327.7, 994.3]	**<0.001**
Western	2799.5 [2549.0, 3261.0]	3616.5 [3271.0, 4138.0]	825.0 [404.8, 1245.2]	**<0.001**
Western North	870.0 [685.0, 997.0]	1217.0 [1025.0, 1371.0]	335.0 [161.0, 509.0]	**<0.001**
Regional Belts				
Northern Belt	949.0 [664.0, 2859.0]	760.0 [506.0, 2064.0]	-192.0 [-655.1, 271.0]	0.415
Middle Belt	1284.0 [900.0, 5562.0]	1673.5 [884.5, 6176.5]	-409.0 [44.2, 773.8]	**0.028**
Southern Belt	4327.5 [2549.0, 6168.0]	3570.0[2106.0, 4970.0]	-813.0 [-1402.7, -223.4]	**0.007**

4.1.5 Stroke care visits before and after the Pandemic

From Table 5 below, stroke care visits, after the pandemic, increased significantly in the Ashanti region [155.0 (p<0.001, CI=78.0, 232.0)], the Greater Accra region [111.0 (p=0.029 CI=11.6, 210.4)], the Bono region [20 (p=0.049, CI=0.05, 40.0)], the Upper West region [8.0 (p=0.03, CI=2.8, 13.2)] and the North East region [3.0 (p<0.001, CI=1.6, 4.4)], from the highest to the least. Contrarily, the Central region recorded the highest significant decline [-199, (p<0.001, CI=-272.3, -125.7)] in stroke care visits after the pandemic. Stroke care visits also dropped significantly in the Volta region [-29.0 (p=0.03 CI=-48.0, -10.0)] and the Savannah region [-2.0 (p=0.019, CI=-3.7, -0.3)] after the pandemic. Across the regional belts, stroke care visits increased significantly by 3 (p=0.028, CI=0.3, 5.7) in the Northern belt after the pandemic.

Table 5: Reported stroke care visits before and after COVID-19

Area	Stroke			
	Before COVID Median [LQ, UQ]	**After COVID Median [LQ, UQ]**	**Change in Median [95% CI]**	**p-value**
National	32.0 [8.0, 169.0]	32.5 [10.0, 163.0]	1.00 [-12.6, 14.6]	0.890
Regions				
Ahafo	5.0 [2.5, 10.0]	5.0 [3.0, 9.0]	0.0 [-60.0, 60.0]	1.000
Ashanti	277.5 [208.0, 367.0]	433.5 [381.0, 518.0]	155.0 [78.0, 232.0]	**<0.001**
Bono	35.5 [30.0, 81.0]	57.0 [42.0, 70.0]	20.0 [0.1, 40.0]	**0.049**
Bono East	31.0 [13.0, 57.0]	23.5 [17.0, 37.0]	-7.0 [-23.0, 9.0]	0.384
Central	387.0 [248.0, 476.0]	187.0[148.0, 220.0]	-199.0 [-272.3, -125.7]	**<0.001**
Eastern	371.0 [323.0, 386.0]	347.0 [277.0, 433.0]	-21.0 [-81.8, 39.8]	0.492
Greater Accra	235.5 [128.0, 307.0]	347.0 [307.0, 504.0]	111.0 [11.6, 210.4]	**0.029**
North East	2.0 [2.0, 3.0]	5.0 [3.0, 6.0]	3.0 [1.6, 4.4]	<0.001
Northern	6.5 [5.0, 11.0]	9.5 [7.0, 14.0]	3 .0[-0.4, 6.4]	0.087
Oti	12.5 [9.0,18.0]	11.0 [7.0, 16.0]	-2.0 [-6.7, 2.7]	0.401
Savannah	2.5 [2.0, 5.0]	1.0 [1.0, 3.0]	-2.0 [-3.7, -0.3]	**0.019**
Upper East	19.5 [11.0, 38.0]	24.0 [14.0, 38.0]	5.0 [-8.3, 18.3]	0.454
Upper West	6.0[4.0, 10.0]	13.5 [8.0, 21.0]	8.0 [2.8, 13.2]	**0.003**
Volta	151.5 [128.0, 171.0]	124.0 [105.0, 136.0]	-29.0 [-48.0, -10.0]	**0.003**
Western	48.5 [33.0, 68.0]	75.5 [47.0, 107.0]	23.0 [-2.8, 48.8]	0.080
Western North	16.0 [11.0, 26.0]	19.0 [14.0, 30.0]	3.0 [-5.2, 11.2]	0.466
Regional belts				
Northern Belt	6.0[3.0, 11.0]	9.0 [4.0, 19.0]	3.0 [0.3, 5.7]	**0.028**
Middle Belt	44.5 [13.0, 276.0]	45.0 [14.0, 326.0]	-2.0 [-46.0, 42.0]	0.929
Southern Belt	128.0 [37.0, 253.0]	127.5 [50.0, 217.0]	0.0 [-32.8, 32.8]	1.000

4.2 Impact of COVID-19 on NCD care visits: An Interrupted Time Series Analysis

4.2.1 Immediate and Sustained Impact of COVID-19 on Asthma care visits

The results in Table 6 and Fig 2 below revealed that there was no significant immediate and sustained impact of COVID-19 on Asthma care visits nationally, showing how the nation managed to maintain asthma care visits despite the COVID-19 pandemic. Asthma care visits were reduced by 0.081% (p=0.0.636, 95% CI= -.42, 0.25) in the first month of the COVID-19 outbreak. However, this change was not significant. For the sustained impact, that is, after one month of the COVID-19 outbreak, there was a further reduction from 0.081% to 0.0027% (p=0.787, 95% CI=-0.022, 0.017), although this reduction was insignificant. The regional estimates of the impact of COVID-19 on asthma care visits showed that all 16 regions experienced some level of change (either positively or negatively) in asthma care visits, although most were insignificant. Some administrative regions experienced a significant impact on asthma care visits. For the immediate impact, the Central region had a 0.49% (p=0.182, 95% CI=-1.23, 0.24) reduction in asthma care visits, although insignificant. However, there was a significant 0.053% (p=0.014, 95% CI=-0.096,

-0.011) sustained reduction in asthma care after Ghana's first month of the COVID-19 outbreak. Greater Accra region also experienced an insignificant immediate reduction in asthma care visits by 0.12% (p=0.807, 95% CI=-0.89, 1.14), followed by a 0.10 % (p=0.001, 95% CI= 0.044, 0.16) significant sustained increase in asthma care visits. North East region had both significant immediate and sustained reduced impact of 0.96% (p=0.015, 95% CI=-1.73, -0.20) and 0.4% (p<0.001, -0.19, -0.10) respectively from the COVID-19 pandemic on asthma care visits. The Savannah region also experienced both significant immediate and sustained reduced impact of 0.87% (p=0.002, 95% CI=-1.40, -0.35) and 0.03% (p<0.050, -0.061, -0.000025) respectively from the COVID-19 pandemic on asthma care visits. The Northern region Upper West region also had a significant impact of 0.94% (p=0.002, CI=-1.50, -0.37) reduction in asthma care visits and a 0.71% (p=0.018, CI=0.13, 1.28) increase in asthma care visits respectively. However, these changes were just immediate, but not sustained. There was also no significant immediate and sustained impact of COVID-19 on asthma care visits for the three different regional belts.

Table 6: Impact of COVID-19 on Reported Asthma Cases

Area	Asthma			
	Immediate Impact [95% CI]	**P-value**	**Sustained Impact [95% CI]**	**P-value**
National	-0.088 [-0.32, 0.15]	0.453	-0.0066 [-0.020, 0.0069]	0.329
Regions				
Ahafo	-0.35 [-1.00, 0.31]	0.294	-0.0064 [-0.044, 0.032]	0.735
Ashanti	-0.14 [-0.80, 0.52]	0.680	-0.0051 [-0.043, 0.033]	0.788
Bono	0.22 [-0.096, 0.53]	0.170	0.014 [-0.0036, 0.32]	0.115
Bono East	-0.19 [-0.71, 0.32]	0.454	0.0079 [-0.022, 0.038]	0.596
Central	-0.49 [-1.23, 0.24]	0.182	-0.053 [-0.096, -0.011]	**0.014**
Eastern	-0.32 [-0.71, 0.070]	0.106	0.0084 [-0.014, 0.031]	0.457
Greater Accra	0.12 [-0.89, 1.14]	0.807	0.10 [0.044, 0.16]	**0.001**
North East	-0.96 [-1.73, -0.20]	**0.015**	-0.14 [-0.19, -0.10]	**<0.001**
Northern	-0.94 [-1.50, -0.37]	**0.002**	-0.0048 [-0.037, 0.028]	0.769
Oti	0.025 [-0.43, 0.48]	0.911	-0.0064 [-0.033, 0.020]	0.628
Savannah	-0.87 [-1.40, -0.35]	**0.002**	-0.030 [-0.061,0.000025]	**0.050**
Upper East	-0.130 [-0.56, 0.30]	0.549	0.0046 [-0.020, 0.030]	0.713
Upper West	0.71 [0.13, 1.28]	**0.018**	0.020 [-0.013, 0.054]	0.224
Volta	0.065 [-0.60, 0.73]	0.844	0.035 [-0.0033, 0.073]	0.0073
Western	0.035 [-0.47, 0.53]	0.89	-0.0012 [-0.030, 0.028]	0.933
Western North	-0.19[-0.66, 0.28]	0.412	0.026 [-0.00077, 0.053]	0.057
Regional belt				
Northern Belt	-0.31 [-0.73, 0.11]	0.155	-0.020 [-0.045, 0.0044]	0.107
Middle Belt	-0.0068 [-0.53, 0.51]	0.979	-0.0032 [-0.033, 0.027]	0.833
Southern Belt	0.12 [-0.64, 0.88]	0.753	0.0037 [-0.040, 0.048]	0.867

*Note: The immediate effect (regression coefficient for before and after COVID) was measured one month after the index case, whereas the sustained effect was recorded after one month (the coefficient of the interaction term between COVID and time trend). Any effect requires a significant regression coefficient. COVID's sustained and immediate effects require statistically significant regression coefficients. ***p<0.001, **p<0.01, *p<0.05. All models are adjusted for seasonality.*

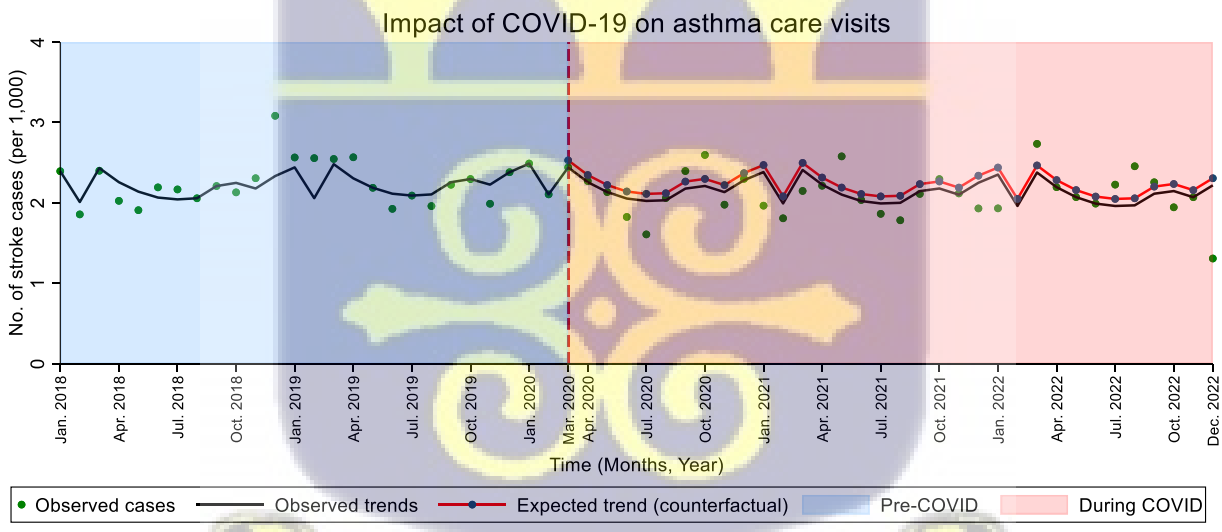

Figure 2: National estimate of the impact of COVID-19 on asthma care visits

4.2.2 Immediate and Sustained Impact of COVID-19 on Diabetes care visits

From Table 7, the pandemic had both an immediate impact and a sustained impact on diabetes care visits nationally. Figure 3 below is a time series graph showing this interruption. Across the regional belts, the impact was only significantly sustained in the northern belt. Ahafo and North East had no significant immediate impacts on diabetes care visits, but only a significant sustained decline of 0.29% ($p<0.001$, CI=-0.39, -0.18) and 0.45% ($p<0.001$, CI=-0.45, -0.34) respectively. Greater Accra and Western region, that notwithstanding, had only a statistically significant immediate increase of 5.61% (p=0.001 CI=2.50, 8.69) and 2.49% (p=0.007, CI=0.70, 4.28) respectively, but no significant sustained impact. The central region had both significant immediate and sustained decline of 3.32% ($p<0.001$, CI=-4.99, -1.66), and 0.16% (p=0.002, CI=-0.25, -0.062) respectively. The eastern region, on the other hand, had statistically significant immediate and sustained increases of 3.45% ($p<0.001$, CI=1.86, 5.03) and 0.15% (p=0.002, CI=-0.061, 0.25) respectively. Volta region also had a significant immediate increase of 2.06% (p=0.018, CI=0.37, 3.75) for diabetes care visits but later experienced a statistically significant sustained decline of 0.13% (p=0.012, CI=-0.22, -0.029).

Table 7: Impact of COVID-19 on Reported Diabetes Cases

Area	Diabetes			
	Immediate Impact [95% CI]	**P-value**	**Sustained Impact [95% CI]**	**P-value**
National	1.22 [0.45, 1.98]	**0.003**	-0.061 [-0.11, -0.017]	**0.008**
Regions				
Ahafo	-0.37 [-2.16, 1.42]	0.676	-0.29 [-0.39, -0.18]	**<0.001**
Ashanti	1.95 [0.18, 3.71]	0.032	0.088 [-0.014, 0.19]	0.088
Bono	1.28 [-0.19, 2.75]	0.085	-0.060 [-0.15, 0.024]	0.158
Bono East	-0.036 [-1.21, 1.14]	0.951	0.061 [-0.0069, 0.13	0.077
Central	-3.32 [-4.99, -1.66]	**<0.001**	-0.16 [-0.25, -0.062]	**0.002**
Eastern	3.45 [1.86, 5.03]	**<0.001**	0.15 [0.061, 0.25]	**0.002**
Greater Accra	5.61 [2.5, 8.69]	**0.001**	-0.12 [-0.29, 0.062]	0.0196
North East	0.41 [-1.43, 2.26]	0.654	-0.45 [-0.45, -0.34]	**<0.001**
Northern	-0.89 [-2.50, 0.72]	0.271	0.016 [-0.077, 0.108]	0.732
Oti	-0.261 [-1.4, 0.88]	0.648	-0.26 [-1.40, 0.88]	0.648
Savannah	-0.47 [-1.83, 0.90]	0.494	-0.052 [-0.13, 0.027]	0.192
Upper East	-0.047 [-0.85, 0.75]	0.906	-0.045 [-0.091, 0.0013]	0.056
Upper West	0.49 [-0.024, 1.01]	0.061	0.00 [-0.29, 0.031]	0.962
Volta	2.06 [0.37, 3.75]	**0.018**	-0.13 [-0.22, -0.029]	**0.012**
Western	2.49 [0.70, 4.28]	**0.007**	-0.010 [-0.11, 0.093]	0.846
Western North	-0.17 [-1.64, 1.31]	0.821	-0.068 [-0.15, 0.017]	0.116
Regional Belt				
Northern Belt	-0.038 [-1.13, 1.06]	0.945	-0.094 [-0.16, -0.031]	**0.004**
Middle Belt	0.59 [-1.00, 2.17]	0.468	-0.010 [-0.10, 0.081]	0.827
Southern Belt	1.29 [-0.93, 3.50]	0.255	-0.030 [-0.16, 0.099]	0.650

Note: The immediate effect (regression coefficient for before and after COVID) was measured one month after the index case, whereas the sustained effect was recorded after one month (the coefficient of the interaction term between COVID and time trend). Any effect requires a significant regression coefficient. COVID's sustained and immediate effects require statistically significant regression coefficients. ***p<0.001, **p<0.01, *p<0.05. All models are adjusted for seasonality.

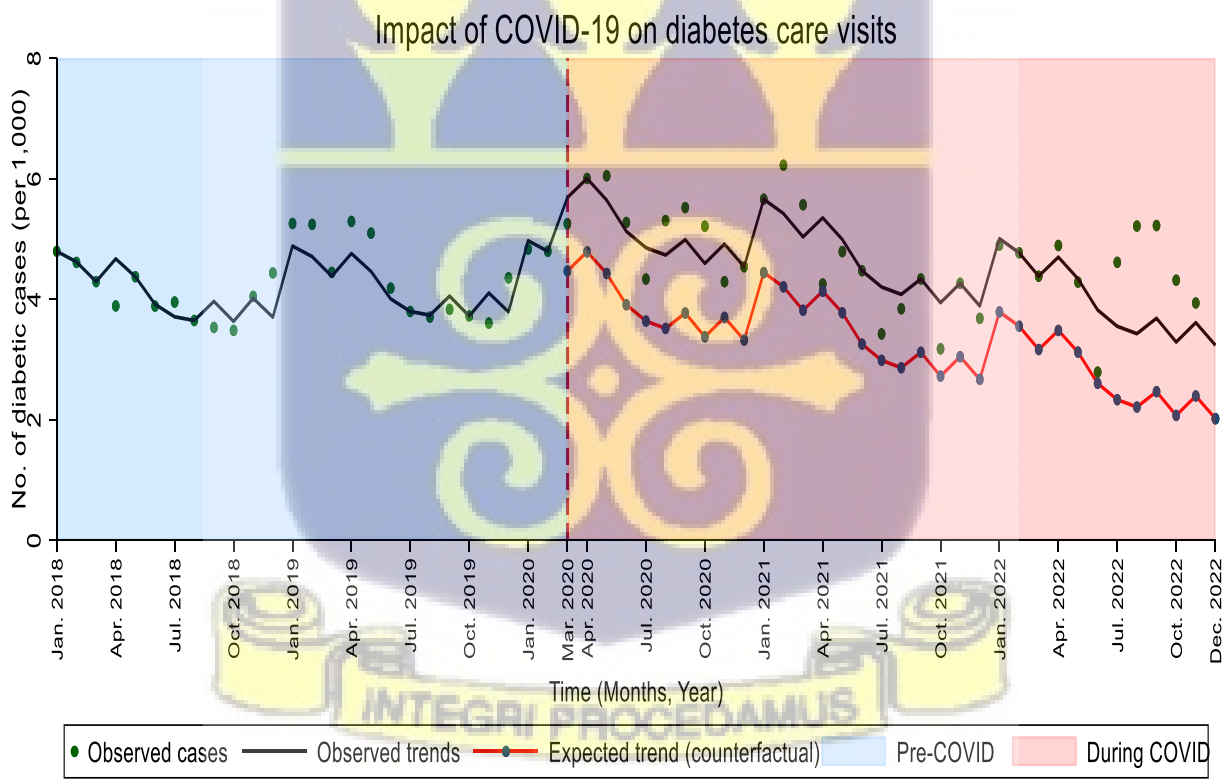

Figure 3: National estimate of the impact of COVID-19 on diabetes care visits

4.2.3 Immediate and Sustained Impact of COVID-19 on Hypertension care visits

In the first month of the pandemic, there appeared to be a statistically significant increase in hypertension care visits in the Ashanti region by 5.87% (p=0.005, CI=1.89, 9.86), Upper East region by 5.20% (p<0.001, CI=2.79, 7.62), Volta region by 10.35% (p=0.001, CI=4.28, 16.42) and Western region by 4.82% (p=0.007, CI=1.41, 8.23). Contrary to the aforementioned regions, the Central region observed a statistically significant decline of 11.84% (p<0.001, CI=-15.70, -7.98) in hypertension care visits. Bono region, Oti region, and Upper West region recorded a significantly increased sustained impact of 0.22% (p=0.001, CI=0.097, 0.35), 0.92% (p<0.001, CI=0.55, 1.30) and 0.13% (p=0.025, 0.017, 0.24) respectively. However, the North East region also had a significant sustained impact but it was rather a negative effect of 1.78% (p<0.001, CI=-2.23, -1.34) decline in hypertension care visits. Bono East and Greater Accra regions observed a positive significant immediate impact of 2.78% (p=0.041, CI=0.12, 5.45) and 12.41% (p=0.030, CI=1.26, 23.53) respectively of the pandemic on hypertension care visits. Additionally, the Bono East region also observed a positive significant sustained effect of 0.086% (p=0.268, CI=-0.068, 0.24) of the pandemic on hypertension care visits while the Greater Accra region recorded a significant decline of 1.11% (p=0.001, CI=-1.76, -0.47) in hypertension care visits due to the COVID-19 outbreak. There was a significant change in hypertension care visits within the first month of the pandemic at the national level as shown in and Table 8 and Fig 4 below.

Table 8: Impact of COVID-19 on Reported Hypertension Cases

Area	Hypertension			
	Immediate Impact [95% CI]	**P-value**	**Sustained Impact [95% CI]**	**P-value**
National	2.05 [0.29, 3.81]	**0.023**	0.054 [-0.048, 0.16]	0.293
Regions				
Ahafo	2.17 [-1.09, 5.43]	0.187	-0.34 [-0.52, -0.15]	**0.001**
Ashanti	5.87 [1.89, 9.86]	**0.005**	0.18 [-0.051, 0.41]	0.125
Bono	0.73 [-1.42, 2.88]	0.497	0.22 [0.097, 0.35]	**0.001**
Bono East	2.78 [0.12, 5.45]	**0.041**	0.086 [-0.068, 0.24]	**0.268**
Central	-11.84 [-15.70, -7.97]	**<0.001**	-0.18 [-0.42, 0.045]	0.114
Eastern	3.51 [-1.43, 8.45]	0.159	0.27 [-0.012, 0.56]	0.060
Greater Accra	12.41 [1.26, 23.55]	**0.030**	-1.11 [-1.76, -0.47]	**0.001**
North East	-4.10 [-11.82, 3.63]	0.291	-1.78 [-2.23, -1.34]	**<0.001**
Northern	-4.60 [-13.08, 3.89]	0.281	-0.15[-0.64, 0.34]	0.549
Oti	4.57 [-1.97, 11.10]	0.166	0.92 [0.55, 1.30]	**<0.001**
Savannah	3.50 [-1.56, 8.56]	0.171	-0.055 [-0.35, 0.24]	0.706
Upper East	5.20 [2.79, 7.62]	**<0.001**	0.12 [-0.021, 0.26]	0.094
Upper West	1.50 [-0.46, 3.46]	0.131	0.13 [0.017, 0.24	**0.025**
Volta	10.35 [4.28, 16.42]	**0.001**	-0.24 [- 0.59, 0.11]	0.173
Western	4.82 [1.41, 8.23]	**0.007**	-0.050 [-0.25, 0.15]	0.612
Western North	-2.21 [-5.38, 0.97]	0.168	-0.24 [-0.43, -0.060]	**0.01**
Regional Belt				
Northern Belt	2.39 [-3.71, 8.48]	0.441	-0.23 [-0.59, 0.12]	0.192
Middle Belt	3.56 [-1.39, 8.51]	0.159	0.26 [-0.022, 0.55]	0.071
Southern Belt	-4.28 [-12.48, 3.91]	0.304	-0.13 [-0.60, 0.34]	0.585

*Note: The immediate effect (regression coefficient for before and after COVID) was measured one month after the index case, whereas the sustained effect was recorded after one month (the coefficient of the interaction term between COVID and time trend). Any effect requires a significant regression coefficient. COVID's sustained and immediate effects require statistically significant regression coefficients. ***p<0.001, **p<0.01, *p<0.05. All models are adjusted for seasonality.34*

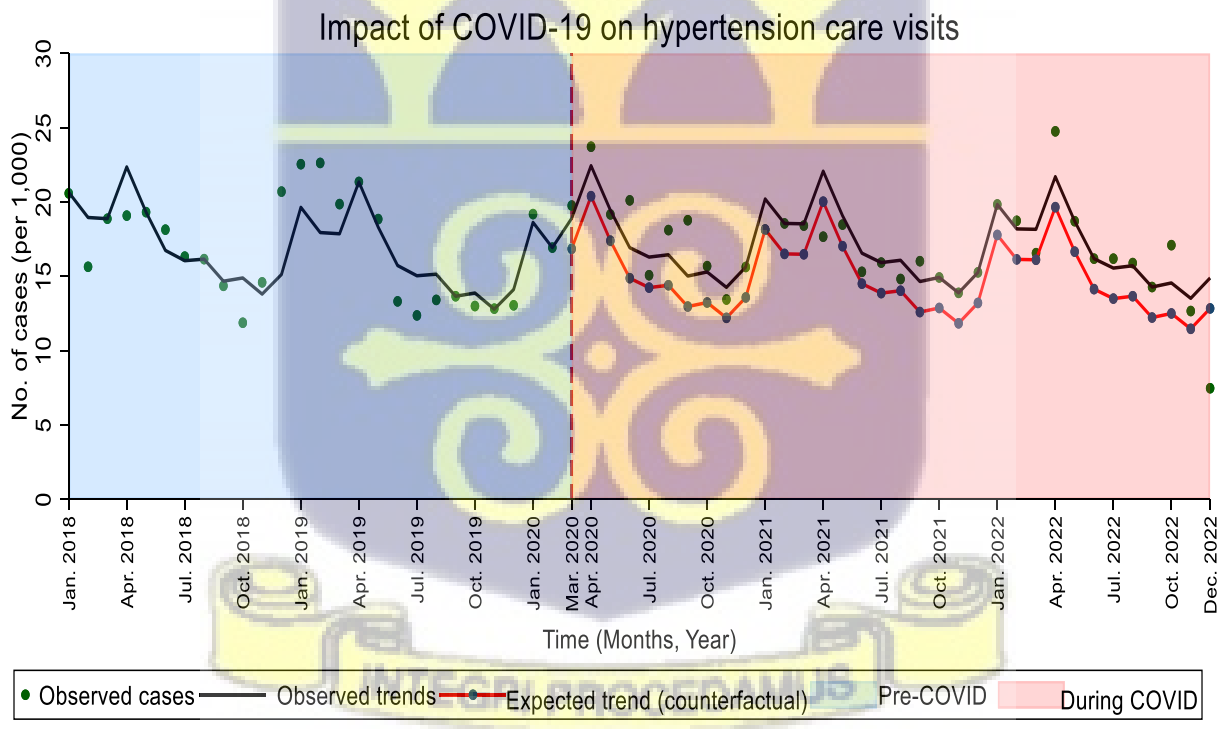

Figure 4: National estimate of the impact of COVID-19 on hypertension care visits

4.2.4 Immediate and Sustained Impact of COVID-19 on Stroke care visits

Stroke care visits were significantly affected nationally after the first month of the pandemic as shown in Fig 5 below. The Central region recorded the greatest significant reduction in stroke care visits by 146.78% ($p<0.001$, CI=-190.55, -103.01) within the first week of the pandemic. This was sustained at a statistically significant rate of 5.05% ($p<0.001$, CI=-7.57, -2.52) after the first week of the pandemic. Within the first week of the pandemic, Stroke care visits appeared to have also declined significantly in the Bono region by 27.86%, ($p=0.005$, CI=-47.00, -8.76), in the Eastern region by 32.80% ($p=0.009$, CI=-56.85, -8.75) and in the Upper West region by 5.70% ($p=0.028$, CI=-10.74, -0.66). Stroke care visits began to rise significantly at the rate of 0.64% ($p<0.001$, CI=0.35, 0.93) after one week of the COVID-19 pandemic in the Upper West region. The Northern region also observed a 9.29% ($p=0.019$, CI=1.62, 16.92) significant rise in stroke care visits just within the first week of the pandemic. Across the different regional belts, there was no reported significant immediate impact of the pandemic on stroke care visits. Also, all the regional belts experience some sustained changes in stroke care visits, but it was only the Southern belt that recorded a statistically significant sustained decline of 2.12% ($p=0.036$, CI=-4.10, -0.14) in stroke care visits. All results of stroke care visits are recorded in Table 9 below.

Table 9: Impact of COVID-19 on Reported Stroke Cases

Area	Stroke			
	Immediate Impact [95% CI]	**P-value**	**Sustained Impact [95% CI]**	**P-value**
National	-10.26 [-22.38, 1.92]	0.097	-1.05 [-1.75, -0.35]	**0.004**
Regions				
Ahafo	5.57 [-17.45, 28.59]	0.627	0.27 [-1.08, 1.63]	0.685
Ashanti	39.63 [6.54, 72.73]	0.020	0.084 [-1.83, 2.00]	0.929
Bono	-27.86 [-47.00, -8.76]	**0.005**	-0.971 [-2.075, 0.13]	0.083
Bono East	-18.17 [-61.05, 24.70]	0.398	-1.24 [-3.71, 1.24]	0.320
Central	-146.78 [-190.55, -103.01]	**<0.001**	-5.05 [-7.57, -2.52]	**<0.001**
Eastern	-32.80 [-56.85, -8.75]	**0.009**	0.65 [-0.74, 2.04]	0.353
Greater Accra	-16.00 [-68.69, 36.69]	0.544	-1.87 [-4.91, 1.17]	0.222
North East	6.76 [-34.66, 48.17]	0.742	0.27 [-1.94, 2.45]	0.804
Northern	9.29 [1.62, 16.96]	**0.019**	-0.15 [-0.60, 0.29]	0.490
Oti	-7.43 [-22.04, 7.18]	0.311	-0.49 [-1.34, 0.35]	0.246
Savannah	1.34 [-20.87, 23.54]	0.903	0.43 [-0.82, 1.67]	0.49
Upper East	-16.44 [-33.38, 0.50]	0.057	-0.31 [-1.29, 0.66]	0.521
Upper West	-5.70 [-10.74, -0.66]	**0.028**	0.64 [0.35, 0.93]	**<0.001**
Volta	15.56 [-7.80, 38.93]	0.186	-0.96 [-2.31, 0.39]	0.157
Western	2.10 [-18.70, 22.90]	0.840	0.10 [-1.10, 1.30]	0.867
Western North	-10.15 [-32.68, 12.39]	0.369	0.35 [-0.95, 1.65]	0.59
Regional Belt				
Northern Belt	0.63 [-4.16, 5.42]	0.796	0.21 [-0.062, 0.49]	0.130
Middle Belt	-30.47 [-64.62, 3.69]	0.080	-2.12 [-4.10, -0.14]	**0.036**
Southern Belt	-29.71 [-82.69, 23.27]	0.271	-2.75 [-5.81, 0.31]	0.078

*Note: The immediate effect (regression coefficient for before and after COVID) was measured one month after the index case, whereas the sustained effect was recorded after one month (the coefficient of the interaction term between COVID and time trend). Any effect requires a significant regression coefficient. COVID's sustained and immediate effects require statistically significant regression coefficients. ***p<0.001, **p<0.01, *p<0.05. All models are adjusted for seasonality.*

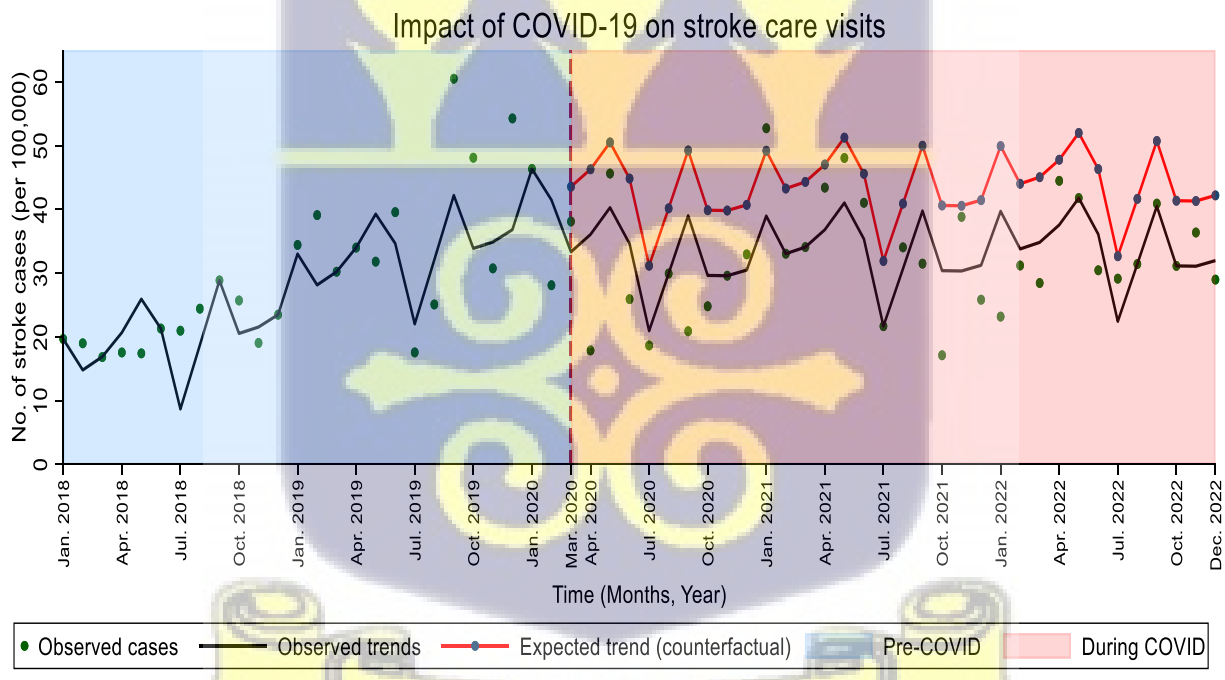

Figure 5: National estimate of the impact of COVID-19 on stroke care visits

From Table 10, only asthma cases reported at the OPD in the Ahafo region decreased significantly by 17% (p=0.029, CI=0.71, 0.98) during the pandemic. For the Ashanti region, only stroke cases

reported at the OPD increased significantly by 46% (p<0.001, 1.35, 1.76) during the pandemic. In the Bono Region, both hypertension and diabetes cases reported at the OPD increased significantly by 43% (p<0.001, CI=1.35, 1.82) and 33% (p<0.001 CI=1.35, 2.07). In the Bono East Region, it was only asthma cases reported at the OPD increased significantly by 72% (p=0.001, CI=1.11, 1.48). In the central region, all the NCD outcome variables reporting at the OPD reduced significantly during COVID-19, with stroke cases being the most reduced, 45% (p<0.001, CI=0.47, 0.64). Hypertension cases reported at the OPD reduced significantly by 33% (p=0.032, CI=0.97, 1.42) in Eastern Region during the pandemic. Stroke care cases reported at the OPD increased significantly by 29% (p<0.001, CI=1.33, 2.21). Asthma cases at the OPD increased significantly in Upper West, Western, and, Western North regions. The Upper West region recorded the highest cases (over 100%, p=0.002, 1.30, 3.16). Hypertension cases recorded at the OPD decreased significantly during the pandemic in the Northern, Savannah, and Volta regions. The Northern region recorded the highest decline of 45% (p<0.001, CI=0.47, 0.65). The Western and Western North regions, however, observed significant increases in hypertension cases reported at the OPD. In the Oti and the Volta regions, diabetes cases reported at the OPD reduced significantly while in the Western and Western North regions, diabetes cases increased significantly. Asthma cases reported at the OPDs in the Northern, Savannah, Upper West, and Volta regions reduced significantly while in the Western it increased significantly. Across the three regional belts, stroke cases increased significantly in the middle belt. Hypertension cases decreased significantly in the Northern Belt. Asthma, cases reduced significantly in the Northern belt.

Table 10: Incidence of reported health outcomes at the health facilities before and after covid.

Area	Stroke		Hypertension		Diabetes		Asthma	
	IRR [95% CI]	**P-value**	**IRR [95% CI]**	**P-value**	**IRR [95% CI]**	**P-value**	**IRR [95% CI]**	**P-value**
National	1.13 [1.00, 1.28}	**0.049**	0.99 [0.90, 1.08]	0.745	1.10 [0.99, 1.22]	0.081	0.96 [0.88, 1.04]	0.354
Regions								
Ahafo	0.70 [0.31, 1.58]	0.396	0.98 [0.85, 1.13]	0.819	1.04 [0.81, 1.35]	0.744	0.83 [0.71, 0.98]	**0.029**
Ashanti	1.54 [1.35, 1.76]	**<0.001**	1.03 [0.94, 1.12]	0.543	1.09 [0.99, 1.19]	0.072	0.99 [0.91, 1.08]	0.808
Bono	1.10 [0.81, 1.49]	0.542	1.57 [1.35, 1.82]	**<0.001**	1.67 [1.35, 2.07]	**<0.001**	1.25 [0.94, 1.65]	0.121
Bono East	0.64 [0.34, 1.18]	0.154	1.10 [0.99, 1.23]	0.067	0.93 [0.81, 1.05]	0.245	1.28 [1.11, 1.48]	**0.001**
Central	0.55 [0.47, 0.64]	**<0.001**	0.82 [0.75, 0.91]	**<0.001**	0.66 [0.59, 0.73]	**<0.001**	0.66 [0.59, 0.75]	**<0.001**
Eastern	1.07 [0.91, 1.27]	0.404	1.20 [1.02, 1.43]	**0.032**	1.67 [0.97, 1.42]	0.109	0.86 [0.74, 1.02]	0.076
Greater Accra	1.71 [1.33, 2.21]	**<0.001**	0.98 [0.91, 1.06]	0.632	1.19 [1.11, 1.28]	**<0.001**	1.08 [0.92, 1.26]	0.340
North East	1.07 [0.32, 3.55	0.916	0.82 [0.63, 1.07]	0.145	0.80 [0.52,1.23]	0.303	0.78 [0.57, 1.07]	0.123
Northern	1.28 [0.71, 2.32]	0.413	0.55 [0.47, 0.65]	**<0.001**	0.92 [0.79, 1.08]	0.294	0.89 [0.79, 0.97]	**0.011**
Oti	0.89 [0.53, 1.50]	0.656	0.84 [0.67, 1.05]	0.123	0.80 [0.65, 0.99]	**0.042**	0.93 [0.81, 1.06]	0.265
Savannah	0.67 [0.25, 1.76	0.411	0.74 [0.61, 0.91]	**0.004**	0.81 [0.58, 1.15]	0.239	0.84 [0.74, 0.95]	**0.005**
Upper East	0.97 [0.63, 1.49]	0.900	0.95 [0.79, 1.15]	0.615	1.00 [0.81, 1.22]	0.965	0.97 [0.82, 1.14]	0.693
Upper West	2.03 [1.30, 3.16]	**0.002**	0.87 [0.75, 1.01]	0.066	1.22 [1.00, 1.49]	**0.049**	0.77 [0.65, 0.92]	**0.003**
Volta	0.92 [0.79, 1.08]	0.325	0.71 [0.61, 0.83]	**<0.001**	0.82 [0.69, 0.97]	**0.018**	0.82 [0.7, 0.92]	**0.001**
Western	1.55 [1.15, 2.09]	**0.004**	1.42 [1.30, 1.57]	**<0.001**	1.50 [1.34, 1.69]	**<0.001**	1.14 [1.04, 1.25]	**0.007**
Western North	1.56 [1.04, 2.37]	**0.034**	1.55 [1.27, 1.89]	**<0.001**	1.84 [1.51, 2.24]	**<0.001**	1.06 [0.89, 1.23]	0.501
Regional Belt								
Northern Belt	1.18 [0.90, 1.56]	0.236	0.74 [0.63, 0.87]	**<0.001**	0.96 [0.79, 1.16]	0.677	0.88 [0.82, 0.97]	**0.007**
Middle Belt	1.18 [1.031.35]	**0.018**	1.11 [0.99, 1.23]	0.070	1.23 [0.99, 1.28]	0.075	0.99 [0.89, 1.10]	0.821
Southern Belt	1.08 [0.90, 1.30]	0.398	1.00 [0.86, 1.15]	0.949	1.11 [0.95, 1.29]	0.199	0.96 [0.83, 1.11]	0.597

Note: all models are adjusted for seasonality.

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This study measured both the immediate and sustained impacts of COVID-19 on patients with Non-Communicable Diseases (NCDs) visiting healthcare centers in Ghana. From our findings, COVID-19 pandemic had no significant immediate and sustained impact on NCD care visits nationally, except for diabetes cares visits and hypertension care visits. For diabetes care visits, the pandemic had both significant immediate and sustained impact nationally. For the immediate impact, there was a significant increase in the utilization of diabetes care services during the COVID-19 period compared to the period before COVID-19, while for the sustained impact, there is a statistically significant decrease in diabetes care visits during the COVID-19 period compared to the period before COVID-19. For hypertension care visits, the pandemic had only a significant immediate impact, such that during the COVID-19 period, there was a significant increase in the utilization of hypertension care services compared to the period before COVID-19. Across the sixteen administrative regions, the pandemic affected NCD care visits differently. The COVID-19 pandemic had significant immediate and/or sustained effect on NCD care visits in some regions while in other regions there was no significant effects.

5.2 Discussion of NCDs Patients' Health Care Visits Results for Pre and Post COVID-19

5.2.1 Impact of COVID-19 on Asthmatic Patients' Healthcare Visits in Ghana

The results presented in Table 1 suggest that the COVID-19 pandemic significantly impacted asthma care visits in Ghana. Specifically, the Central region had the highest decline in asthma care visits, followed by the Eastern and Volta regions. These findings are consistent with studies that

have reported a decrease in non-communicable disease care visits during the COVID-19 pandemic (Baatiema *et al*., 2023). The decline in asthma care visits in these regions could be attributed to the measures put in place to contain the spread of the virus, such as lockdowns, travel restrictions, and reduced healthcare facility hours, which may have made it difficult for patients to access care.

Furthermore, the results show that the Bono region reported a significant rise in asthma care visits after the pandemic. This finding is inconsistent with studies that have reported a decline in non-communicable disease care visits during the pandemic. The increase in asthma care visits in the Bono region could be attributed to several factors, such as increased awareness of the importance of asthma care and improved accessibility to healthcare services. Further research is needed to investigate the underlying reasons for this increase in asthma care visits in the Bono region.

Additionally, the Northern Belt reported a significant decline in asthma care visits after the pandemic. The decline in asthma care visits in this region could be attributed to various factors, including reduced healthcare facility hours, travel restrictions, and limited access to transportation or geographical distance. This is in tandem with the study of Ashigbie *et al.*, (2020) which states that people living with NCDs face several barriers to accessing better NCD care, and the covid-19 may have exacerbated the situation. Findings from the World Health Organization surveys highlighted geographical access to NCD care as a key undermining factor to continuity of care and called for action to address this (World Health Organization [WHO], 2021).

The results of this study suggest that the COVID-19 pandemic has had a significant impact on asthma care visits in Ghana, with some regions reporting a decline in care visits while others reported an increase. The findings are consistent with previous studies that have reported a decrease in non-communicable disease care visits during the pandemic (Baatiema *et al*., 2023). Further research is needed to investigate the underlying reasons for the differences in asthma care

visits across regions and to identify potential interventions that could mitigate the impact of the pandemic on non-communicable disease care visits in Ghana.

5.2.2 Impact of COVID-19 on Diabetic Patients' Healthcare Visits in Ghana

The results from the study on the impact of the COVID-19 pandemic on diabetes care visits in Ghana revealed that there was a significant decline in diabetes care visits in some regions, while others reported a significant increase. The Central region recorded the highest decline in diabetes care visits, which was statistically significant. This finding is consistent with a study by Tagoe *et al*., (2023), which reported that the lockdown and the closure of diabetes clinics during the pandemic contributed greatly to the reduced availability of diabetes services, leading to a decline in diabetes care visits. This finding also corresponds to some other studies around the world (Hartmann-Boyce, 2020).

On the other hand, the Greater Accra region recorded the highest increase in diabetes care visits after the pandemic, which was also statistically significant. This result suggests that some people with diabetes may have sought care more frequently during the pandemic. This finding is consistent with a study by Pal and Bhadada (2021), which reported that the COVID-19 pandemic had increased awareness among people with diabetes about the importance of seeking regular care.

It is worth noting that the Ashanti, Bono, Western, and Western North regions also reported a significant increase in diabetes care visits after the pandemic. These findings suggest that efforts by healthcare providers and policymakers to ensure continuity of care during the pandemic may have been successful in some regions. This finding is consistent with a study by Baatiema *et al*.,

2022), which reported that implementing telehealth services (such as telemedicine) was associated with an increase in diabetes care visits during the pandemic.

Overall, the findings suggest that the COVID-19 pandemic had a mixed impact on diabetes care visits in Ghana, with some regions experiencing a decline while others reported an increase. The results confirm previous studies that have reported a decline in diabetes care visits during the pandemic. The findings also suggest that efforts to ensure continuity of care during the pandemic, such as implementing telehealth services, may have been successful in some regions. Nevertheless, more studies are needed to understand the reasons for the regional differences in the impact of the pandemic on diabetes care visits.

5.2.3 Impact of COVID-19 on Hypertension Patients Care Visits in Ghana

The results of the study indicate a significant decrease in non-communicable disease care visits in several regions of Ghana after the COVID-19 pandemic. Specifically, the Central, Eastern, and Volta regions reported the highest declines in asthma care visits. Similarly, the Central and Volta regions also had the highest declines in diabetes care visits. The Northern region had the highest decline in hypertension care visits. These findings suggest that the COVID-19 pandemic has had a significant impact on non-communicable disease care visits in Ghana, and this could have serious implications for the management of these diseases. This is consistent with the finding of Mekonnen *et al.*, (2022), where a significant statistical relationship was found between a reduction in the number of visits to non-communicable disease (NCD) management services in an outpatient setting.

Several studies have reported similar findings to the results of this study. For instance, a study conducted by Shibata *et al* (2020) found that the COVID-19 pandemic had a significant impact on non-communicable disease care visits, with a decrease in visits for hypertension, diabetes, and cardiovascular diseases. The reason was that people living with NCDs have had difficulties accessing high-quality health care during the pandemic This decrease in care visits could lead to an increase in disease-related complications, including hospitalizations and mortality.

Another study conducted in the United States found that the COVID-19 pandemic had a significant impact on the utilization of healthcare services, including a decrease in preventive care visits, such as hypertension, diabetes, cancer, and cardiovascular diseases (Baatiema *et al*., 2023). This decrease in preventive care visits could lead to an increase in disease-related complications, as early detection and prevention are critical for effective disease management.

However, some regions in Ghana recorded significant rises in hypertension care visits after the pandemic. For example, the Western region, Ashanti region, and Bono region had the highest rise in hypertension, with the Western region being the highest in hypertension care visits. This finding could suggest that some regions in Ghana may have implemented effective strategies to mitigate the impact of the pandemic on non-communicable disease care visits.

To sum up, the COVID-19 pandemic has had a significant impact on non-communicable disease care visits in Ghana, with several regions reporting significant declines in care visits for asthma, diabetes, and hypertension. These findings suggest that there is a need for urgent interventions to mitigate the impact of the pandemic on non-communicable disease management in Ghana. Health policymakers and stakeholders should prioritize the development and implementation of effective strategies to improve access to non-communicable disease care services, especially in the regions that recorded significant declines in care visits after the pandemic.

5.2.4 Impact of COVID-19 on Stroke Patients Care Visits in Ghana

The findings from this study suggest that the COVID-19 pandemic has significantly impacted stroke care visits in Ghana, with some regions experiencing an increase in visits while others have experienced a decline. The regions with the highest increase in stroke care visits after the pandemic were the Ashanti and Greater Accra regions, which are two of the most populous regions in Ghana. This increase may be attributed to the higher population density and better health infrastructure in these regions, as well as the increased awareness of stroke symptoms and the need for prompt treatment. A study conducted in Thailand by Songsermpong *et al.*, (2021) revealed that the presence of a robust primary healthcare system, a team of community health volunteers (CHVs), and a well-established infrastructure formed the basis for an inventive initiative aimed at preserving crucial non-communicable disease (NCD) services.

However, the Central region recorded the highest significant decline in stroke care visits after the pandemic, which could be attributed to the region's relatively lower population density, limited health infrastructure, and reduced access to transportation due to lockdown restrictions. The decline in stroke care visits in the Volta and Savannah regions could also be due to limited access to healthcare services, including stroke care, during the pandemic.

The increase in stroke care visits in the Northern Belt after the pandemic suggests that efforts to improve stroke care and awareness in this region may have been successful. The findings from this study are consistent with previous studies that have shown that the COVID-19 pandemic has had a significant impact on healthcare services, including stroke care, globally. For instance, a study conducted in the United States found that the COVID-19 pandemic led to a significant reduction in stroke admissions to hospitals (Fridman *et al*., 2020).

In nutshell, this study provides valuable insights into the effect of the COVID-19 pandemic on stroke care visits in Ghana. The findings suggest that the pandemic has had a significant impact on stroke care visits in different regions of the country, with some regions experiencing an increase in visits while others have experienced a decline. These findings highlight the need for policymakers to develop and implement strategies that ensure equitable access to healthcare services, including stroke care, during pandemics and other emergencies. Further study will be required as well to investigate the reasons for the findings of this study.

5.3 Immediate and Sustained Impact of COVID-19 on NCDs Patients' Health Care Visit

5.3.1 Immediate and Sustained Impact of COVID-19 on Asthma Care Visit

The results presented in this study suggest that the COVID-19 pandemic did not have a significant impact on asthma care visits in Ghana, as seen in Table 5 and Figure 2. The findings reveal that although there was a small reduction in asthma care visits in the first month of the COVID-19 outbreak, this change was not significant. Also, the sustained impact of the pandemic on asthma care visits was not significant. This finding is consistent with some studies conducted worldwide which reported no significant impact of the COVID-19 pandemic on NCD care visits. Contrarily, a study published in the Journal of General International Medicine discovered that routine care visits for non-communicable diseases such as asthma, reduced significantly in the United States during the COVID-19 pandemic. Also, a study conducted by Gates *et al*., (2023) in the US recorded that asthma care visits to the emergency department decreased by 31% on March 15, 2020, 19% in 2021, and 26% in 2022, compared with the pre-COVID-19 era. Another study conducted by de Boer *et al*, (2021), reported that asthmatic patients are more likely to avoid or delay necessary medical visits due to concerns about the risk of contracting SARS-CoV-2 at healthcare facilities. Although there are limited studies that evaluated the impact of COVID-19 on

asthma care visits, a study published in the Ghana medical journal also reported a decrease in hospital outpatient visits for all NCDs. The number of NCD patients admitted during the early months of the COVID-19 ons*et al*so decreased according to the study. These observations, which are contrary to the findings of our study might be due to reduced access to health facilities, and the fear of contracting COVID-19, among many others. However, it is worth noting that there is a limited number of studies investigating the impact of COVID-19 on asthma care visits in Ghana. Also, future research could explore the reasons behind the insignificant impact of COVID-19 on asthma care visits nationally, as observed in this study.

However, the results show that some administrative regions experienced significant changes in asthma care visits. For example, the North East region, the Savannah region, and the Northern region had significant immediate and sustained reductions in asthma care visits, while the Greater Accra region had a significant sustained increase in asthma care visits. These findings highlight the need for targeted interventions to ensure that all regions have equitable access to asthma care, particularly during the COVID-19 pandemic. Additionally, the insignificant changes observed in most regions could be attributed to the measures put in place to mitigate the spread of COVID-19 in healthcare facilities, such as the use of telemedicine and appointment scheduling. However further studies can also be done to ascertain and confirm why the impact was insignificant in these regions.

The results of this study suggest that the COVID-19 pandemic did not have a significant impact on asthma care visits in Ghana as a whole. However, some administrative regions experienced significant changes in asthma care visits, highlighting the need for targeted interventions to ensure equitable access to asthma care. The study's findings align with the WHO (2021) report that

emphasizes the importance of maintaining essential health services during the COVID-19 pandemic.

5.3.2 Immediate and Sustained Impact of COVID-19 on Diabetes Care Visit

As seen in Table 6 and Figure 3, the COVID-19 pandemic had both immediate and sustained impacts on diabetes nationally. From our findings, diabetes care visits increased significantly within the first month that the index case of COVID-19 was recorded. This increased visit within the first month might be due to the awareness created about diabetes patients being at high risk of contracting COVID-19, and also the fear of having serious complications as a diabetic patient. According to Hartmann-Boyce *et al.*, (2020), diabetes patients seem to be more susceptible to experiencing more severe cases of COVID-19, but the extent of this risk is uncertain due to the limited available evidence. Interestingly, the care visits began to decrease significantly after the first month of the index of COVID-19 cases in Ghana. This can be due to some non-pharmaceutical measures put in place during COVID-19 to curb if not eliminate the spread of the virus. These results are consistent with previous studies that have shown a reduction in the number of patients seeking care for chronic conditions during the pandemic (Golin *et al.*, 2020; Mehrotra *et al.*, 2020). According to the respondents from a study by Tagoe *et al.*, (2023), the pandemic-induced lockdown and the consequent shutdown of diabetes clinics resulted in a substantial decrease in the availability of diabetes-related facilities. Additionally, the interviewees added that, due to the lack of enough trained health professionals, the rise in COVID-19 cases caused the limited number of skilled diabetes service providers to shift their focus toward treating COVID-19 patients. They also mentioned that to prevent overcrowding in clinics and mitigate the risk of higher COVID-19 infection rates, healthcare providers have decreased the number of patients scheduled per clinic day and increased the time between prescription review appointments from one month to

approximately three months. These could be some of the reasons for the observed significant sustained decline in diabetes care visits nationally, and they are consistent with the findings of Hartmann-Boyce *et al.*, (2020). The significant decline in diabetes care visits in the central region is consistent with a study by Pimouguet *et al.* (2016), which found that patients in rural areas have less access to healthcare facilities and are less likely to receive regular care for chronic conditions. This may explain why the central region, which is predominantly rural, had a significant decline in diabetes care visits.

On the other hand, the significant increase in diabetes care visits in the Greater Accra region and Western region may be due to the availability of better healthcare facilities and resources in urban areas, as shown in a study by Oladepo *et al*. (2017). However, the lack of sustained impact in these regions suggests that patients may have initially sought care but subsequently discontinued due to the pandemic's ongoing effects.

The sustained decline in diabetes care visits in the Northern belt, Ahafo, and North East regions could be attributed to the pandemic's impact on the economy, making it difficult for patients to afford care or access healthcare facilities. This finding is consistent with previous research that has shown a link between economic factors and healthcare utilization (Brandli *et al*., 2020).

Overall, the findings highlight the need for healthcare policymakers to implement strategies to maintain the provision of care for patients with chronic conditions during pandemics. These strategies could include telemedicine services, home visits by healthcare workers, and increased outreach efforts to ensure patients are aware of available resources for care.

5.3.3 Immediate and Sustained Impact of COVID-19 on Hypertension Care Visit

From Table 7 and Figure 4, the number of hypertensive patients visiting healthcare centers increased significantly within the first of COVID-19 onset nationally. The finding of our study is contrary to one study conducted by Rhatomy *et al.,* (2022) in Indonesia where patients with hypertension rather showed an undesirable significant reduction in healthcare visits during the early weeks of the COVID-19 pandemic. However, there was no statistically significant impact on the number of hypertension patients visiting healthcare centers after the first of the index COVID-19 cases in Ghana. Lee *et al.,* (2022), reported a similar outcome in a study they conducted in Korea where COVID-19 did not have any significant impact on the continuity of care (COC) among hypertension patients.

At the regional level, some regions showed immediate and sustained impacts, while others only showed sustained impacts and others showed no significant impact. The Bono East and Greater Accra regions had both a statistically significant immediate and sustained impact on hypertension patients' health care visits. This finding suggests that the COVID-19 pandemic had a long-lasting effect on the healthcare visits of hypertension patients in these regions. The sustained impact in these regions may be due to the continued fear of contracting COVID-19 and a reluctance to seek medical care. Moreover, these regions are densely populated, which may have increased the risk of contracting COVID-19.

In contrast, regions such as Ahafo, Bono, Oti, and Upper West did not observe a statistically significant immediate impact but recorded a statistically significant sustained impact. This result implies that the initial shock of the pandemic did not affect hypertension patients' healthcare visits in these regions, but the sustained impact might be due to the lingering fear and uncertainty associated with the pandemic. Conversely, regions like Ashanti, Central, Upper East, Volta, and

Western observed statistically significant immediate impact but no significant impact on the sustained period. This finding suggests that the initial shock of the pandemic affected hypertension patients' healthcare visits, but the effect was not sustained in these regions. The reason for this may be that these regions had better preparedness and response strategies in place to mitigate the impact of the pandemic on healthcare services. It is noteworthy that some regions did not observe any significant immediate or sustained impact. This finding may be due to several factors such as the lower number of reported COVID-19 cases in these regions, better healthcare infrastructure, and a higher level of health literacy among the population.

These findings are consistent with previous studies that have shown the impact of pandemics on the management of non-communicable diseases. One study found that the COVID-19 pandemic has affected the delivery of hypertension care services in low- and middle-income countries, resulting in decreased access to essential medicines, reduced visits to healthcare providers, and disrupted care continuity (Baatiema *et al*., 2023). Similarly, a study in China found that the pandemic has led to a decrease in hypertension management, particularly for patients with poor blood pressure control (Hu *et al*., 2020).

On the other hand, the observed increased hypertension care visits in some regions of Ghana during the pandemic could be attributed to heightened awareness of the importance of managing non-communicable diseases during the pandemic, as well as increased availability of virtual healthcare services. Some studies have highlighted the potential benefits of telemedicine in managing non-communicable diseases during pandemics, particularly in improving access to care for vulnerable populations (Nouri *et al*., 2020).

In conclusion, the study's results suggest a significant change in hypertension care visits in Ghana during the first month of the COVID-19 pandemic. While some regions experienced an increase

in hypertension care visits, others experienced a decline. The findings highlight the need for targeted interventions to improve access to hypertension care services during pandemics, particularly for vulnerable populations. Additionally, the study underscores the potential benefits of virtual healthcare services in managing non-communicable diseases, such as hypertension during pandemics.

5.3.4 Immediate and Sustained Impact of COVID-19 on Stroke Patients Health Care Visit

According to this study, the COVID-19 pandemic did not have any significant immediate effect on stroke care visits nationally. However, there was a significant sustained decline in the number of stroke patients visiting healthcare centers during COVID-19 as seen in Table 8 and Figure 5. This might be due to the prolonged COVID-19 period, leading to reduced capacity of our healthcare systems and limited resources for treating non-COVID-19 conditions like stroke.

This is quite similar to a study conducted by Wosik *et al.*, (2021) in the United States which documented that during the initial 15 weeks of the COVID-19 pandemic, the number of cardiovascular visits recorded by the Duke University healthcare system decreased by 33.1%. On the contrary, a research study conducted in the United States by Pines *et al.* (2021) found that there was a significant decrease of 64% in visits for ischemic stroke care during the initial phase of the COVID-19 pandemic, which was followed by a gradual increase in the subsequent months

At the regional level, there were variations in the impact of COVID on stroke patient visits. For instance, the Central and Upper West region recorded a statistically significant immediate and sustained impact of COVID on stroke patients, which may be due to the high burden of stroke cases in the region and the disruptions caused by the pandemic on the health care system. There was a statistically significant immediate impact of COVID-19 on stroke patients' healthcare visits

observed in the Bono, Eastern, and Northern regions, but the sustained impact was not significant. This result may be due to various reasons, such as the successful implementation of preventive measures in these regions, the availability of telemedicine services, or other factors that prevented the long-term effects of the pandemic on stroke patients' healthcare visits. Further research may be necessary to identify the underlying factors contributing to these results. The immediate and sustained impact of stroke patients' healthcare visits in most regions (Greater Accra, Ahafo, Ashanti, Oti, Savannah, Upper East, Upper West, Western, and Western North) was not statistically significant. This observation can be a result of several factors such as the nature of stroke as a chronic condition that requires regular medical attention, the availability and accessibility of healthcare facilities, and the patient's ability to afford medical care.

The Central region experienced the greatest significant reduction in stroke care visits by 146.78% within the first week of the pandemic, and this was sustained at a statistically significant rate of 5.05% after the first week of the pandemic. The high burden of COVID-19 cases and the resulting strain on the healthcare system may have contributed to the observed reduction in stroke patients' visits in the Central region. Stroke care visits also began to reduce significantly in the Upper West region. However, after one month of the pandemic, stroke care visits began to rise significantly in the Upper West region. The Northern region also observed a significant rise in stroke care visits just within the first month of the pandemic. Across the different regional belts, there was no reported significant immediate impact of the pandemic on stroke care visits. The outcomes show mixed evidence of COVID-19 pandemic increasing or decreasing the number of stroke patients visiting healthcare centers. This is consistent with the study of Pines *et al.* (2021), where they found mixed evidence on whether Acute ST-segment elevation myocardial infarction (STEMI), an uncommon occurrence that arises from acute ischemic stroke (AIS) visits decreased or

increased during the COVID-19 pandemic. Also, all the regional belts experience some sustained changes in stroke care visits, but it was only the Southern belt that recorded a statistically significant sustained decline in stroke care visits, as seen in Table 8. It is also important to note that the impact of COVID-19 on stroke patients' healthcare visits may have been influenced by various public health interventions implemented in response to the pandemic, such as lockdowns, travel restrictions, and social distancing measures. These interventions may have made it difficult for stroke patients to access healthcare facilities, especially in regions with limited healthcare infrastructure. Further research will be helpful to appreciate the reasons for this study's observations.

5.4 Implications of Finding with regards to Health Services Provision and Research

The conclusion that the pandemic had no appreciable immediate and sustained effect on the number of NCD care visits nationwide (except for hypertension and diabetes) suggests that Ghana's healthcare system as a whole responded well. It appears from this that health services for some NCDs have stayed largely stable, which is good news for patient care. This finding could prompt additional investigation into the reasons for the greater prevalence of some NCDs during the pandemic, such as diabetes and hypertension, compared to others. Investigating the particular measures that helped keep NCD care services unaffected would also be necessary. The significant rise in diabetes care visits that occurred during the COVID-19 pandemic indicates that the measures made to accommodate and manage diabetic patients during the pandemic were effective. The persistent decline, however, suggests that continuous care strategies require enhancement. In order to find strategies that can support patient care in comparable situations, future research should investigate the causes of the decline in sustained diabetic care visits during the pandemic.

The significant rise in care visits for hypertension during the COVID-19 pandemic indicates that health facilities were responsive to patients' urgent needs. It's essential to maintain this adaptability for future crises. Studies may concentrate on identifying the causes of the rise in care visits for hypertension and if comparable adjustments can be used for other non-communicable diseases or for upcoming medical emergencies.

The regional differences emphasise the necessity to address each region differently to identify the reason for the various observations across the different regions. During times of crisis, areas that were severely affected would need more help and resources to support healthcare services. Subsequent studies should investigate the reasons for the greater impact in some areas and if the healthcare system, the local population, or other variables contributed to the varying effects.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

According to this study, it can be concluded that the COVID-19 pandemic did not have a significant immediate or sustained impact on asthma care visits in Ghana. The results also showed that all regions experienced some level of change in asthma care visits, although most were insignificant. Some regions experienced a significant impact, both immediately and sustained, while others had only immediate impacts. In conclusion, this study highlights that the healthcare system in Ghana was able to maintain asthma care visits during the COVID-19 pandemic

Secondly, the COVID-19 pandemic had both an immediate and sustained impact on diabetes care visits in Ghana. The central region experienced a significant decline in diabetes care visits, while the eastern region had a significant increase in both immediate and sustained care visits. The northern belt was the only region with a sustained decline in diabetes care visits. While some regions experienced an immediate increase in diabetes care visits, there was no significant sustained impact in these regions. These findings suggest that the COVID-19 pandemic has significantly disrupted diabetes care visits in Ghana, and further research is needed to explore the reasons for the varied impacts observed across the different regions.

Additionally, the pandemic had both immediate and sustained effects on hypertension care visits in different regions of Ghana. In the first month of the pandemic, there was a statistically significant increase in hypertension care visits in the Ashanti, Upper East, Volta, and Western regions, while the Central region observed a significant decline in hypertension care visits. In the sustained period, the Bono, Oti, and Upper West regions recorded a significant increase in

hypertension care visits, while the North East region had a significant decline in hypertension care visits.

Lastly, it can be concluded that the COVID-19 pandemic had a significant and sustained impact on stroke care visits in Ghana. The Central region was the most affected region with a significant reduction in stroke care visits both in the immediate and sustained period. Other regions such as the Bono, Eastern, and Upper West also experienced significant declines in stroke care visits in the immediate period. However, the Upper West and Northern regions recorded significant rises in stroke care visits after the first week of the pandemic. Across the different regional belts, there was no reported significant immediate impact of the pandemic on stroke care visits. However, the Southern belt recorded a statistically significant sustained decline in stroke care visits.

From other literature, the fear of contracting COVID-19, redeployment of healthcare providers, and transport restrictions among others were some identified reasons for the observed impacts.

The findings underscore the need for policymakers and health practitioners to prioritize NCD care during pandemics and develop innovative strategies to mitigate the impact. The study also contributes to the literature on the impact of pandemics on routine health services in low- and middle-income countries, emphasizing the importance of strengthening the resilience of healthcare systems to ensure the provision of uninterrupted NCD care services during pandemics.

6.2 Recommendations

Based on the results of this study, the following recommendations could be considered:

3. The Ghana Ministry of Health (MOH) should develop targeted interventions to address the observed sustained decline in stroke care visits in Ghana during the COVID-19 pandemic.

These interventions could involve implementing public awareness campaigns to increase awareness of the signs and symptoms of stroke, including the importance of seeking care promptly and exploring strategies to improve access to stroke care services, even during pandemics.

4. The National Diabetes Association (NDA) Ghana should strengthen efforts to maintain or improve access to diabetes care during the pandemic, particularly in light of the significantly sustained impact of the COVID-19 pandemic on diabetes care visits observed in this study. These efforts could include developing remote care options, such as telemedicine or home-based care, and ensuring that essential medications and supplies are available.
5. The Ghana health Service (GHS) should also explore the factors that may have contributed to the sustained increase in hypertension care visits during the first month of the pandemic in Ghana to identify strategies to maintain or improve access to care over the longer term.
6. Conduct further research to investigate the reasons for the sudden decrease in diabetes care visits following the immediate impact of the COVID-19 pandemic in Ghana. This research could involve surveying patients and healthcare providers to understand the barriers to care and identify potential solutions. The GHS and NDA could do this collaboratively.
7. The Ministry of Health and Ghana Health Service could consider the potential role of digital health interventions, such as telemedicine and mobile health applications, in maintaining access to non-communicable disease care during the pandemic and beyond. This process could involve evaluating the effectiveness and feasibility of these interventions in the Ghanaian context and identifying potential barriers and facilitators to their implementation.

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APPENDIX

Data Retrieval Procedure

Data for this study was retrieved from the District Health Information Management System version 2 (DHIMS2), the main data repository of the Ghana Health Service of the Ministry of Health.

The DHIMS 2 is an online data repository where service delivery and health outcome data are stored from the various health facilities across Ghana.

Data in the DHIMS2 is organized by date, organizational unit or service delivery level and data category.

For this study, the following parameters were used for data retrieval:

Period: monthly

Date: January 2018 to December 2022

Organizational unit: Regions (including all 16 regions of Ghana)

Variables extracted

1. Asthma
2. Diabetes
3. Hypertension
4. Stroke

Processes Involved

1. The criteria or parameters for data retrieval were selected from the DHIMMS 2 website (https://chimgh.org/)
2. Data were then downloaded in spreadsheet form.

3. Data were cleaned and converted to appropriate format.
4. Data were imported into Stata 17 for statistical analysis.