ENSIGN GLOBAL UNIVERSITY, KPONG

EASTERN REGION, GHANA

FACULTY OF PUBLIC HEALTH

DEPARTMENT OF COMMUNITY HEALTH

A RESEARCH THESIS

ON

ASSESSING THE PREVALENCE, DISTRIBUTION AND ASSOCIATION BETWEEN SICKLE CELL DISEASE AND GROWTH OUTCOMES AMONG CHILDREN IN OTI AND VOLTA REGIONS, GHANA: A COMMUNITY-BASED CROSS-SECTIONAL STUDY

BY

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JUNE, 2026

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A THESIS SUBMITTED TO THE DEPARTMENT OF COMMUNITY HEALTH, FACULTY OF PUBLIC HEALTH, ENSIGN GLOBAL UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

MASTER OF PUBLIC HEALTH DEGREE

MAY, 2026

DECLARATION

I, Noble Selorm Gbormittah, hereby certify that, except for references to other people's work, which I have duly cited, this project submitted to the Department of Community Health, Ensign Global University, Kpong is the result of my own investigation, and has not been presented for any other degree elsewhere.

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(Head of Academic Program)	Signature	Date

DEDICATION

This work is dedicated to the children and families whose participation made this study possible, and to my family for their unwavering support and encouragement throughout my academic journey.

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First and foremost, I give thanks to the Almighty God for granting me life, strength, wisdom, and guidance throughout this academic journey. Without His grace and direction, the successful completion of this work would not have been possible.

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ABBREVIATIONS

Abbreviation	Meaning
AA	Normal hemoglobin A genotype
AC	Hemoglobin A and C genotype
AF	Hemoglobin A and F genotype
AS	Sickle cell trait (Hemoglobin A and S)
CC	Hemoglobin C and C genotype
CHPS	Community-based Health Planning and Services
CONSA	Consortium on Newborn Screening in Africa
GBD	Global Burden of Disease
GLSS	Ghana Living Standards Survey
GSS	Ghana Statistical Service
Hb	Hemoglobin
HbSC	Hemoglobin SC disease
HbSS	Hemoglobin SS disease (Sickle Cell Anaemia)
SCD	Sickle Cell Disease
SD	Standard Deviation
SEM	Social Ecological Model
WHO	World Health Organization

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ABSTRACT

Background: Sickle cell disease (SCD) is one of the most common inherited blood disorders globally and remains a significant public health concern in sub-Saharan Africa. Ghana is among the countries with a high burden of the disease, with a considerable proportion of the population carrying the sickle cell gene. The study aimed to determine the prevalence, demographic distribution, and growth-related impacts of sickle cell disease among children aged 3-14 years in selected communities in the Oti and Volta Regions of Ghana.

Methods: A community cross-sectional study design was used. The study analyzed secondary data obtained from sickle cell disease screening activities conducted by Medlook Ghana in collaboration with Compassion Ghana using Stata version 17. The dataset included hemoglobin genotype results, demographic characteristics, and anthropometric measurements of children aged 3-14 years screened in selected communities. A total of 1,226 children with complete records were included in the analysis.

Results: The prevalence of SCD and its genotypes was calculated. The results showed that 76.75% of participants had the AA genotype, while 11.42% had AS and 9.79% had AC. Genotypes associated with SCD included SS (0.65%), SC (0.57%), and FS (0.08%), giving an overall SCD prevalence of 1.31%. Nutritional assessment showed that stunting was present in 0.33% of participants, underweight in 0.49%, and wasting in 1.47%. Chi-square tests indicated no statistically significant association between SCD status and stunting ($\chi^2 = 0.053$, $p = 0.818$), underweight ($\chi^2 = 0.080$, $p = 0.778$), or wasting ($\chi^2 = 0.242$, $p = 0.623$).

Conclusion: The study highlights the importance of strengthening community-based screening, early diagnosis, and genetic counseling programmes to improve the detection and management of sickle cell disease among children in Ghana.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Sickle cell disease (SCD) is an inherited blood disorder caused by a change in the gene responsible for producing hemoglobin. This leads to the formation of an abnormal type of hemoglobin called hemoglobin S, which makes red blood cells take on a rigid, sickle shape (Ampomah *et al.*, 2024). These misshapen cells tend to break down easily and block blood flow, resulting in chronic anemia, repeated pain episodes, and damage to various organs. Together, these complications significantly affect the quality of life and survival of those living with the condition (Kato *et al.*, 2018). The most common types of SCD include HbSS, which is the most severe; HbSC, which often presents with milder symptoms; and less common forms such as HbS/β-thalassemia and HbSF (Makani, 2020).

On a global scale, SCD continues to be a major public health concern. According to the World Health Organization (WHO), more than 300,000 babies are born with the disease each year, with the majority born in sub-Saharan Africa (WHO, 2024). This number is expected to rise to over 400,000 by 2050 due to population growth and the continued high rates of sickle cell gene carriers in many parts of the world. In low-resource regions, the effects of SCD are often worsened by limited access to early diagnosis, treatment, and specialized care (Makani, 2020). Recognizing this, the WHO has identified SCD as a condition that deserves greater policy attention, especially in countries where the burden remains largely overlooked (WHO, 2025).

Sub-Saharan Africa, and particularly West Africa, bears the heaviest burden of SCD. Countries like Nigeria, Ghana, and the Democratic Republic of Congo record some of the highest numbers of affected births each year (Asare *et al.*, 2018). In many of these places, health systems struggle

with inadequate resources, leading to delays in diagnosis and care. Children with SCD are also more vulnerable to infections like malaria and sepsis, which can further complicate their condition (Anie, Egunjobi and Akinyanju, 2016). In fact, it is estimated that between 50% and 90% of children with undiagnosed or untreated SCD in sub-Saharan Africa die before reaching the age of five (Grosse *et al.*, 2017).

In Ghana, the impact of SCD is significant. Recent figures show that around 1.36% of newborns are affected by the disease, while about 22.8% of the population carry a sickle cell trait (Ibrahim *et al.*, 2024). The common genotypes found in Ghana include HbSS, HbSC, and HbSF, with HbSC being especially common (Awaitey *et al.*, 2020). In response, national programs like the Consortium on Newborn Screening in Africa (CONSA) have helped introduce early screening services across the country (CONSA, 2025). These efforts have improved early diagnosis, but challenges still exist in ensuring that children diagnosed through screening are linked to the care they need. For example, a study at Tamale Teaching Hospital found that only 62.5% of infants diagnosed with SCD through newborn screening were successfully connected to follow-up care (Ibrahim *et al.*, 2024).

Regional inequalities are also a concern. While hospitals in urban areas may provide services such as diagnosis and treatment with hydroxyurea, more rural parts of the country face serious gaps. These areas often lack the facilities, equipment, and trained personnel needed to manage SCD effectively. Cultural beliefs and misunderstandings about chronic diseases can also delay care-seeking, leading to underreporting and late diagnoses (Oppong *et al*., 2020). Despite signs that SCD is just as common in these areas as in urban settings, there is a noticeable lack of community-based research that looks at how the disease affects children in these regions.

Apart from the issue of prevalence, the effects of SCD on children's growth and development are a growing concern. Children with SCD are at higher risk of stunted growth due to a mix of chronic oxygen shortage, higher energy needs, frequent infections, and poor nutrition (Charlotte *et al.*, 2022). For example, a study using data from the 2018 Nigeria Demographic and Health Survey found that 55.4% of children under five with SCD were stunted, compared to 38.2% of children without the condition (Islam *et al.*, 2021).

There are several reasons why SCD can slow growth. The body uses more energy to produce new red blood cells to replace those lost through constant breakdown (Ajusiyine, 2021). At the same time, pain episodes linked to blocked blood vessels can interfere with digestion and the absorption of nutrients. Frequent hospital visits and missed school days also take a toll on children's mental, emotional, and academic development (Seah *et al.*, 2019). In low-resource settings like Ghana, these challenges are often made worse by poverty, food insecurity, and a lack of support services for child nutrition and rehabilitation (Paintsil *et al.*, 2022).

Given the diversity of environments and ethnic groups in the Oti and Volta Regions of Ghana, it’s important to understand how the disease affects children across different communities. Understanding these local variations can help shape more effective, region-specific health interventions. As sickle cell disease gains more recognition in national health planning, there is a clear need for reliable, locally relevant data. By focusing on the prevalence, geographic spread, and impact on growth of SCD among children in the Oti and Volta Regions of Ghana, this research aims to fill an important gap in current knowledge and support the design of targeted health policies and interventions.

1.2 Problem Statement

Sickle cell disease (SCD) is one of the most widespread inherited blood disorders globally, carrying significant public health and socio-economic consequences. According to the World Health Organization (WHO, 2021), an estimated 300,000 to 400,000 babies are born with SCD each year, a figure projected to surpass 400,000 by 2050 due to high birth rates in regions where the sickle cell gene is common. Over 75% of these births occur in sub-Saharan Africa, where health systems often lack the resources to effectively manage chronic genetic conditions. Although SCD is both preventable and manageable with timely diagnosis, health education, and clinical care, it remains a major cause of illness and early death among children in low- and middle-income countries (Makani, 2020).

Despite the national burden of SCD, there is a limited understanding of how the disease affects children in different parts of the country. While cities like Accra and Kumasi benefit from better healthcare infrastructure, rural and peri-urban regions such as the Oti and Volta Regions of Ghana remain underserved. This area faces challenges such as limited access to specialized care, cultural misconceptions about chronic illnesses, and widespread undernutrition which can worsen outcomes for children with SCD. However, most available data on SCD in Ghana come from hospital-based studies in urban areas, with little to no information from rural communities (Asare *et al.*, 2018).

There are no known community-based studies focused on assessing the prevalence, demographic spread, and growth-related impacts of SCD among children aged 3-14 years in the Oti and Volta regions. This is a significant gap in literature, given the genetic distribution of the disease and the likelihood of undiagnosed cases in underserved populations. Without accurate and localized data,

it becomes difficult to design effective health interventions or policies that respond to the realities of affected communities.

This study therefore seeks to address this gap by conducting a community-based assessment of the prevalence, distribution, and growth impacts of SCD among children in the Oti and Volta Regions of Ghana. The results of this research are expected to provide valuable insights for informing health policy, guiding community-based screening programs, and supporting child health interventions in resource-constrained areas of Ghana.

1.3 Rationale of the Study

In Ghana, although efforts have been made to address SCD through education, treatment programs, and advocacy, critical gaps remain in the availability and granularity of data needed to inform equitable and context-sensitive interventions. One of the most pressing challenges is the lack of population-level, community-based data that captures the true burden and impact of SCD beyond urban tertiary hospital settings.

Current research in Ghana has largely focused on hospital-based populations, which, while valuable, may exclude a significant proportion of individuals living in rural and peri-urban areas who either lack access to specialized care or are unaware of their disease status. These settings often experience infrastructural limitations, health workforce shortages, and socio-cultural barriers to care, which may worsen the outcomes for children living with SCD. Without robust data from these areas, national efforts to reduce the disease burden are likely to be skewed, leading to disparities in diagnosis, care, and survival outcomes.

Furthermore, understanding the associations between SCD and growth-related outcomes such as stunting, wasting, and underweight is essential not only for clinical management but also for

aligning public health nutrition policies with genetic health priorities. This is particularly relevant in regions like the Oti and Volta Regions of Ghana.

This study, therefore, responds to a critical need for localized, community-based epidemiological dat**a** on SCD. By assessing the prevalence, demographic distribution, and growth impacts of SCD among children aged 3-14 years in the Oti and Volta Regions of Ghana, the research aims to provide actionable evidence for policymakers, public health officials, and healthcare providers. It also contributes to broader efforts to integrate genetic disorders into mainstream child health and nutrition programming. The findings will serve as a foundation for future targeted interventions, including neonatal screening, growth monitoring, and culturally appropriate community education initiatives in resource-constrained areas.

1.4 Conceptual Framework

Figure 1 Conceptual Framework

Source: Author's Construct, Adapted from McLeroy et al. (1988)

The Social Ecological Model (SEM) provides a useful framework for understanding the factors that influence health outcomes among children living with sickle cell disease (SCD). Although the SEM traditionally comprises five interconnected levels (individual, interpersonal, community, organizational, and policy), this study was limited to variables available in the secondary dataset. Consequently, the framework was operationalized primarily at the individual level, while community of residence was included only as a geographical characteristic to examine the

distribution of SCD. The interpersonal, organizational, and policy levels were not operationalized because variables representing these constructs were not available for analysis.

At the individual level, biological and demographic characteristics such as SCD genotype, age, sex, and nutritional status were the principal factors examined. Children with the HbSS genotype often experience more severe disease manifestations, including chronic anaemia, recurrent vaso-occlusive crises, and increased basal metabolic demands, all of which contribute to impaired growth and poor nutritional outcomes (Marfo et al., 2023). Similarly, Islam et al. (2021), using data from the Nigeria Demographic and Health Survey, reported significantly higher rates of stunting and underweight among children with SCD than among children without the disease, largely because of chronic haemolysis, recurrent infections, and increased energy requirements. These biological mechanisms provide the theoretical basis for examining the relationship between SCD status and growth outcomes in the present study.

The study also included community of residence as a descriptive geographical variable to assess the distribution of SCD across the selected communities in the Oti and Volta Regions. Unlike the broader community level of the SEM, this variable was not intended to measure community influences such as health service accessibility, cultural beliefs, social support, or environmental conditions. Rather, it was included to determine whether the prevalence of SCD varied geographically across the study communities, consistent with the study objectives.

Accordingly, the interpersonal, organizational, and policy levels of the Social Ecological Model were not examined because information on caregiver knowledge, family support, health-seeking behaviour, healthcare accessibility, and policy-related factors was not available in the secondary dataset. These levels remain important determinants of SCD outcomes and have been highlighted

in previous studies (Asare et al., 2018; Oppong et al., 2020; Ohemeng et al., 2023), but they were beyond the scope of the current analysis.

The adapted SEM for this study focuses on the individual biological and demographic factors that were measured, SCD status, age, sex, and growth indicators (stunting, underweight, and wasting), while incorporating community of residence as a geographical variable.

1.5 Research Questions

1. What is the prevalence rate of sickle cell disease (SCD) and its genotypes (HbSS, HbSC, HbSF)?

2. How is SCD distributed across different age groups and communities?

3. What are the associations between SCD and growth parameters such as stunting, underweight, and wasting?

1.6 General Objective

To determine the prevalence, demographic distribution, and association between sickle cell disease and growth outcomes among children aged 3–14 years in the Oti and Volta Regions of Ghana.

1.6.1 Specific Objectives

1. To calculate the prevalence rate of SCD and its genotypes (HbSS, HbSC, HbSF) in the study population.

2. To map the distribution of SCD across age groups, communities.

3. To evaluate associations between SCD and growth parameters (stunting, underweight, wasting).

1.7 Profile of the Study Area

The Oti and Volta Regions of Ghana, both formerly part of the larger Volta Region prior to the 2018 administrative re-demarcation, present unique demographic and health system characteristics relevant to this study (GSS, 2021). The Oti Region, carved out of the northern part of the former Volta Region, comprises districts such as Nkwanta North, Nkwanta South, Krachi East, Krachi West, Krachi Nchumuru, and Biakoye. The remaining Volta Region includes key urban and semi-urban districts such as Ho, Hohoe, Kpando, and South Dayi. Together, these regions feature a mix of predominantly rural and peri-urban communities with dispersed settlements and a largely youthful, agrarian population.

According to the 2021 Population and Housing Census, the Oti Region had a population of approximately 747,227, with over 70% residing in rural areas (GSS, 2021). In the Volta Region, the total population stood at about 1,655,000, with significant rural residency in districts outside the regional capitals (GSS, 2021). Within Oti, districts like Krachi East and Nkwanta South are the most populous, each with more than 120,000 inhabitants. Across both regions, children and adolescents constitute a significant demographic, with over 42% of the population under 15 years of age, underscoring the urgent need for targeted pediatric and adolescent health interventions (GSS, 2021).

The ethnic landscape of the two regions is diverse, including groups such as the Guan (Nchumuru), Ewe, Konkomba, Adele, and Krachi, among others. Traditional beliefs and cultural practices

remain influential, particularly in rural communities, shaping health-seeking behaviors and perceptions of chronic illnesses such as sickle cell disease (Oppong *et al*., 2020).

Despite their demographic significance, both regions face considerable socioeconomic challenges. The Ghana Living Standards Survey Round 7 (GLSS 7) reports that over 40% of the population lives below the national poverty line, with poverty more acute in rural and farming communities (GSS, 2018). Health infrastructure is unevenly distributed and often inadequate. While urban districts like Ho and Hohoe in the Volta Region host regional and municipal hospitals, many districts in Oti and rural Volta rely primarily on Community-based Health Planning and Services (CHPS) compounds and health centers with limited capacity. Specialist care for chronic conditions like sickle cell disease remains scarce, compelling affected families to travel long distances to better-equipped facilities in Ho and Hohoe. These structural and cultural barriers make the Oti and Volta regions an ideal setting for examining healthcare access, utilization, and outcomes related to sickle cell disease.

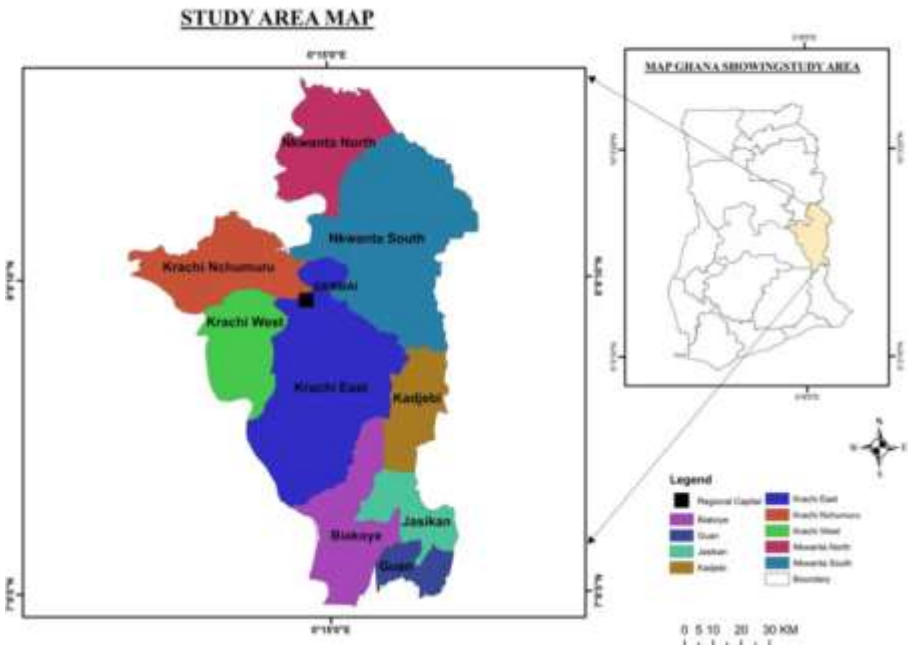

Figure 1.1 Map of Oti Region

Figure 1.2 Map of Volta Region

1.8 Scope of the Study

This study focuses on assessing the prevalence, distribution, and growth-related impacts of sickle cell disease (SCD) among children aged 3-14 years in selected communities within the Oti and Volta Regions of Ghana. The study is based on secondary data obtained from community-based screening exercises conducted by Medlook Ghana in collaboration with Compassion Ghana.

Geographically, the study covers selected districts including Guan District in the Oti Region, and Afadzato South District, Hohoe Municipality, and Ho-West District in the Volta Region. The analysis is limited to children who had complete records of hemoglobin genotype and anthropometric measurements at the time of screening.

The study specifically examines the prevalence of SCD and its genotypes (HbSS, HbSC, and HbSF), their distribution across age groups, sex, and communities, and their association with growth indicators such as stunting, underweight, and wasting.

However, the study is limited in scope in several ways. It relies on cross-sectional secondary data and therefore cannot establish causal relationships. It does not assess clinical severity, treatment outcomes, or longitudinal growth patterns. Additionally, findings may not be fully generalizable to all children in Ghana, as the study is restricted to selected communities within the Oti and Volta Regions.

1.9 Organization of the Study

This thesis is organized into six chapters. Chapter One presents the introduction to the study, including the background, problem statement, rationale, conceptual framework, research questions, objectives, and profile of the study area.

Chapter Two reviews relevant literature on sickle cell disease, focusing on prevalence, genotype distribution, geographic and demographic patterns, and growth-related outcomes among children.

Chapter Three describes the methodology used in the study, including the study design, study sites, data source, sampling approach, study variables, data management, and methods of data analysis.

Chapter Four presents the results of the study, including descriptive and inferential statistical findings on SCD prevalence, distribution, and associations with growth indicators.

Chapter Five discusses the findings in relation to existing literature and provides interpretations of the results within the study context.

Chapter Six concludes the study by summarizing key findings and providing recommendations for policy, practice, and future research.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction to the Literature Review

This chapter critically reviews empirical and institutional literature on sickle cell disease (SCD), with particular focus on its prevalence, demographic and geographic distribution, and growth-related impacts among children. The review is structured in line with the study objectives and integrates conceptual clarification with empirical evidence to explain how genetic, biological, and contextual factors shape observed disease patterns. Rather than treating theory and evidence separately, the chapter synthesises findings to show how population-level prevalence, spatial distribution, and child growth outcomes are interrelated.

Adopting a funnel approach, the review begins with global evidence on SCD prevalence and genotype patterns, narrows to sub-Saharan Africa where the burden is highest, and then focuses on Ghana and comparable West African settings. This progression provides the analytical foundation for interpreting community-based data on SCD prevalence and outcomes among children aged 3-14 years in the Oti and Volta Regions.

2.2 Prevalence of Sickle Cell Disease and Genotype Distribution

Prevalence of sickle cell disease refers to the proportion of individuals within a defined population who have laboratory-confirmed SCD at a specific point in time. In inherited conditions such as SCD, observed prevalence is influenced not only by genetic inheritance but also by survival, early diagnosis, and access to healthcare services. Genotype distribution, particularly the relative frequency of HbSS, HbSC, and other variants, is clinically and epidemiologically important because disease severity, complication risk, and survival differ markedly across genotypes.

Globally, sickle cell disease remains one of the most common monogenic disorders affecting children. Robust modelling studies estimate that more than 300,000 infants are born with SCD each year worldwide, with over three-quarters of these births occurring in sub-Saharan Africa (Piel *et al*., 2017). Updated analyses indicate that the absolute number of affected births continues to rise due to population growth in high-burden regions, even in the absence of changes in gene frequency (Piel *et al*., 2021). In high-income countries, widespread newborn screening and comprehensive care have transformed SCD into a chronic childhood condition with high survival, resulting in relatively stable prevalence across childhood age groups (Grosse *et al*., 2011).

In sub-Saharan Africa, however, SCD prevalence among older children is shaped by markedly different survival trajectories. Although the genetic prevalence at birth is high, a substantial proportion of affected children die undiagnosed in early childhood due to infections, severe anemia, and lack of access to basic care (Grosse *et al*., 2017). As a result, prevalence estimates based on older children or facility data often underestimate the true burden of disease. Genotype patterns across the region reflect long-standing evolutionary selection related to malaria endemicity, with HbSS and HbSC predominating in West Africa (Weatherall, 2018). However, observed genotype frequencies among children are also influenced by differential survival, with children with severe HbSS disease less likely to survive into later childhood in resource-constrained settings.

Recent African evidence demonstrates that community-based and newborn screening approaches provide more accurate estimates of SCD prevalence than hospital-based data. A multicountry review of newborn screening programmes in Africa showed that facility records capture only a fraction of affected children, particularly those with milder disease or limited access to care (Tshilolo *et al*., 2019). Similarly, community screening studies have consistently reported higher

prevalence than routine health facility data, underscoring the extent of underdiagnosis in rural and peri-urban populations (Ndeezi *et al*., 2016).

In Ghana, national and subnational evidence indicates that SCD remains highly prevalent, with important regional variation in genotype distribution. Secondary analyses of screening and diagnostic data show that HbSC genotype is relatively more common in southern Ghana, while HbSS predominates in parts of the middle belt and northern regions (Sims *et al*., 2021). Importantly, these patterns are shaped not only by inheritance but also by differences in diagnosis and survival. Children living in areas with limited access to screening and referral services are less likely to be diagnosed early, resulting in underrepresentation in prevalence statistics derived from health facilities.

Evidence further suggests that reliance on hospital-based prevalence estimates systematically excludes asymptomatic children and those with less severe disease, particularly those with HbSC genotype, who may not present to care until later childhood or adolescence (Tshilolo *et al*., 2019; Sims *et al*., 2021). Community-based screening therefore offers a more comprehensive picture of SCD prevalence and genotype distribution across childhood age groups. The literature demonstrates that SCD prevalence is highest in sub-Saharan Africa, with substantial heterogeneity across regions and genotypes, and that observed prevalence among children is strongly shaped by survival and access to early diagnosis.

2.3 Distribution of Sickle Cell Disease Across Age Groups, Communities

The distribution of sickle cell disease (SCD) across age groups, communities, and geographic settings reflects the interaction of genetic inheritance with survival, diagnosis, and access to care. Although SCD is inherited and therefore present from birth, the way it appears within populations

at different ages and locations is shaped largely by when children are diagnosed, whether they survive early childhood, and the extent to which health systems can identify affected individuals. Understanding these distributional patterns is essential for interpreting community-based prevalence data and for identifying populations that are likely to be missed by routine health services.

Globally, age-specific distribution of SCD is strongly influenced by the availability of early diagnosis and comprehensive care. In high-income countries where newborn screening and organised clinical follow-up are routine, most children with SCD survive into adolescence and adulthood, resulting in relatively stable prevalence across childhood age groups (Piel, Steinberg & Rees, 2017). In such settings, observed prevalence among older children closely mirrors genetic prevalence at birth because early mortality has been substantially reduced.

In sub-Saharan Africa, however, the situation is markedly different. The distribution of SCD across age groups is heavily affected by early childhood mortality and delayed diagnosis. Reviews of SCD care in Africa consistently show that many affected children die undiagnosed within the first five years of life due to preventable complications such as severe anaemia, infections, and malaria (McGann *et al*., 2017). As a result, facility-based or school-age prevalence estimates often underestimate the true burden of disease, particularly in communities where access to paediatric care and diagnostic services is limited. This survival bias means that lower observed prevalence among older children frequently reflects loss of affected children rather than true absence of disease.

Recent global burden analyses further highlight the strong age gradient in SCD distribution in African settings. The Global Burden of Disease 2021 study on SCD reported that the highest mortality and disability burden occurs in children under five years of age, with prevalence and

documented cases declining sharply in later childhood in regions with weak health systems (GBD 2021 Sickle Cell Disease Collaborators, 2023). Similarly, analyses from Nigeria have shown that a substantial proportion of under-five deaths in high-burden areas are attributable to undiagnosed SCD, reinforcing the idea that age-related patterns are driven largely by survival and detection rather than by differences in genetic risk (Nnodu *et a*l., 2021).

At the community level, differences between urban, peri-urban, and rural settings also shape observed distribution. Evidence from Ghana demonstrates that children living in or near urban centres are more likely to be diagnosed with SCD because of proximity to hospitals, laboratories, and specialised services. Secondary analysis of diagnostic patterns in Ghana revealed that many children with SCD are first identified during acute health crises at referral hospitals rather than through routine screening, meaning that children in communities with poor access to such facilities remain undetected for longer periods (Sims *et al*., 2021). Consequently, urban areas tend to record higher numbers of diagnosed cases, while rural and peri-urban communities may appear to have lower prevalence despite carrying similar genetic risk.

These patterns are consistent with broader African evidence indicating that the apparent geographic distribution of SCD is often a reflection of health system reach rather than true biological variation. Reviews of SCD in Africa emphasise that disparities in access to newborn screening, laboratory diagnosis, and routine follow-up care create significant inequities in where and when children are identified (Wonkam, 2019). Communities with organised screening programmes and stronger referral systems report higher prevalence simply because more children are diagnosed and survive long enough to be counted.

Taken together, the literature indicates that the distribution of SCD across age groups and communities is shaped primarily by structural and health-system factors. Apparent variations by

location or age often reflect differences in diagnosis, survival, and service accessibility rather than genuine differences in underlying genetic prevalence. Recognizing these influences is critical when interpreting community-based data, particularly in peri-urban and rural regions where underdiagnosis and early mortality remain significant challenges.

2.4 Growth and Nutritional Outcomes Among Children with Sickle Cell Disease

Sickle cell disease (SCD) is widely recognised as a chronic condition with substantial effects on the physical growth and nutritional status of affected children. Beyond its acute clinical complications, SCD imposes a continuous physiological burden that interferes with normal growth processes. Children living with the disease commonly experience chronic anaemia, recurrent infections, increased metabolic demands, and reduced appetite, all of which contribute to impaired linear growth and poor nutritional outcomes (Umeakunne & Hibbert, 2019). As a result, anthropometric deficits have become an important dimension of the overall disease burden in paediatric SCD.

Globally, evidence consistently demonstrates that children with SCD have poorer growth indicators than their non-affected peers. Contemporary reviews describe a multifactorial pathway linking SCD to malnutrition and growth failure, including chronic inflammation, increased resting energy expenditure, and nutrient deficiencies (Umeakunne & Hibbert, 2019). Even in relatively stable clinical states, children with SCD often require higher caloric intake to maintain normal growth, yet frequent illness episodes and reduced dietary intake make this difficult to achieve. These biological and behavioural mechanisms place affected children at heightened risk of stunting, underweight, and wasting.

In sub-Saharan Africa, where access to specialised SCD care and nutritional support is often limited, the impact of SCD on child growth is particularly pronounced. A recent regional review of childhood SCD in Africa reported that growth impairment remains one of the most common non-haematological complications of the disease, with malnutrition frequently coexisting with anaemia and recurrent infections (Egesa *et al*., 2022). The review emphasised that in many African settings, children with SCD face a "double burden" of genetic disease and socioeconomic disadvantage, both of which negatively affect nutritional status.

Empirical studies from West Africa provide detailed evidence of these growth challenges. In Nigeria, Esezobor *et al*. (2017) compared anthropometric indices of children with SCD to those of age-matched controls and found significantly lower height-for-age and weight-for-age scores among affected children. More than one-third of children with SCD in that study were classified as stunted, and underweight was markedly more common than in the general paediatric population. These findings illustrate that growth impairment is not an occasional complication but a routine feature of paediatric SCD in resource-constrained environments.

Biological mechanisms underlying these deficits have also been explored. A study by Adekile *et al*. (2017) demonstrated that children with SCD frequently exhibit micronutrient deficiencies and elevated inflammatory markers, both of which are associated with poor growth trajectories. The authors showed that chronic inflammation and oxidative stress in SCD interfere with normal metabolism and nutrient utilisation, helping to explain why affected children may remain undernourished even when food intake appears adequate. Such evidence reinforces the understanding that growth failure in SCD is driven by both disease-specific physiology and environmental factors.

Ghanaian and neighbouring West African experiences mirror these regional patterns. Although paediatric nutrition challenges are common in the general population, children with SCD are consistently identified as a particularly vulnerable group. Studies examining clinic-attending children with SCD in West Africa have shown that frequent painful crises, hospital admissions, and infections are strongly associated with poorer anthropometric outcomes (Egesa *et al*., 2022). These clinical disruptions interrupt normal feeding patterns and increase metabolic demands, thereby compounding existing socioeconomic constraints on adequate nutrition.

Importantly, genotype severity influences the degree of growth impairment. Children with the more severe HbSS genotype tend to demonstrate worse anthropometric indicators than those with HbSC or other milder variants (Esezobor *et al*., 2017). This suggests that the biological intensity of the disease interacts with contextual factors to determine individual growth outcomes. Consequently, assessing nutritional status alongside genotype and clinical history is essential for a comprehensive understanding of SCD burden in children.

Overall, the literature provides strong and consistent evidence that SCD is closely associated with impaired growth and poor nutritional status in childhood. Stunting, underweight, and wasting occur more frequently among children with SCD than among their unaffected peers, driven by a combination of chronic disease processes, recurrent illness, and constrained social environments. These findings underscore the importance of integrating routine nutritional assessment and support into SCD care and of examining growth outcomes as a key component of community-based evaluations of the disease.

2.5 Factors Influencing Sickle Cell Disease Outcomes and Growth Among Children

The health and growth outcomes of children with sickle cell disease are shaped by a complex interaction of biological, socioeconomic, and health-system factors. While the genetic basis of SCD determines the underlying risk of complications, the severity of its impact on children's wellbeing is heavily influenced by contextual conditions such as access to care, household resources, caregiver knowledge, and community support systems. Understanding these interacting determinants is essential for explaining why children with similar genotypes may experience markedly different health and growth trajectories.

At the individual level, genotype severity remains one of the strongest predictors of clinical and nutritional outcomes. Children with the HbSS genotype generally experience more frequent painful crises, infections, and anaemia than those with HbSC or other variants, placing them at greater risk of growth impairment (Esezobor *et al*., 2017). Disease severity affects appetite, energy expenditure, and school attendance, all of which indirectly influence nutritional status and physical development. Recurrent illness episodes disrupt normal feeding patterns and increase metabolic requirements, creating a cycle in which poor health and poor growth reinforce each other (Umeakunne & Hibbert, 2019).

Beyond biological factors, household socioeconomic conditions play a critical role in shaping outcomes for children with SCD. Studies across sub-Saharan Africa have consistently shown that poverty, food insecurity, and low parental education are strongly associated with worse clinical and nutritional outcomes among affected children (Egesa *et al*., 2022). Families with limited financial resources often struggle to provide nutrient-rich diets, transport to clinics, and the medications required for routine SCD management. In such contexts, the additional costs of caring

for a child with a chronic illness can further deepen household vulnerability, indirectly worsening the child's growth prospects.

Health-system factors also exert a major influence on SCD outcomes. Access to early diagnosis, regular follow-up care, and preventive interventions such as pneumococcal vaccination and malaria prophylaxis significantly improve survival and reduce disease complications (McGann *et al*., 2017). However, in many African settings, paediatric SCD services are concentrated in tertiary hospitals located in major cities, leaving children in peri-urban and rural communities with limited access to specialised care. Where routine screening is unavailable, children are often diagnosed only after severe complications arise, by which time growth deficits may already be established (Sims *et al*., 2021).

Caregiver knowledge and health-seeking behaviour further mediate these outcomes. Evidence indicates that parents and guardians who understand the chronic nature of SCD, recognise danger signs, and adhere to preventive treatment schedules are more likely to maintain regular clinic attendance and to seek early care during illness episodes (Wonkam, 2019). Conversely, misconceptions about the causes of SCD, reliance on traditional remedies, and fear of stigma can delay appropriate treatment and worsen disease control. Such behavioural factors are particularly influential in communities where health literacy is low and formal health services are distant.

Environmental and community-level conditions also contribute to variations in outcomes. Children living in overcrowded households, areas with poor sanitation, or regions with high malaria transmission face additional health risks that interact with SCD to undermine growth (GBD 2021 Sickle Cell Disease Collaborators, 2023). Limited availability of nutritious foods, lack of clean water, and frequent exposure to infections all compound the physiological stress already imposed by the disease. These contextual challenges help explain why children with SCD in

resource-constrained settings often experience more severe growth impairment than those in better-resourced environments.

Taken together, the literature demonstrates that outcomes among children with SCD are determined by far more than genotype alone. Biological severity, socioeconomic status, caregiver practices, and health-system accessibility combine to shape patterns of illness, survival, and growth. Effective interventions must therefore address not only the medical management of SCD but also the broader social and structural factors that influence how the disease affects children's everyday lives.

2.6 Identified Study Gaps

Although the literature on sickle cell disease in sub-Saharan Africa has expanded considerably in recent years, important empirical and contextual gaps remain, particularly in relation to community-level data and child growth outcomes. These gaps, which emerge directly from the reviewed studies, provide the basis for the present investigation.

First, most existing evidence on SCD prevalence and distribution in Africa is derived from hospital-based or programme-based data rather than community-based assessments**.** Several studies have emphasised that prevalence estimates drawn from health facilities systematically underestimate the true burden of SCD because they capture only children who present to care (Sims *et al*., 2021; McGann *et al*., 2017). The Ghanaian analysis by Sims *et al*., (2021) specifically showed that many children are diagnosed only during acute crises at referral hospitals, leaving those in rural and peri-urban communities largely undocumented. This indicates a clear gap in population-based prevalence data that include children who may not be connected

to formal health services. Few studies in Ghana have attempted active community screening to determine actual prevalence among school-aged children.

Second, there is limited evidence on the age-specific distribution of SCD in community populations. The Global Burden of Disease analysis highlights that SCD mortality and disability are concentrated in early childhood, leading to a decline in observed prevalence among older children in low-resource settings (GBD 2021 SCDC, 2023). However, most available Ghanaian studies report aggregate prevalence figures without examining how SCD cases are distributed across different childhood age groups. Consequently, little is known about whether older children in many communities are truly less affected or are simply less likely to be diagnosed and followed up. This creates a gap in understanding how SCD prevalence varies across the 3-14 year age spectrum in real community settings.

Finally, there is a notable lack of integrated studies that simultaneously examine prevalence, distribution, and growth outcomes within the same population**.** Existing research tends to address these issues separately; some studies focus on diagnosis patterns (Sims *et al*., 2021), others on survival and mortality (GBD 2021 SCDC, 2023), and others on nutrition (Egesa *et al*., 2022; Esezobor *et al*., 2017). Very few investigations combine these dimensions to provide a holistic picture of how many children are affected, where they are located, and how the disease influences their physical development. This limits the ability to draw comprehensive conclusions for specific regions such as Volta and Oti. This study therefore aims to determine the prevalence, demographic distribution, and growth-related impacts of Sickle Cell Disease among children aged 3-14 years in Oti and Volta Regions of Ghana.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Research Design

This study utilized a cross-sectional design analyzing secondary data obtained from Sickle Cell Disease (SCD) screening activities conducted by Medlook Ghana in collaboration with Compassion Ghana. The data, comprising hemoglobin genotype results and anthropometric measurements of children aged 3 to 14 years, enabled an assessment of SCD prevalence, genotype distribution, and growth outcomes among children in selected districts of the Oti and Volta regions.

3.2 Study Sites

The study was conducted in the following districts and areas within the Northern Volta and Oti Regions of Ghana:

- Guan District, Oti Region: Lolobi Kumase, Likpe, Santrokofi
- Afadzato South District, Volta Region: Logba, Liati, Ve-Koloenu, Ve-Agbome
- Hohoe Municipal, Volta Region: Wli
- Ho-West District, Volta Region: Fume-Gbedzeme

3.3 Source of Data

Secondary data were sourced from Medlook Ghana's SCD screening database, which contained individual-level records of children screened under the Compassion Ghana program. The dataset included hemoglobin genotype results obtained through cellulose acetate electrophoresis, along with anthropometric and demographic data collected during the screening exercise. The data were collected over a defined period from 22 February 2025 to 1 April 2025, across selected

communities in the Oti and Volta Regions, beginning with Ve-Koloenu and ending with Fume-Gbedzeme.

3.4 Study Population

The study population consisted of 1605 children aged 3 to 14 years who were screened for SCD in the selected districts. Inclusion was limited to those with complete data on SCD genotype and anthropometric measurements.

3.5 Inclusion Criteria

- Children aged 3-14 years screened by Medlook Ghana within the target districts.
- Complete and valid records of hemoglobin genotype and anthropometric measurements.
- Consent obtained from caregivers for participation in the screening program.

3.6 Exclusion Criteria

- Children outside the specified age range.
- Records with incomplete or missing data on key variables.
- Children whose caregivers did not consent to screening or data use.

3.7 Sample Size

This study did not undertake a formal sample size calculation because it was based on secondary data obtained from a community-based sickle cell disease (SCD) screening programme conducted by Medlook Ghana in collaboration with Compassion Ghana. Instead, a **census approach** was employed, whereby all available records that met the study eligibility criteria were included in the analysis.

The source population comprised 1,605 children aged 3–14 years who participated in the SCD screening programme across the selected communities in the Oti and Volta Regions between 22 February 2025 and 1 April 2025. Following data cleaning, records were assessed against the predefined inclusion and exclusion criteria. Records with incomplete or missing information on key study variables, including hemoglobin genotype and anthropometric measurements, were excluded from the analysis.

After applying these eligibility criteria, 1,226 children with complete records remained and constituted the final analytical sample. This sample represented all eligible participants within the available secondary dataset and was therefore considered appropriate for achieving the study objectives of estimating SCD prevalence, describing its distribution, and examining its association with growth outcomes.

3.8 Sampling Method

A census sampling approach was applied, as the dataset comprised all children screened by Medlook Ghana through Compassion Ghana's outreach activities within the study districts during the screening period.

3.9 Data Collection Techniques and Tools

The data collection was conducted by Medlook Ghana. A census sampling approach was employed, whereby all eligible children aged 3-14 years who were present at the screening sites during the outreach period and met the inclusion criteria were included in the study. Hemoglobin electrophoresis was performed using the cellulose acetate electrophoresis technique. A small quantity of venous blood was placed in a plain test tube and mixed with three drops of water and frozen to lyse the red blood cells. The test tube was taken out and allowed to thaw (hemolysate).

Using an applicator, the resulting hemolysate was applied to cellulose acetate paper. Electrophoresis was then carried out in Tris buffer solution for 15-20 minutes at an electromotive force (e.m.f.) of 250 volts, enabling the identification of hemoglobin variants such as HbSS, HbSC, and HbSF.

Anthropometric data, including weight and height/length, were measured using calibrated scales and stadiometers, following WHO guidelines for child growth assessment. **Specifically, weight-for-age, height-for-age (or length-for-age), and weight-for-height/BMI-for-age z-scores were computed against the WHO Child Growth Standards (2006) for children under five years and the WHO Growth Reference (2007) for children aged five to fourteen years, consistent with the age range of the study population.** In addition, demographic data such as age, sex, and community of residence were collected at the time of screening. For this study, a de-identified dataset from the screening exercise was requested and extracted for analysis.

3.10 Study Variables

Dependent Variables:

- Growth indicators classified according to WHO child growth standards, specifically:
    - Stunting (height-for-age Z-score < -2 SD)
    - Underweight (weight-for-age Z-score < -2 SD)
    - Wasting (weight-for-height Z-score < -2 SD)

Independent Variables:

- SCD genotype status (HbSS, HbSC, HbSF, and non-SCD)
- Age

- Sex (male/female)
- District/community of residence

3.11 Data Management and Storage

Upon receipt, the data were securely stored on password-protected computers accessible only to the research team. Data cleaning involved checking for completeness, consistency, and removal of duplicate or invalid records. Confidentiality was maintained by anonymizing all personal identifiers.

3.12 Data Analysis

Statistical analysis was conducted using Stata version 17. Descriptive statistics summarized participant demographics, SCD prevalence, genotype distribution, and growth outcomes. Chi-square tests examined associations between SCD status and growth outcomes. Statistical significance was determined at a p-value < 0.05.

3.13 Assumptions

This study assumed that the secondary data accurately reflected the SCD status and growth measurements of the screened children. It further assumed that the variables captured were sufficient to assess associations between SCD and growth outcomes, and that the sample was representative of the broader population in the study districts.

3.14 Ethical Considerations

Permission to use the secondary dataset was obtained from Compassion Ghana and Medlook Ghana. Ethical approval was sought from the Institutional Review Board of Ensign Global

University. All data were handled confidentially, and participant anonymity was strictly maintained. No direct interaction with participants occurred in this secondary data analysis.

CHAPTER FOUR

4.0 RESULTS

4.1 Demographic Characteristics

Table 4.1 gives an overview of the demographic traits of the study participants. A total of 1,226 children were included in the analysis. The majority of participants were aged 5-9 years (87.42%), followed by those aged 10-14 years (9.57%), while 3.01% were aged 3-4 years. In terms of sex distribution, 50.82% were female and 49.18% were male, indicating a relatively balanced representation of both sexes in the study population.

The mean weight of the children was 22.53 ± 4.97 kg, while the mean height was 121.96 ± 12.92 cm.

Table 4.1 Demographic Characteristics

Variable	Category	Frequency (n)	Percentage (%)
Age Group	3-4 years	76	3.01
	5-9 years	1002	87.42
	10-14 years	148	9.57
Sex	Female	623	50.82
	Male	603	49.18
Weight (kg)	Mean ± SD	22.53 ± 4.97	—
Height (cm)	Mean ± SD	121.96 ± 12.92	—

4.2 Prevalence of SCD and Its Genotypes

Table 4.2 shows the distribution of hemoglobin genotypes among the study participants. The majority of the children had the normal hemoglobin genotype AA (76.75%)**.** This was followed by AS (11.42%) and AC (9.79%)**,** indicating that a considerable proportion of the children carried sickle cell traits.

A small proportion of participants had genotypes associated with sickle cell disease, including SS (0.65%), SC (0.57%), and FS (0.08%)**.** Overall, 16 children were identified with sickle cell disease, resulting in an overall SCD prevalence of approximately 1.31% in the study population.

Table 4.2 Prevalence of SCD and Its Genotypes

Hemoglobin Genotype	Frequency (n)	Percentage (%)
AA	941	76.75
AC	120	9.79
AF	2	0.16
AS	140	11.42
CC	7	0.57
FS	1	0.08
SC	7	0.57
SS	8	0.65

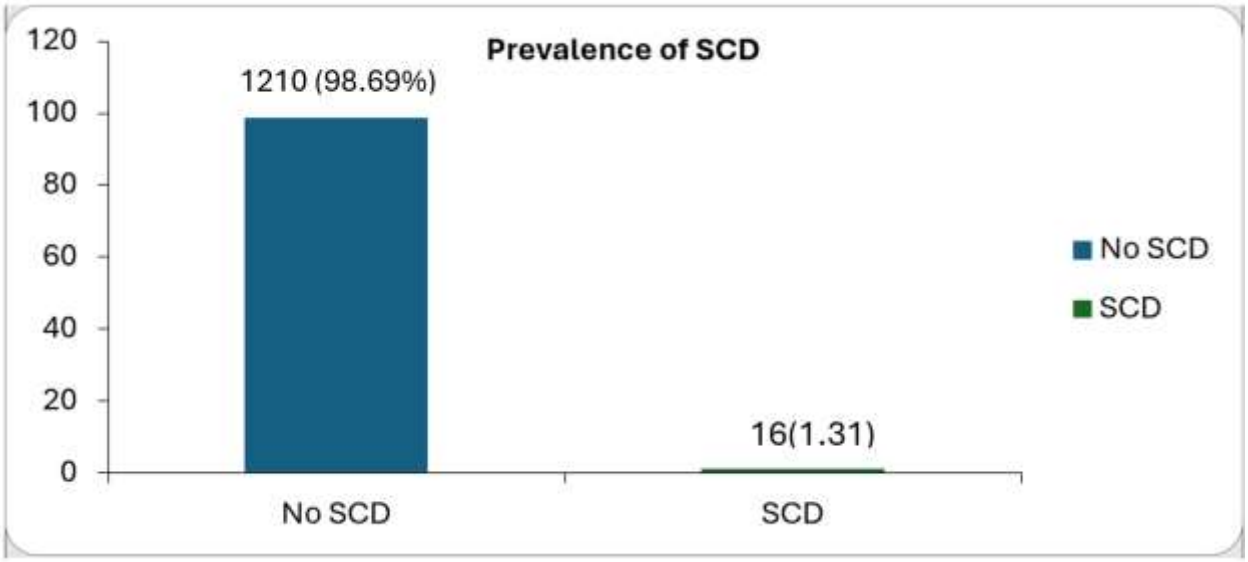

Figure 4.1 Prevalence of SCD

Figure 4.1 shows the prevalence of Sickle Cell Disease (SCD) among the study participants**.** The results indicate that the majority of participants did not have SCD**,** representing 1210 (98.69%) of the study population. In contrast, only a very small proportion of participants 16 (1.31%) had SCD**.**

4.3 Distribution of Sickle Cell Disease (SCD) by Age Group, Gender and Community

Table 4.3 presents the distribution of sickle cell disease (SCD) among children across age groups, gender, and communities in the study area.

The prevalence of SCD varied slightly across age groups. Among children aged 3-4 years, none had SCD, with 76 (100.0%) having no SCD. In the 5-9 years age group, 14 children (1.25%) had SCD while 995 (98.75%) had no SCD. Similarly, among children aged 10-14 years**,** 2 (0.95%) had SCD and 139 (99.05%) had no SCD. SCD cases were observed mainly among children aged 5-9 years**.**

The distribution of SCD was nearly identical between males and females. Among female children**,** 8 (1.28%) had SCD while 615 (98.72%) had no SCD. Similarly, among male children**,** 8 (1.33%) had SCD and 595 (98.67%) had no SCD.

The highest proportion of SCD cases was observed in Santrokofi, where 3 children (2.34%) had SCD. This was followed by Liati with 3 cases (1.86%)**,** Likpe with 2 cases (1.52%)**,** Wli with 2 cases (1.42%)**,** Ve-Koloenu with 2 cases (1.32%)**,** and Ve Agbome with 2 cases (1.27%)**.** The lowest proportions were observed in Logba (0.56%) and Lolobi (0.57%)**,** each reporting one case of SCD**.**

Table 4.3 Distribution of Sickle Cell Disease (SCD) by Age Group, Gender and Community

Variable	**Category**	**No SCD n (%)**	**SCD n (%)**	**Total**
Age Group				
	3-4 years	76 (100.0)	0 (0.0)	76
	5-9 years	995 (98.75)	14 (1.25)	1009
	10-14 years	139 (99.05)	2 (0.95)	141
Gender				
	Female	615 (98.72)	8 (1.28)	623
	Male	595 (98.67)	8 (1.33)	603
Community				
	Liati	158 (98.14)	3 (1.86)	161
	Likpe	130 (98.48)	2 (1.52)	132
	Logba	179 (99.44)	1 (0.56)	180
	Lolobi	174 (99.43)	1 (0.57)	175
	Santrokofi	125 (97.66)	3 (2.34)	128
	Ve Agbome	156 (98.73)	2 (1.27)	158
	Ve-Koloenu	149 (98.68)	2 (1.32)	151
	Wli	139 (98.58)	2 (1.42)	141

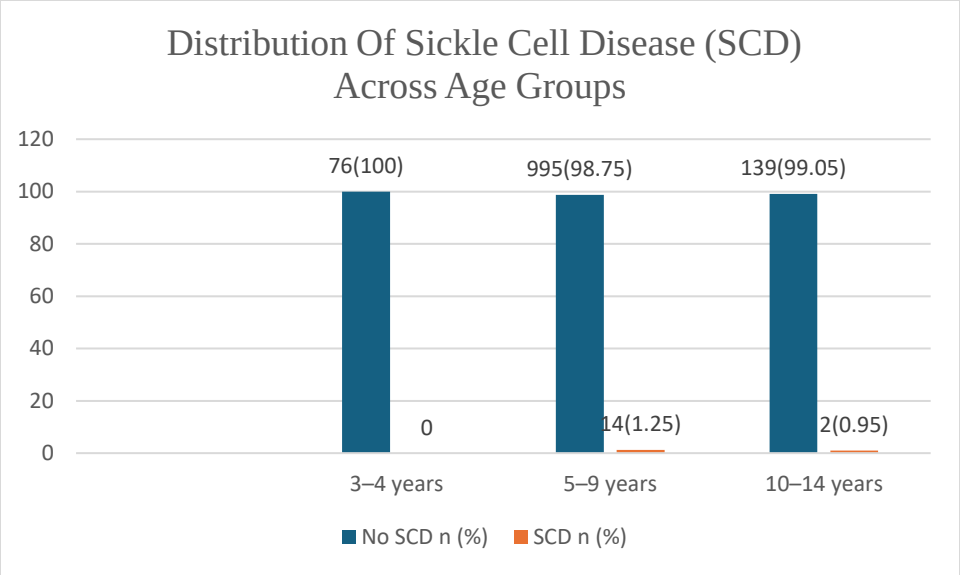

Figure 4.2 Distribution of Sickle Cell Disease (SCD) Across Age Groups

In the 5-9 years age group, 98.75% of children had no SCD, while 1.25% had SCD, representing the highest proportion of SCD cases among the age categories. Similarly, in the 10-14 years age group, 99.05% had no SCD, whereas 0.95% had SCD.

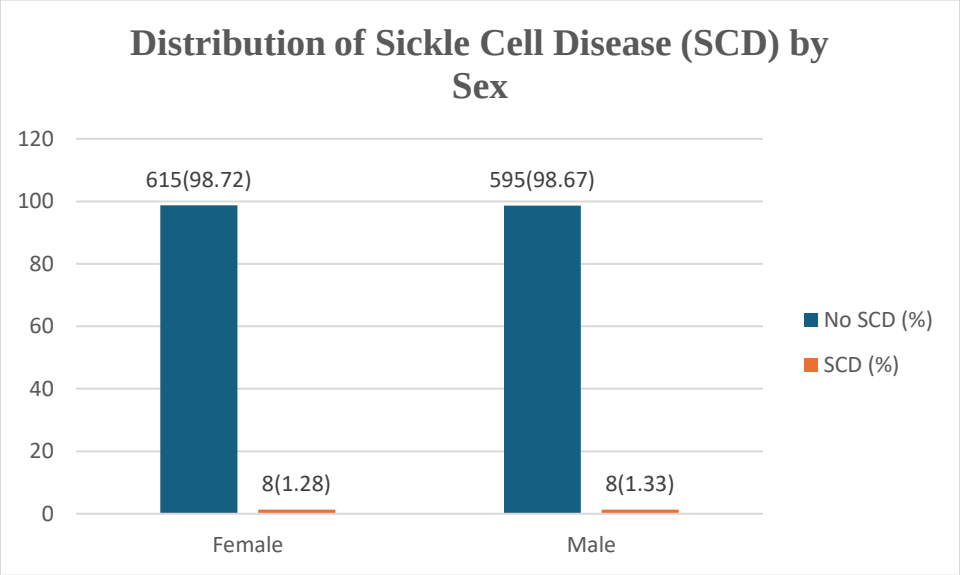

Figure 4.3 Distribution of SCD by Sex

The proportion of SCD was slightly higher among males compared to females, although the difference between the two groups was very small. Among female children, 98.72% had no SCD, while 1.28% had SCD. Similarly, among male children, 98.67% had no SCD, whereas 1.33% had SCD

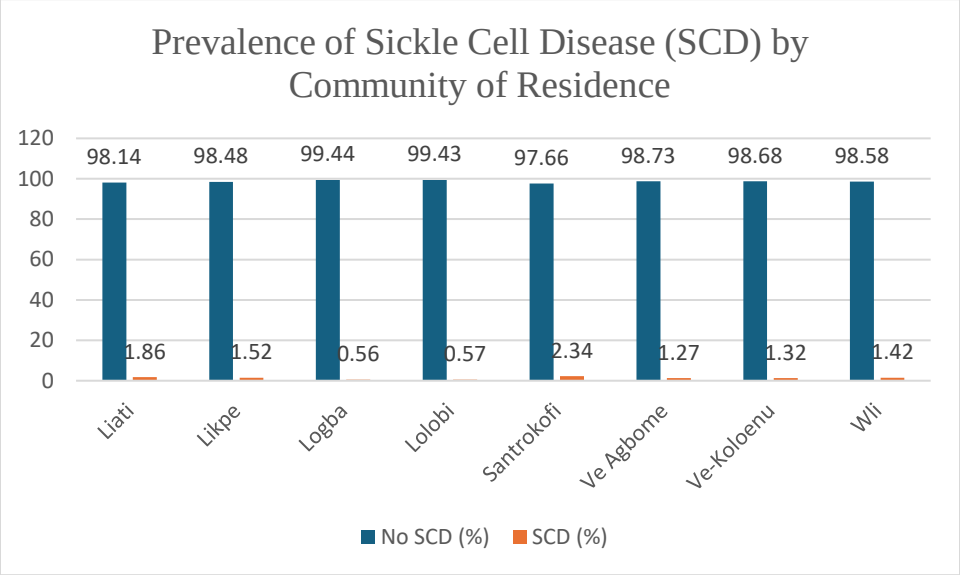

Figure 4.4 Prevalence of Sickle Cell Disease (SCD) by Community of Residence

The figure shows the proportion of children with SCD across the different communities included in the study. In Liati, 3 children (1.86%) were identified with SCD, while 2 children (1.52%) in Likpe had SCD. In Logba, 1 child (0.56%) had SCD, and similarly in Lolobi, 1 child (0.57%) had SCD, representing the lowest proportions among the communities.

In Santrokofi, 3 children (2.34%) had SCD, representing the highest prevalence of SCD among the study communities. In Ve Agbome, 2 children (1.27%) were identified with SCD, while 2 children (1.32%) in Ve-Koloenu had SCD. Similarly, 2 children (1.42%) in Wli were identified with SCD.

4.4 Stunting, Underweight and Wasting Among Children

The nutritional status of children in the study population was assessed using standard anthropometric indices. The prevalence of stunting was 0.33% (4 children)**,** while 0.49% (6 children) were underweight**.** Wasting was the most common nutritional deficit, affecting 1.47% (18 children) of the participants.

Table 4.4 Stunting, Underweight and Wasting Among Children

Nutritional Indicator	Category	Frequency (n)	Percentage (%)
Stunting (Height-for-Age)	Normal	1,222	99.67
	Stunted	4	0.33
Underweight (Weight-for-Age)	Normal	1,220	99.51
	Underweight	6	0.49
Wasting (Weight-for-Height)	Normal	1,208	98.53
	Wasted	18	1.47

4.5 Association between SCD Status and Nutritional Status Indicators

The chi-square test showed that there was no statistically significant association between SCD status and stunting ($\chi^2 = 0.053$, $p = 0.818$), underweight ($\chi^2 = 0.080$, $p = 0.778$) or wasting ($\chi^2 = 0.242$, $p = 0.623$).

Table 4.5 Association between SCD Status and Nutritional Status Indicators

Nutritional Indicator	Category	No SCD n (%)	SCD n (%)	χ^2	p-value
Stunting	Normal	1206 (99.67)	16 (100.00)		
	Yes	4 (0.33)	0 (0.00)	0.053	0.818
Underweight	Normal	1204 (99.50)	16 (100.00)		
	Yes	6 (0.50)	0 (0.00)	0.080	0.778
Wasting	Normal	1192 (98.51)	16 (100.00)		
	Yes	18 (1.49)	0 (0.00)	0.242	0.623

4.6 To examine the Gender and Geographical Variations in the Prevalence of Sickle Cell Disease

The chi-square test showed that there was no statistically significant association between gender and SCD prevalence ($\chi^2 = 0.004$, $p = 0.948$)**.** Likewise, there was no statistically significant association between community of residence and SCD prevalence ($\chi^2 = 3.040$, $p = 0.881$)**.**

Table 4.6 Gender and Geographical Variations in the Prevalence of Sickle Cell Disease

Variable	Category	No SCD n (%)	SCD n (%)	χ^2	p-value
Gender	Female	615 (98.72)	8 (1.28)		
	Male	595 (98.67)	8 (1.33)	0.004	0.948
Community	Liati	158 (98.14)	3 (1.86)		
	Likpe	130 (98.48)	2 (1.52)		
	Logba	179 (99.44)	1 (0.56)		
	Lolobi	174 (99.43)	1 (0.57)		
	Santrokofi	125 (97.66)	3 (2.34)		
	Ve Agbome	156 (98.73)	2 (1.27)		
	Ve-Koloenu	149 (98.68)	2 (1.32)		
	Wli	139 (98.58)	2 (1.42)	3.040	0.881

4.7 Logistic Regression Analysis of Gender and Geographical Variations in Sickle Cell Disease Prevalence

Logistic regression analysis was conducted to examine gender and geographical variations in the prevalence of sickle cell disease among the study population. The results showed that there was no statistically significant variation in SCD prevalence between males and females. With respect to geographical variation, there were also no statistically significant differences in SCD prevalence across the various communities.

Table 4.7 Logistic Regression Analysis of Gender and Geographical Variations in Sickle Cell Disease Prevalence

Variable	Category	AOR	95% CI	P-value
Gender	Reference: Female			
	Male	0.88	(0.29 - 2.64)	0.813
Community	Reference: Liati			
	Likpe	0.79	(0.11 - 5.67)	0.814
	Logba	0.40	(0.04 - 4.43)	0.453
	Lolobi	0.39	(0.04 - 4.36)	0.446
	Ve Agbome	0.87	(0.12 - 6.29)	0.894
	Ve-Koloenu	0.90	(0.12 - 6.53)	0.917

CHAPTER FIVE

5.0 DISCUSSION

5.1 Prevalence of Sickle Cell Disease (SCD) and Its Genotypes

This study examined the prevalence and genotype distribution of sickle cell disease among children aged 3-14 years in selected communities in the Oti and Volta regions of Ghana. The results showed that the majority of participants had the normal hemoglobin genotype AA (76.75%), while a considerable proportion carried sickle cell traits including AS (11.42%) and AC (9.79%). Only a small proportion of children were identified with genotypes associated with sickle cell disease, including SS (0.65%), SC (0.57%), and FS (0.08%), resulting in an overall SCD prevalence of 1.31% in the study population.

The predominance of the normal hemoglobin genotype (AA) observed in this study is consistent with the typical genetic distribution reported in many populations where individuals without abnormal hemoglobin variants form the majority. However, the relatively high proportion of heterozygous carriers (AS and AC) indicates that a substantial number of children in the study population carry the sickle cell gene. This pattern reflects the genetic epidemiology of SCD in malaria-endemic regions of sub-Saharan Africa. The persistence of the sickle cell trait in these populations has been widely explained by the protective advantage it confers against severe malaria, which allows the gene to remain prevalent in the population (Piel, Steinberg and Rees, 2017; Wonkam, 2019).

The overall SCD prevalence of 1.31% observed in this study is broadly consistent with estimates reported in Ghana and other parts of West Africa. Previous studies indicate that approximately 1–2% of newborns in Ghana are born with SCD, while about 20-25% of the population carries the sickle cell trait (Asare *et al*., 2018; Ibrahim *et al*., 2024). Similarly, modelling studies of the global

burden of sickle cell disease estimate that the highest prevalence of SCD occurs in sub-Saharan Africa, where genetic carrier rates are high and contribute to a substantial number of affected births each year (Piel *et al*., 2021; GBD 2021 Sickle Cell Disease Collaborators, 2023). The similarity between the prevalence observed in this study and national estimates suggests that the burden of SCD in the study communities reflects the broader epidemiological pattern seen in Ghana.

One possible explanation for the relatively low prevalence observed in this study is the community-based nature of the sample, which included children from the general population rather than individuals seeking care at health facilities. Hospital-based studies often report higher prevalence because they capture individuals who present for treatment due to symptoms or complications. For example, a study conducted at Ho Teaching Hospital in the Volta Region reported higher proportions of hemoglobin variants among patients attending the hospital compared with general population samples (Awaitey *et al*., 2020). This difference highlights how the study setting can influence observed prevalence patterns, with clinical settings typically reflecting a higher concentration of affected individuals.

Another possible explanation relates to early mortality among children with severe forms of SCD in many African settings. Evidence suggests that without early diagnosis and adequate treatment, a significant proportion of children with severe SCD-particularly those with the HbSS genotype-may die before reaching five years of age (Grosse *et al*., 2017; McGann, Hernandez and Ware, 2017). Consequently, prevalence estimates among older children may underestimate the true burden of the disease at birth because some affected children may not survive long enough to be captured in community-based surveys. This survival bias may partly explain the relatively low proportion of SCD cases observed in the present study.

The genotype distribution identified in this study, where HbSS and HbSC constituted the main forms of SCD, is also consistent with patterns reported in Ghana and other West African countries. Studies have shown that HbSS is generally the most severe and common genotype, while HbSC is particularly common in Ghana and neighbouring countries due to regional genetic variations (Kato *et al*., 2018; Marfo *et al*., 2023). Evidence from clinical studies in Ghana similarly indicates that HbSS and HbSC account for the majority of SCD cases seen in healthcare facilities (Asare et al., 2018). These patterns confirm that the genotype distribution observed in this study reflects the broader genetic characteristics of SCD in the region.

The presence of a notable proportion of carriers (AS and AC genotypes) in this study also has important public health implications. Individuals with these genotypes are usually asymptomatic but can transmit the sickle cell gene to their offspring. When two carriers reproduce, there is a 25% probability that their child will inherit SCD. Studies in Ghana and other African countries have highlighted that the high prevalence of carriers contributes significantly to the continued burden of SCD in the region (Wonkam, 2019; Sims *et al*., 2021). This underscores the importance of strengthening public health interventions such as premarital screening, genetic counselling, and community education to reduce the incidence of new SCD cases.

Overall, the findings of this study reinforce the understanding that sickle cell disease remains an important genetic and public health concern in Ghana, even though the proportion of affected individuals in community-based samples may appear relatively small. The prevalence and genotype distribution identified in this study are broadly consistent with existing evidence from Ghana and sub-Saharan Africa. However, differences in study design, population characteristics, and survival patterns among affected children may contribute to variations in reported prevalence across studies. Expanding community-based screening programmes and improving early diagnosis

and linkage to care remain critical strategies for reducing morbidity and mortality associated with sickle cell disease in Ghana.

5.2 Distribution of Sickle Cell Disease (SCD) by Age Group, Gender and Community

This study examined how sickle cell disease (SCD) was distributed across age groups, gender, and communities among children aged 3-14 years in selected districts of the Oti and Volta regions. The findings showed that SCD prevalence varied slightly across age groups, with the majority of cases occurring among children aged 5-9 years (1.25%), followed by those aged 10-14 years (0.95%), while no cases were recorded among children aged 3-4 years. The distribution of SCD was also almost identical between males and females, with 1.28% among females and 1.33% among males, suggesting no meaningful gender difference in prevalence. At the community level, the proportion of SCD cases varied modestly, with the highest prevalence recorded in Santrokofi (2.34%), followed by Liati (1.86%), while the lowest proportions were observed in Logba (0.56%) and Lolobi (0.57%).

The absence of SCD cases among children aged 3-4 years in this study may be explained by several factors. First, the relatively small number of children in this age group (76 participants) may have limited the likelihood of detecting cases. Second, survival bias may play a role in shaping the age distribution of SCD in many African settings. Studies have shown that without early diagnosis and comprehensive care, a significant proportion of children with severe SCD may die before reaching five years of age (Grosse *et al*., 2017; McGann, Hernandez and Ware, 2017). Consequently, community-based samples of older children may reflect only those who have survived the early high-risk years of the disease. A similar observation was noted in global burden analyses of SCD, which report that mortality associated with the disease is highest during early childhood in sub-Saharan Africa (GBD 2021 Sickle Cell Disease Collaborators, 2023). This survival pattern may

partly explain why SCD cases in this study were more commonly identified among children aged 5-9 years.

The finding that the highest proportion of SCD cases occurred among children aged 5-9 years may also reflect the timing of diagnosis and health-seeking behaviour in many low-resource settings. In several African countries, SCD is often diagnosed only after repeated illness episodes or hospital visits rather than through routine newborn screening programmes (Sims *et al*., 2021). As a result, children may not be identified as having SCD until they begin to experience complications such as recurrent pain crises, infections, or severe anaemia during early school-age years. Studies conducted in Ghana and other African countries similarly report that many children are diagnosed later in childhood rather than at birth due to limited access to early screening programmes (Wonkam, 2019; Ibrahim *et al*., 2024). This pattern supports the observation that the majority of cases in this study occurred within the 5-9 year age group.

The findings also showed no meaningful difference in SCD prevalence between male and female children, with almost identical proportions observed in both groups. This result is consistent with the biological nature of SCD as an autosomal recessive genetic disorder, meaning that inheritance of the disease is not linked to sex chromosomes. Therefore, males and females have an equal probability of inheriting the sickle cell gene from carrier parents (Kato *et al*., 2018). Several studies in Africa have similarly reported no significant gender differences in SCD prevalence. For example, research examining SCD diagnosis patterns in Ghana found that the distribution of the disease was relatively similar between males and females (Sims *et al*., 2021). Likewise, studies conducted in West African clinical populations have reported comparable prevalence rates across sexes, reinforcing the understanding that gender does not significantly influence the occurrence of SCD (Egesa *et al*., 2022).

The slight differences observed in SCD prevalence across communities may reflect variations in sample size and the distribution of participants across communities. Communities such as Santrokofi and Liati, which recorded relatively higher proportions of SCD cases, may have a higher concentration of individuals carrying the sickle cell trait. Because SCD results from the inheritance of two abnormal hemoglobin genes from carrier parents, areas with higher carrier frequencies may experience relatively higher numbers of affected individuals. Studies examining the spatial distribution of SCD in Ghana have shown that genotype frequencies can vary across communities due to population genetics, marriage patterns, and migration (Oppong *et al*., 2020). These local variations can influence the observed prevalence of SCD within specific communities.

The higher occurrence of cases among children aged 5-9 years may be influenced by the age distribution of the study population and the small number of SCD cases identified, while the absence of gender differences aligns with the autosomal recessive inheritance pattern of the disease.

Furthermore, the relatively small number of SCD cases observed across communities in this study may have contributed to the apparent variation in prevalence. With only 16 confirmed cases in the entire sample, even small differences in case numbers between communities can produce noticeable differences in percentages. Similar observations have been reported in other community-based studies where small case numbers can lead to fluctuations in estimated prevalence across locations (Piel *et al*., 2021).

Overall, the findings of this study suggest that the distribution of SCD among children in the study area is influenced by a combination of genetic, demographic, and health system factors. The higher occurrence of cases among children aged 5-9 years reflects patterns of delayed diagnosis and survival beyond early childhood, while the absence of gender differences aligns with the autosomal

recessive inheritance of the disease. Variations observed across communities may be related to differences in carrier frequency and population genetics. These findings are broadly consistent with existing literature on SCD epidemiology in Ghana and sub-Saharan Africa, which emphasizes that the distribution of the disease within populations is shaped not only by genetic inheritance but also by broader social and health system factors influencing diagnosis and survival.

5.3 Stunting, Underweight and Wasting Among Children and Their Association with SCD Status

This study assessed the nutritional status of children in the study population using standard anthropometric indicators. The results showed that the prevalence of stunting was 0.33%, underweight was 0.49%, and wasting was 1.47%, with wasting being the most common nutritional deficit among the children. Overall, the prevalence of these nutritional problems was relatively low in the study population. Furthermore, the statistical analysis showed no significant association between sickle cell disease (SCD) status and the nutritional indicators of stunting, underweight, or wasting.

The relatively low prevalence of stunting, underweight, and wasting observed in this study may be explained by several factors. First, the study population consisted largely of apparently healthy children from community-based screening activities rather than hospital-based samples. Children who are severely malnourished or chronically ill are more likely to be identified in clinical settings, which often leads to higher estimates of malnutrition in hospital-based studies. Second, the majority of children in the study population did not have SCD, which may have influenced the overall nutritional profile of the sample. Third, improvements in child health and nutrition programmes in Ghana over the past decade, including school feeding programmes, community nutrition interventions, and child welfare services, may have contributed to better nutritional

outcomes among children in many communities (Ghana Statistical Service, 2021; WHO and UNICEF, 2023).

Previous research has consistently shown that children with SCD are generally more vulnerable to growth impairment and poor nutritional outcomes than children without the disease. SCD is associated with chronic anaemia, increased metabolic demands, recurrent infections, and reduced appetite, all of which can interfere with normal growth and nutritional status (Umeakunne and Hibbert, 2019). These physiological factors increase the energy requirements of affected children and may lead to deficiencies in weight gain and linear growth if nutritional intake is inadequate.

Several studies in sub-Saharan Africa have reported substantially higher rates of malnutrition among children with SCD compared with the findings of the present study. For example, a study conducted in Nigeria by Esezobor *et al*. (2017) found that more than one-third of children with SCD were stunted and a significant proportion were underweight, highlighting the strong relationship between the disease and impaired growth. Similarly, research examining nutritional outcomes among children with SCD in Cameroon reported high levels of stunting and underweight among affected children when compared with the general paediatric population (Charlotte *et al*., 2022). These studies suggest that growth impairment remains a common complication among children living with SCD in many African settings.

The absence of a statistically significant association between SCD status and the nutritional indicators assessed in this study contrasts with findings from many previous studies that have reported strong relationships between SCD and growth deficits. For example, Islam *et al*. (2021) found that children with SCD had significantly higher rates of stunting and underweight compared with non-affected children, indicating that the disease contributes to long-term growth impairment.

Similarly, research across sub-Saharan Africa has consistently shown that children with SCD often exhibit lower height-for-age and weight-for-age scores than their healthy peers (Egesa *et al*., 2022).

One possible explanation for the lack of a significant association observed in this study is the small number of children with SCD in the sample. Only 16 children in the study population were diagnosed with SCD, which may have limited the statistical power of the analysis to detect meaningful differences between children with and without the disease. When the number of cases is small, statistical tests such as chi-square may not be sensitive enough to identify associations even when differences exist in the population.

Another possible explanation is that the children identified with SCD in this study may have had relatively mild disease phenotypes or may have been receiving some level of care that helped maintain adequate nutritional status. Previous research has shown that the severity of nutritional deficits in children with SCD often varies depending on genotype, frequency of complications, and access to healthcare services (Marfo *et al*., 2023). Children who receive regular medical care, nutritional counselling, and infection prevention measures may experience better growth outcomes than those without access to such services.

Additionally, the cross-sectional design of the study may limit the ability to detect long-term nutritional impacts of SCD. Growth impairment associated with SCD often develops gradually over time due to repeated illness episodes, chronic inflammation, and increased metabolic demands. Longitudinal studies are generally more effective in capturing these cumulative effects compared with cross-sectional assessments conducted at a single point in time (Umeakunne and Hibbert, 2019).

Overall, while there was no stunting, underweight, and wasting observed in this study and no significant association with SCD status was identified, the findings should be interpreted with caution given the small number of SCD cases in the sample. Existing literature consistently highlights the vulnerability of children with SCD to growth impairment and malnutrition due to the physiological and socioeconomic challenges associated with the disease. Continued monitoring of nutritional outcomes among children with SCD remains important, particularly in community settings where early diagnosis and supportive care interventions can help mitigate long-term health complications.

5.4 Gender and Geographical Variations in the Prevalence of Sickle Cell Disease

This study examined whether there were significant gender and geographical variations in the prevalence of sickle cell disease (SCD) among children in the study population. The results showed that there was no statistically significant association between gender and SCD prevalence (χ^2 = 0.004, p = 0.948). Similarly, there was no statistically significant association between community of residence and SCD prevalence (χ^2 = 3.040, p = 0.881). These findings suggest that the occurrence of SCD among children in the study area is relatively evenly distributed across both sexes and across the communities included in the study.

The absence of a significant difference in SCD prevalence between males and females is consistent with the biological basis of the disease. Sickle cell disease is inherited as an autosomal recessive genetic disorder, meaning that the gene responsible for the condition is located on non-sex chromosomes. As a result, both males and females have an equal probability of inheriting the abnormal hemoglobin gene when both parents are carriers (Kato *et al*., 2018). Because the inheritance pattern is independent of sex chromosomes, the prevalence of SCD is generally expected to be similar among males and females in most populations.

The findings of this study are consistent with previous research conducted in Ghana and other parts of sub-Saharan Africa, which have reported minimal or no gender differences in the prevalence of sickle cell disease. For instance, a study examining patterns of SCD diagnosis in Ghana found that the disease affected males and females in almost equal proportions, reflecting the autosomal inheritance of the condition (Sims *et al*., 2021). Similarly, broader epidemiological analyses of SCD in African populations have shown that the distribution of the disease does not differ substantially between sexes (Egesa *et al*., 2022). These findings support the observation in this study that gender does not appear to play a significant role in determining the likelihood of having SCD.

Although the results of this study did not show a statistically significant association between community of residence and SCD prevalence, slight variations were observed across the different communities included in the study. Such variations are common in genetic disorders and may reflect differences in local genetic structures, population mixing, or marriage patterns within communities. In many African settings, community-level prevalence of hemoglobin variants can vary due to historical population movements, ethnic composition, and patterns of intermarriage among individuals carrying the sickle cell trait (Wonkam, 2019).

However, the lack of a statistically significant association between community of residence and SCD prevalence in this study may also be explained by the relatively small number of SCD cases identified in the sample. With only a limited number of confirmed cases across several communities, the statistical analysis may not have had sufficient power to detect meaningful geographical differences in prevalence. Similar challenges have been noted in other community-based studies where small case numbers can reduce the ability of statistical tests to identify spatial patterns of disease distribution (Piel *et al*., 2021).

Another possible explanation is that the communities included in the study are located within relatively close geographic proximity and share similar environmental, cultural, and demographic characteristics. Populations that are geographically and ethnically related often exhibit similar genetic profiles, including similar frequencies of the sickle cell trait. Previous studies conducted in the Volta Region have shown that hemoglobin genotype distribution among children tends to be relatively uniform across communities with similar ethnic composition and environmental conditions (Oppong *et al*., 2020).

Furthermore, the increasing availability of screening programmes and community health interventions in Ghana may contribute to more uniform detection of SCD cases across different areas. Public health initiatives aimed at improving awareness and diagnosis of SCD, including community-based screening programmes and newborn screening initiatives, may reduce disparities in the identification of cases across communities (Ibrahim *et al*., 2024). As screening becomes more accessible, the detection of SCD may become less dependent on geographical location and more reflective of the underlying genetic distribution within the population.

Overall, the findings of this study indicate that the prevalence of sickle cell disease among children in the study population does not vary significantly by gender or community of residence. This pattern is consistent with the genetic inheritance of SCD and with findings from other studies conducted in Ghana and sub-Saharan Africa. Although minor variations in prevalence were observed across communities, these differences were not statistically significant and may reflect random variation rather than true geographical disparities. Continued efforts to expand screening programmes and genetic counselling services across communities remain important for improving early detection and management of sickle cell disease.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study found that the overall prevalence of sickle cell disease among the children was relatively low at 1.31%. However, a considerable proportion of the children carried sickle cell traits, particularly the AS(11.42%) and AC(9.79%) genotypes. The distribution of SCD cases showed slight variation across age groups and communities, with most cases occurring among children aged 5-9 years. However, no statistically significant differences were observed across age groups, gender, or communities. The findings also showed that SCD prevalence was almost equally distributed between males and females.

The study further examined the nutritional status of the children and found relatively low prevalence rates of stunting, underweight, and wasting in the study population. In addition, there was no statistically significant association between SCD status and these nutritional indicators. Overall, the findings suggest that while the current burden of SCD among children in the study area appears relatively low, the presence of a substantial number of carriers highlights the need for continued public health interventions aimed at early detection, genetic counselling, and improved management of the disease.

Limitations of the Study

This study was limited in its ability to detect associations between SCD status and nutritional outcomes because of the small absolute number of SCD cases identified (16 out of 1,226 children) and the correspondingly low number of children with stunting (4), underweight (6), and wasting (18) in the sample. With such sparse cell counts, the chi-square tests and logistic regression models had very limited statistical power, and a true association between SCD and growth outcomes may

not have been detected even if one existed. This finding should therefore be interpreted as inconclusive rather than as evidence of no relationship between SCD and nutritional status.

In addition, the complete absence of SCD cases among children aged 3-4 years, alongside the highest proportion of cases among those aged 5-9 years, is a notable limitation of the community-camp screening data used in this study. Rather than reflecting the true age distribution of SCD in the population, this pattern may result from survival bias, whereby children with the most severe forms of SCD (particularly HbSS) die before reaching screening age, and from limited reach of community screening camps to infants and toddlers. As a secondary dataset drawn from screening camps rather than a birth cohort or newborn screening programme, the data used in this study are therefore unlikely to capture the full burden of SCD among the youngest children, and prevalence estimates by age group should be interpreted with this limitation in mind.

6.2 Recommendations

1. The Ghana Health Service (GHS), in collaboration with CHPS compounds and relevant NGOs, should strengthen community-based sickle cell screening programmes for children aged 3-14 years to promote early diagnosis and timely intervention.
2. The Ghana Health Service (Health Promotion Unit) and Ghana Education Service (GES) should intensify public education and genetic counselling on sickle cell disease and carrier status, particularly targeting parents and caregivers, to reduce the risk of future disease transmission.
3. The Ministry of Health (MoH) and Ghana Health Service should integrate routine sickle cell screening and counselling services into primary healthcare and school health programmes (SHEP) to improve accessibility and coverage.

4. The Ministry of Health and Ghana Health Service should promote premarital and adolescent sickle cell genotype testing and counselling services through health facilities and community outreach programmes.

REFERENCES

Ajusiyine, J.M. (2021) *Quality of life of adolescents living with sickle cell disease in the Accra Metropolis*. Master of Philosophy thesis. University of Ghana. Available at: http://ugspace.ug.edu.gh (Accessed: 26 May 2025).

Ampomah, M.O., Atkin, K., Ohene, L.A., Achempim-Ansong, G., Korsah, K.A. and Laari, L. (2024) 'Financial strain and resilience: a qualitative exploration of parental perspectives on caring for children with sickle cell disease in Ghana', *BMC Health Services Research*, 24(1), p.1380.

Anie, K.A., Egunjobi, F.E. and Akinyanju, O.O. (2016) 'Psychosocial impact of sickle cell disorder: perspectives from a Nigerian setting', *Globalization and Health*, 6(1), pp.1–6.

Asare, E.V., Wilson, I., Benneh-Akwasi Kuma, A.A., Dei-Adomakoh, Y., Sey, F. and Olayemi, E. (2018) 'Burden of sickle cell disease in Ghana: the Korle-Bu experience', *Advances in Hematology*, 2018.

Awaitey, D.K., Akorsu, E.E., Allotey, E.A., Kwasie, D.A., Kwadzokpui, P.K., Tawiah, P.A., Amankwah, S.A. and Abaka-Yawson, A. (2020) 'Assessment of hemoglobin variants in patients receiving health care at the Ho Teaching Hospital: a three-year retrospective study', *Advances in Hematology*, 2020.

Brousse, V., Arnaud, C., Lesprit, E., Odièvre-Montanié, M.H., Etienne-Julan, M., Elana, G., Belloy, M., Dumesnil, C., Quinet, B., Chamouine, A., Guillaumat, C., Garnier, N., Pondarré, C., Couque, N., Bernaudin, F., de Montalembert, M., Boutin, E., Benkerrou, M. and Thuret, I. (2019) 'Evaluation of outcomes and quality of care in children with sickle cell disease

diagnosed by newborn screening: a nationwide study in France', *Blood*, 134(Supplement 1), p.1001.

Charlotte, E.E., Ritha Carole, M.B., Calixthe, I.P., Jeanne Georgette, M.E., Patricia, E., Iyawa, H., Edgar, M.M.L., Michael Ngenge, B., Gaelle, N.K., Claudia, E.B.B., Dicka, S.M., Paul, K.N. and Daniele-Christiane, K.M.K. (2022) 'Describing the growth and nutritional status of children and adolescents with sickle cell disease using WHO standards in Cameroon', *BMC Nutrition*, 8(1), pp.1–9.

CONSA (2025) *Consortium on Newborn Screening in Africa*. Available at: https://www.hematology.org/global-initiatives/consortium-on-newborn-screening-in-africa (Accessed: 24 May 2025).

Egesa, W.I., Nakibuuka, J. and Kaddumukasa, M. (2022) 'Sickle cell disease in children and adolescents in sub-Saharan Africa: a public health perspective', *International Journal of Pediatrics*, Article 3885979.

Esezobor, C.I., Akintan, P., Lesi, F.E. and Temiye, E.O. (2016) 'Wasting and stunting are still prevalent in children with sickle cell anaemia in Lagos, Nigeria', *Italian Journal of Pediatrics*, 42, p.45.

GBD 2021 Sickle Cell Disease Collaborators (2023) 'Global, regional, and national prevalence and mortality burden of sickle cell disease, 2000–2021', *The Lancet Haematology*, 10(8), pp.e585–e599.

Ghana Statistical Service (2018) *Ghana Living Standards Survey (GLSS 7) 2017*. Available at: https://www2.statsghana.gov.gh (Accessed: 26 May 2025).

Ghana Statistical Service (2021) *Administrative Map of Ghana*. Accra: Ghana Statistical Service.

Grosse, S.D., Odame, I., Atrash, H.K., Amendah, D.D., Piel, F.B. and Williams, T.N. (2017) 'Sickle cell disease in Africa: a neglected cause of early childhood mortality', *American Journal of Preventive Medicine*, 41(6 Suppl 4).

Ibrahim, L.S., Aurora, T., Adjinkpang, S., Ibrahim, S., Kanamu, M.H., Owusu, S.A., Hankins, J.S., Ness, K.K. and Abdul-Mumin, A. (2024) 'Determinants of linkage to care in a newborn screening program for sickle cell disease in Ghana', *Blood*, 144(Supplement 1), p.392.

Islam, M.R., Moinuddin, M., Ahmed, A. and Rahman, S.M. (2021) 'Association of sickle cell disease with anthropometric indices among under-five children', *BMC Medicine*, 19(1), pp.1–11.

Ismail, A. and Inusa, B.P. (2020) 'Effectiveness of comprehensive newborn screening programs for sickle cell disease: a systematic review', *Blood*, 136(Supplement 1), pp.11–11.

Kato, G.J., Piel, F.B., Reid, C.D., Gaston, M.H., Ohene-Frempong, K., Krishnamurti, L., Smith, W.R., Panepinto, J.A., Weatherall, D.J., Costa, F.F. and Vichinsky, E.P. (2018) 'Sickle cell disease', *Nature Reviews Disease Primers*, 4(1), pp.1–22.

Makani, J. (2020) 'Curative options for sickle cell disease in Africa: approach in Tanzania', *Hematology/Oncology and Stem Cell Therapy*, 13(2), pp.66–70.

Marfo, K., Dei-Adomakoh, Y., Segbefia, C., Dwomoh, D., Edgal, A., Ampah, N., Ramachandrachar, B.C., Subramanyam, K., Natarajan, A., Egbujo, O. and Ataga, K.I. (2023) 'Evaluation of treatment patterns and healthcare resource utilization for sickle cell disease in Ghana', *BMC Health Services Research*, 23(1), pp.1–14.

McGann, P.T., Hernandez, A.G. and Ware, R.E. (2017) 'Sickle cell anemia in sub-Saharan Africa: advancing the clinical paradigm', *Blood*, 129(2), pp.155–161.

Ndeezi, G., Kiyaga, C., Hernandez, A.G., Munube, D., Howard, T.A., Ssewanyana, I. and Ware, R.E. (2016) 'Burden of sickle cell trait and disease in Uganda', *The Lancet Global Health*, 4(3), pp.e195–e200.

Nnodu, O.E., Oron, A.P., Sopekan, A., Adegoke, S.A., Piel, F.B. and Wirth, K.E. (2021) 'Child mortality from sickle cell disease in Nigeria', *The Lancet Haematology*, 8(10), pp.e723–e731.

Ohemeng, A., Nartey, E.B., Quaidoo, E., Ansong, R.S. and Asiedu, M.S. (2023) 'Knowledge and nutrition-related practices among caregivers of adolescents with sickle cell disease in Ghana', *BMC Public Health*, 23(1), pp.1–10.

Oppong, M., Lamptey, H., Kyei-Baafour, E., Aculley, B., Ofori, E.A., Tornyigah, B., Kweku, M. and Ofori, M.F. (2020) 'Prevalence of sickle cell disorders and malaria infection in children in the Volta Region, Ghana', *Malaria Journal*, 19(1), pp.1–11.

Paintsil, V., Amuzu, E.X., Nyanor, I., Asafo-Adjei, E., Mohammed, A.R., Yawnumah, S.A., Oppong-Mensah, Y.G., Nguah, S.B., Obeng, P., Dogbe, E.E., Jonas, M., Nembaware, V., Mazandu, G., Ohene-Frempong, K., Wonkam, A., Makani, J., Ansong, D. and Osei-Akoto, A. (2022) 'Establishing a sickle cell disease registry in Africa: experience from Kumasi, Ghana', *Frontiers in Genetics*, 13, p.802355.

Piel, F.B., Steinberg, M.H. and Rees, D.C. (2017) 'Sickle cell disease', *New England Journal of Medicine*, 376(16), pp.1561–1573.

Piel, F.B., Hay, S.I., Gupta, S., Weatherall, D.J. and Williams, T.N. (2021) 'Global burden of sickle cell anaemia in children', *PLoS Medicine*, 18(7), e1003650.

Seah, T., Zhang, C., Halbert, J., Prabha, S. and Gupta, S. (2019) 'Therapy abandonment in pediatric conditions in low- and middle-income countries', *Pediatric Blood and Cancer*, 66(6), e27692.

Sims, A.M., Bonsu, K.O., Urbonya, R., Farooq, F., Tavernier, F., Yamamoto, M. and Campbell, A. (2021) 'Diagnosis patterns of sickle cell disease in Ghana', *BMC Public Health*, 21, p.1507.

ThinkNews (2024) *National sickle cell strategy and vaccine policy launched*. Available at: https://www.thinknewsonline.com (Accessed: 26 May 2025).

Umeakunne, K. and Hibbert, J.M. (2019) 'Nutrition in sickle cell disease: recent insights', *Nutrition and Dietary Supplements*, 11, pp.9–17.

World Health Organization (2021) *Sickle Cell Disease – Regional Office for Africa*. Available at: https://www.afro.who.int (Accessed: 26 May 2025).

World Health Organization (2024) *WHO Africa guidance on sickle cell disease*. Available at: https://www.afro.who.int (Accessed: 24 May 2025).

World Health Organization (2025) *Sickle Cell Disease – WHO Africa*. Available at: https://www.afro.who.int (Accessed: 24 May 2025).

Wonkam, A. (2019) 'Sickle cell disease in Africa: current situation and the way forward', *The Lancet Haematology*, 6(10), pp.e485–e486.