UNIVERSITY FOR DEVELOPMENT STUDIES

THE EFFECT OF HOUSEHOLD ACCESS TO WATER SANITATION AND HYGIENE FACILITIES ON CHILDHOOD UNDERNUTRITION IN THE BOLGATANGA MUNICIPALITY OF THE UPPER EAST REGION OF GHANA

DORZIE K. JOHN BAPTIST

FEBRUARY, 2025

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BY

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A THESIS SUBMITTED TO THE DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH, SCHOOL OF PUBLIC HEALTH, UNIVERSITY FOR DEVELOPMENT STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PUBLIC HEALTH DEGREE IN

ENVIRONMENTAL HEALTH SCIENCE

FEBRUARY, 2025

DECLARATION

Student

I hereby declare that this thesis is the result of my own work, and that no part of it has been presented for another degree at this university or elsewhere.

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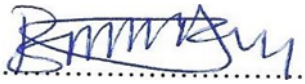
Signature:  .....Date:1ST MARCH, 2024

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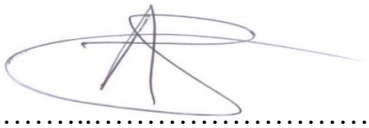
Signature:  Date:1ST MARCH, 2024

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ABSTRACT

Background: Childhood undernutrition is a disease of public health concern in developing countries and has been found to be associated with poor water, sanitation, and hygiene practices. Objective: This study sought to assess the effect of household access to WASH services on childhood undernutrition in the Bolgatanga Municipality of the Upper East Region of Ghana. This study adopted Amartya Sen and Martha Nussbaum's capability approach and social cognitive theory frameworks to explain how inadequate WASH access can lead to childhood undernutrition. Methodology: A cross-sectional study design involving 19 health facilities was conducted. The study sample included 422 mother-baby pairs who attended selected health facilities for Child Welfare Clinic services. A simple random sampling technique using the lottery method was used to select participants for this study. A standard questionnaire was used to obtain primary data, whereas a checklist was used to extract secondary data from maternity booklets. Data was analyzed using STATA IC version 17. Results: The prevalence of childhood undernutrition in the study sample was 48.5% (95% CI: 43.5- 53.5). About 28.5% (95% CI: 23.9-33.1) of the children had stunted growth, 20.8% (95% CI: 16.6-24.9) were wasted, while 11.3% (95% CI: 8-14.6) were found to be underweight. Children from households with insufficient sanitation facilities were 2.2 times more likely to be stunted compared to children from households with sufficient sanitation services (AOR: 2.20, 95% CI: 1.21 - 4.02, P-value = 0.010). Children from households with unimproved sanitation services were 3.25 times more likely to be underweight compared to children residing in households with improved sanitation services (AOR: 3.25, 95% CI: 1.22 - 8.68, P-value = 0.018). This study found no statistically significant relationship between household access to WASH facilities and childhood wasting.

Conclusion: The study found that inadequate sanitation and hygiene practices contribute to childhood stunting and underweight. I recommend that the Bolgatanga Municipal Health Directorate should design and implement integrated programs that address both WASH and nutrition to tackle the interconnected issues of poor sanitation and undernutrition.

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DEDICATION

In my loving memory of my late father, Dorzie Edward Dery.

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LIST OF ABBREVIATIONS

ANC	Antenatal Care
AOR	Adjusted Odds Ratio
BMI	Body Mass Index
BMHD	Bolgatanga Municipal Health Directorate
CDC	Centre for Disease Control
CHPS	Community Health Planning Services
CWC	Child Welfare Clinic
DHS	Demographic and Health Survey
DHIMS	District Health Information Management System
EDD	Environmental Enteric Dysfunction
GDHS	Ghana Demographic and Health Survey
GSS	Ghana Statistical Service
JMP	Joint Monitoring Program
LMICs	Low and Middle-Income Countries
MDGs	Millennium Development Goals
NGOs	Non-Governmental Organizations
ODK	Open Data Kit
OR	Odds Ratio
SCT	Social Cognitive Theory
SSA	Sub-Saharan Africa
SDGs	Sustainable Development Goals
UNICEF	United Nations Children's Funds

VIP	Ventilated Improved Pit
WHO	World Health Organization
WASH	Water, Sanitation, and Hygiene
WIFA	Women In Fertility Age

CHAPTER ONE

INTRODUCTION

1.1 Background

Childhood undernutrition refers to a condition in which a child's body does not receive adequate nutrients to sustain healthy growth and development. This deficiency arises from insufficient dietary intake and/or recurrent infectious diseases (Saba et al. 2016). Undernutrition includes stunting, wasting, and underweight. Childhood wasting is characterized by low weight for height and reflects acute malnutrition. Stunting is characterized by impaired linear growth due to poor nutrition or frequent infection (Otiti & Allen, 2021). Underweight or low weight for age is caused by wasting, stunting, or both (Ersado, 2022). The World Health Organization (WHO) states that nearly half of all deaths among children under five years of age (CU5) are associated with undernutrition (WHO, 2021). In 2020, 149 million CU5 years were estimated to have stunted growth, and an additional 45 million children were at risk of wasting (WHO, 2021). Further estimates suggest that 85 million children are either moderately or extremely underweight (Amir-ud-Din et al. 2022). More than 50% of global malnutrition cases originate from low- and middle-income countries (LMICs), especially in sub-Saharan Africa (SSA) and Asia with CU5 being the most vulnerable (Otiti & Allen, 2021). SSA alone accounts for one-third of the global undernutrition burden in children (Akombi et al., 2017). In Ghana, an estimated 13% of children are underweight, 23% are stunted, and approximately 6% are wasted (Frempong & Annim, 2017).

Water Sanitation and Hygiene (WASH) involves excellent hygiene practices, access to improved water supply, and safe sanitation facilities. Globally, more than 50% of individuals use unsafe or inadequate sanitation services, and approximately 2 billion people consume water from

contaminated sources (Oppong et al., 2022). Moreover, close to 494 million individuals around the world defecate in the open (WHO, 2022). In SSA, about 70% of people lack safe sanitation facilities, while approximately 32% do not have access improved or reliable water sources (Angoua et al., 2018). In Ghana, an estimated 8.9% of families continue to use contaminated water, 81.6% lack improved sanitation facilities, and about 15.2% defecate in open spaces (Oppong et al., 2022). The Northern part of Ghana has the highest prevalence (20.4%) of households using unimproved water sources compared to the country's prevalence of 8.9%. Additionally, this part of the country is first among households using inadequate sanitation facilities with a prevalence of 92.8% as against 81.6% across the entire country(Oppong et al., 2022). In the Upper East region, 94.6% of families lack access to basic sanitation (The highest in the country) whiles about 8.1% use unimproved drinking water (Oppong et al., 2022). According to reports from the latest Ghana multiple indicator cluster survey, about 48.5% of Ghanaian households have improved hand hygiene facilities on their premises for hand washing (GSS & UNICEF, 2018). The Upper East Region was found to have the the lowest (18%) number of households with water and soap at designated hand washing locations compared to about 51% in the Greater Accra Region (GSS), 2015).

It has been suggested that childhood undernutrition is caused by three main biological mechanisms that are influenced by unsafe drinking water use, poor sanitation, and inadequate hygiene practices. These include helminth infections, frequent diarrhea, and environmental enteric dysfunction (EED) (Patlán-Hernández et al., 2022). Diarrhea results in nutrient and water loss from the body causing undernutrition. Enteric infections can cause undesirable changes in the gut structure and function, thereby impacting nutrient absorption in children, which consequently leads to undernutrition (Patlán-Hernández et al., 2022). Evidence suggests that

people living in unsanitary conditions with inadequate WASH access are more likely to experience undernutrition and this accounts for about 16% of the global undernutrition burden (Patlán-Hernández et al., 2022). Furthermore, diarrhea-related illnesses linked to Poor WASH practices are responsible for approximately 50% of childhood undernutrition cases worldwide (Mshida et al., 2018). Children living in homes with improved water facilities have a reduced chance of experiencing growth impairment and being underweight compared with children residing in households that unclean water use for their daily needs (Mshida et al., 2018).

There is a lack of extensive research in Ghana regarding the influence of household access to WASH facilities on child malnutrition. Therefore, this study aimed to investigate the relationship between household access to WASH facilities and childhood undernutrition in Bolgatanga Municipality.

1.2 Problem Statement

Improve sanitation, good hygiene, and access to clean water are essential for maintaining human health and well-being. Safe and adequate WASH is essential in preventing a number of diseases such as diarrhea. Evidence suggests that, improving WASH conditions and practices could avert up to 45% of child deaths worldwide caused by malnutrition (Mshida et al., 2018). Notwithstanding the global improvement in providing clean drinking water and basic sanitation, nearly two billion people worldwide still drink contaminated water and over fifty percent still use inadequate sanitation facilities (Oppong et al., 2022). It is further estimated that 494 million individuals globally defecate in the open space and close to 2 billion persons lack access to basic sanitation (W.H.O, 2022).

In Ghana, 8.9% of families use contaminated water, 81.6% have unimproved sanitation facilities, and about 15.2% of Ghanaians defecate in the open (Oppong et al., 2022). The Northern part of

Ghana has the highest prevalence (20.4%) of households using unimproved water sources compared to the country's prevalence of 8.9%. Additionally, this part of the country is first among households using inadequate sanitation facilities with a prevalence of 92.8% as against 81.6% across the entire country(Oppong et al., 2022). In the Upper East region, 94.6% of families lack access to basic sanitation (The highest in the country) whiles about 8.1% use unimproved drinking water (Oppong et al., 2022).

Different studies in SSA, including those conducted in Ghana, have identified child, maternal, and household factors as persistent risk factors influencing child malnutrition (Akombi et al., 2017; Sulaiman et al., 2018; Boah et al., 2019). However, many of these studies did not consider household WASH components in their assessment. In contrast, other studies have shown that household access to unclean drinking water, poor sanitation facilities, and improper hygiene practices increase the likelihood of childhood undernutrition (Sahiledengle et al., 2022; Mshida et al., 2018 & Bountogo et al., 2022). According to Patlán-Hernández et al. (2022), insufficient WASH practices account for approximately 16% of the global undernutrition burden. Furthermore, Poor WASH practices are associated with diarrhoea-related illnesses, accounting for nearly 50% of child undernutrition cases worldwide (Mshida et al., 2018).

The most recent Ghana Demographic and Health Survey (GDHS) report shows that about 14% of CU5 in the Upper East Region has stunted growth, 9% suffers from wasting, and an estimated 11% are underweight (GSS et al., 2015). Hence, this study aimed to evaluate the impact of household access to WASH facilities on childhood undernutrition in the Bolgatanga Municipality. This survey findings are expected to provide evidence to aid the design of effective interventions and policies that aim to lower undernutrition prevalence in children in the region and Ghana as a whole.

1.3 Justification

Access to WASH facilities is a critical determinant of public health. Access to improved WASH facilities are associated with better hygiene practices, reduced risk of waterborne diseases, and childhood undernutrition. Evaluating the proportion of households with access to these facilities is essential for identifying gaps and implementing effective interventions. In addition, undernutrition remains a leading cause of morbidity and mortality among children under five in low-resource settings. Assessing its prevalence in Bolgatanga Municipality is vital for understanding the extent of the problem and designing targeted nutritional and health programs. Furthermore, investigating the effect of household WASH facilities on childhood undernutrition will provide evidence for integrated WASH and nutrition interventions to improve child health outcomes.

Finally, the findings of this study will guide local policymakers and health authorities in Bolgatanga Municipality in formulating evidence-based strategies to enhance WASH access and combat child undernutrition,which aligns with national health goals and international targets such as the Sustainable Development Goals (SDGs).

1.4 Significance

Sustainable Development Goal (SDG) 2 Target 2.2 seeks to ‘end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age’. In this regard, addressing social and economic inequality, promoting child growth, and accelerating the achievement of sustainable development goal 2 target 2.2 will all depend on addressing all factors associated with child malnutrition through evidence from research. This is especially true given the social and economic burden of malnutrition in LMICs. The results from this study will contribute to the knowledge gap

regarding the potential influence of poor WASH facilities access and child undernutrition. Furthermore, the study's findings will serve as a useful guide for students and academicians in similar research in the future. In addition, the evidence from this study will guide the development and implementation of policies by the Bolgatanga Municipal health authorities and NGOs in the WASH sector that prioritises improving household WASH facilities. This will to combat childhood undernutrition. Finally, the knowledge from this study will lead to community-driven initiatives for better WASH practices by the Bolgatanga Municipal Assembly

1.5 Research Questions

This study sought to answer the following questions:

1. What proportion of households in the Bolgatanga Municipality have access to improved WASH facilities?
2. What is the prevalence of child undernutrition in the Bolgatanga Municipality?
3. What is the effect of household access to WASH facilities on childhood undernutrition in the Bolgatanga Municipality?

1.6 Objectives

1.6.1 General Objective

The general objective of this study was to assess the effect of household access to WASH facilities on childhood undernutrition in the Bolgatanga Municipality.

1.6.2 Specific objectives

The specific objectives of this study were as follows:

1. Determine the proportion of households with access to improved WASH facilities in the Bolgatanga Municipality.

2. Determine the prevalence of child undernutrition in the Bolgatanga Municipality.
3. Assess the effect of household access to WASH facilities on childhood undernutrition in the Bolgatanga Municipality.

1.7 Hypothesis

This study hypothesizes the following:

1. Household access to WASH facilities has no effect on childhood stunting.
2. Household access to WASH facilities has no effect on childhood wasting.
3. Household access to WASH facilities has no effect on childhood underweight.

CHAPTER TWO

LITERATURE REVIEW

2.1 Chapter Introduction

The objective of this literature review is to synthesize current research on how household accessibility to WASH amenities impacts the nutritional status of CU5 years. The chapter begins by examining the theoretical framework and conceptual models that have been used to explain this relationship. It further examines worldwide household WASH service coverage and challenges. The prevalence of childhood undernutrition and its connection with household WASH service availability are also discussed. The chapter concludes by highlighting key research findings.

2.2 Theoretical Frameworks

This study adopted Amartya Sen and Martha Nussbaum's capability approach and social cognitive theory frameworks to explain how inadequate WASH access can lead to childhood undernutrition. These theoretical frameworks are discussed below.

2.2.1 Amartya Sen and Martha Nussbaum's Capability Approach

The Capability Approach is a theoretical framework developed by economist Amartya Sen and philosopher Martha Nussbaum. This theory focuses on enhancing individual freedoms and opportunities to achieve well-being, highlighting what people are actually able to do (their "capabilities") rather than solely their income, resources, or utility outcomes. It has been widely used to address inequality and promote social justice in fields such as development studies, economics, philosophy, and public policy (Sen, 2007).

The Capability Approach was first articulated by Sen Amartya in the 1980s. According to him, well-being should be measured by an individual’s ability to achieve valuable states of being and

doing, termed as “functionings.” His work opposes traditional metrics of development, such as GDP or income due to their failure to capture real freedoms and quality of life (Robeyns, 2006). Sen contends that development should be understood as a process of expanding the real freedoms people enjoy. These freedoms are fundamental to well-being and instrumental in enabling individuals to pursue goals they value. For example, access to education, healthcare, and political rights enables individuals to lead lives of their choosing (Sen, 1999). Martha Nussbaum expanded the approach by offering a concrete list of central capabilities necessary for human flourishing. These include health, education, political freedoms, and control over one’s environment. Her work highlights the importance of addressing gender inequalities and the ethical dimensions of justice (Nussbaum, 2011).

The central team in this approach is the distinction between "functionings" (achieved states, such as being healthy or literate) and "capabilities" (freedoms to achieve these states). A good life involves both valuable “functionings” and the genuine freedom to achieve them (Robeyns, 2005). The approach recognizes that individuals have diverse needs and aspirations. Nussbaum has particularly focused on gender inequalities, arguing that women's capabilities are often curtailed due to systemic discrimination. Her framework provides a way to assess and redress these injustices (Nussbaum, 2000).

2.2.1.1 Relevance of Amartya Sen and Martha Nussbaum's Capability Approach to the Study

The “Capability Approach” is a useful framework for analyzing and addressing inequalities in household access to water, sanitation, and hygiene (WASH) facilities. By concentrating on what individuals are able to do and be (their “capabilities”), this approach emphasizes the significance

of enabling access to WASH facilities as a critical factor in achieving well-being and human development.

Access to clean water, proper sanitation, and hygiene are essential for achieving a life of dignity and health. The Capability Approach highlights that 'Functionings' such as being free from disease and living a healthy life depend heavily on access to WASH facilities (Mehta, 2014). Capabilities are expanded when individuals have access to WASH, as it enables them to pursue other valuable activities, such as education, employment, and social participation (UNICEF, 2024). The Capability Approach stresses addressing inequalities in access to resources. Many marginalized communities lack adequate WASH infrastructure due to systemic neglect or geographic challenges. Ensuring access to WASH can mitigate gender inequalities, as women and girls often bear the burden of water collection and suffer disproportionately from inadequate sanitation (Nussbaum, 2000). Again, ensuring access to WASH promotes dignity and social inclusion, particularly for those in rural or informal urban settlements (Egge & Ajibade, 2023). The approach recognizes that achieving health is not merely about access to healthcare but also involves addressing determinants such as clean water and sanitation. Poor WASH access can lead to waterborne diseases, malnutrition, and stunted growth in children, limiting their future capabilities (W.H.O, 2022).

Policies guided by the Capability Approach can prioritize investments in WASH infrastructure to maximize the freedoms and opportunities of disadvantaged groups (Mehta, 2014). For example, subsidizing household toilets or ensuring free access to clean water expands individual capabilities and fosters equity.

2.2.2 Social Cognitive Theory

Social Cognitive Theory (SCT) is a framework for understanding, predicting, and changing human behaviour. It emphasizes the role of observational learning, social experiences, and reciprocal determinism in understanding and predicting human behaviour. SCT suggests that learning occurs in a social context and can happen purely through observation or direct instruction, even in the absence of motor reproduction or direct reinforcement (Bandura, 2014). Bandura, the primary architect of SCT, challenged the behaviourist view that learning is solely a result of direct reinforcement. He introduced the concept of observational learning, where individuals can learn by watching others, without performing the actions themselves or receiving direct reinforcement (Bandura, 2014). His theoretical arguments are centered on observational learning, reciprocal determinism, Self-efficacy, and moral agency.

Bandura's research demonstrated that people can acquire new behaviours by observing others, a significant departure from traditional behaviourist theories that emphasized direct reinforcement (EANDURA, 1977). His concept of reciprocal determinism suggests that a person's behaviour, personal factors (such as cognitive skills or attitudes), and environmental influences all interact and influence each other bidirectionally. This dynamic interplay is central to understanding behaviour within SCT (Riley et al., 2016). A key component of SCT is self-efficacy. This refers to an individual's belief in their ability to succeed in specific situations. This belief can significantly influence how people approach goals, tasks, and challenges (Bandura & Wessels, 1997). Moral agency on the other hand, concerns the role of moral reasoning and self-regulatory mechanisms in guiding moral conduct, emphasizing that moral behaviour is influenced by cognitive processes and social factors (Bandura et al., 1996). SCT focuses predominantly on

social and environmental influences, and it remains a robust framework for understanding the complexities of human learning and behaviour.

2.2.2.1 Relevance of the Social Cognitive Theory to the Study

SCT is relevant for understanding how psychosocial factors influence household behaviours related to water, sanitation, and hygiene (WASH) facilities. This theory emphasizes the role of observational learning, self-efficacy, and social norms in shaping individual behaviours, which are critical for promoting effective WASH practices. Self-efficacy is a key determinant of behavioural intentions in water conservation, where higher self-efficacy correlates with increased adoption of water-efficient behaviours (Shahangian et al., 2021). Observational learning influences behaviours, as individuals often mimic the actions of others in their community, impacting toileting and hygiene practices (Hebert-Beirne et al., 2021). While SCT effectively explains the psychosocial factors influencing WASH behaviours, structural barriers such as economic constraints and infrastructure deficiencies can also play a significant role in access to these facilities (Hulland et al., 2015).

2.3 Conceptual Framework

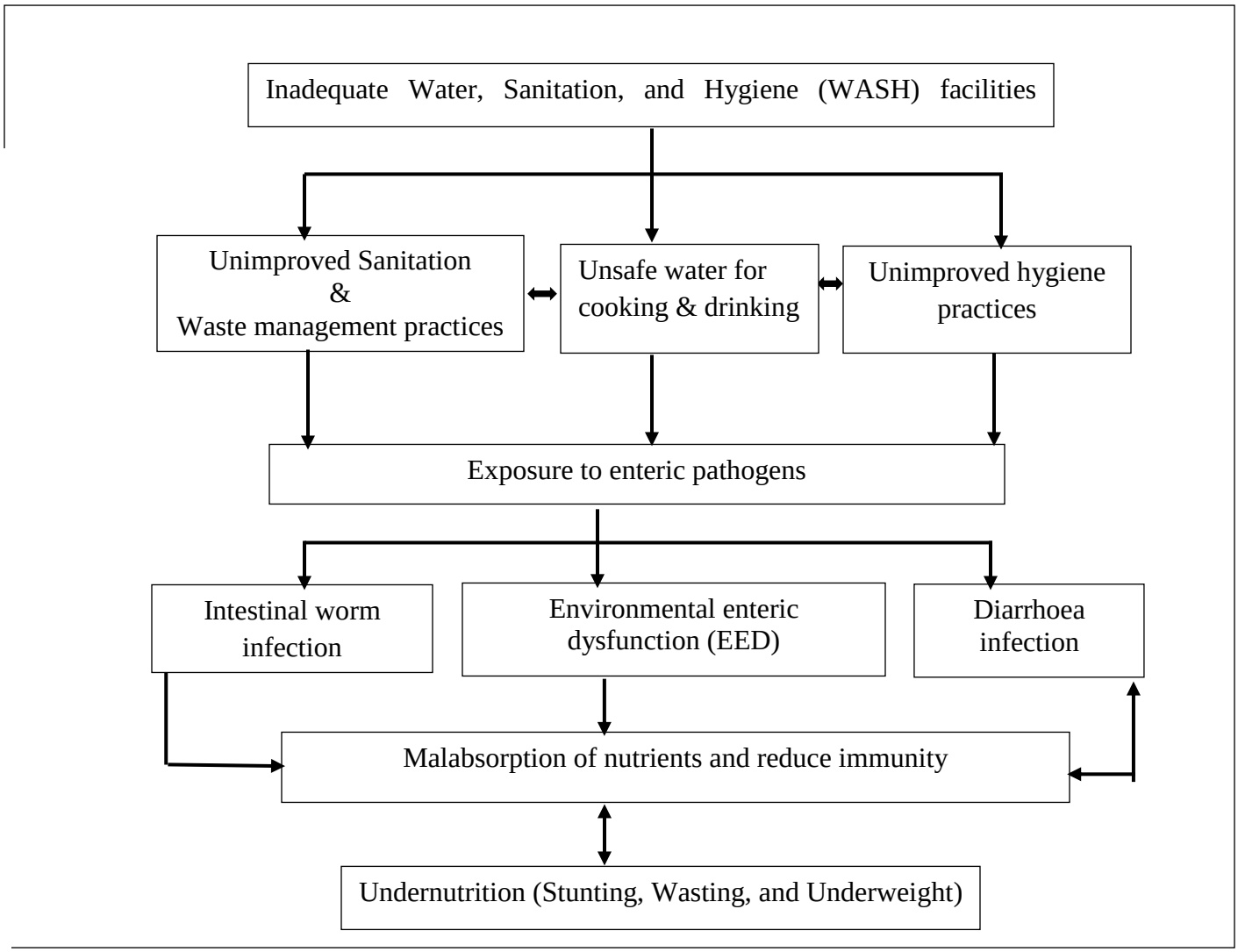
2.3.1 The WASH nutrition framework

This conceptual framework highlights the complex interplay between poor WASH practices, exposure to pathogens, nutrient malabsorption, and reduced immune function, and how these factors can contribute to childhood undernutrition. This framework was adopted based on the theories used in this study.

According to this framework, poor WASH facilities in households can result in inadequate hygiene, substandard sanitation practices, and reliance on contaminated water sources such as rivers, lakes, and wells (WHO, 2019). Consequently, this may lead to the spread of germs,

exposing young children to intestinal worm infection, environmental enteric dysfunction, and pathogens that cause illnesses such as diarrhea, cholera, and typhoid fever (Ngure et al., 2014). Diarrhea may lead to reduced appetite in children, which may result in a low intake of important nutrients, leading to malnutrition (Dewey & Mayers, 2011). Intestinal worm infection can damage the lining of the intestine, reducing its ability to absorb nutrients and leading to undernutrition. On the other hand, Environmental enteric dysfunction can result in impaired nutrient absorption, contributing to undernutrition (Budge et al., 2019). Undernutrition can also compromise the immune system and increase the vulnerability of children to diarrheal infections. This creates a cycle in which poor WASH practices result in undernutrition, subsequently increasing susceptibility to infections and further undernutrition (Mshida et al. 2018). This is illustrated as below.

Figure 1: The WASH nutrition framework



Source: Dearden et al., 2017

2.4 Definitions

Childhood undernutrition refers to a condition in which a child's body does not receive sufficient nutrients to support healthy growth and development. This condition arises from inadequate dietary intake and/or recurrent infectious diseases (Saba et al., 2016). It is common in LMICs, where nutritious foods and quality healthcare are often limited. Undernutrition can occur in different forms, including stunting, wasting, and underweight (Ersado, 2022).

The WHO characterizes stunting as a condition whereby a child's measurement of height relative to age is more than or equal to two standard deviations below the median for children of similar age and gender who are well-nourished. Stunting serves as an indicator of the prolonged consequences of persistent inadequate nutrition during the initial 1,000 days of life. This condition can result in physical and cognitive impairments and has also been linked to increased morbidity and mortality rates in children (Ersado, 2022).

Wasting reflects a child's weight, which is significantly lower than what is considered normal for height. It typically results from acute undernutrition such as a sudden shortage of food or severe illness (Ersado, 2022).

Underweight is a condition in which a child's weight is lower than what is considered normal for their age and sex. It can be caused by both acute and chronic undernutrition (Ersado, 2022).

Childhood undernutrition can have significant consequences on a child’s health, both in the short term and in the future. This can lower immunity, making them more prone to diseases and infections. It can also impair cognitive development and lead to learning difficulties. In severe cases, undernutrition can result in death (Miller et al., 2016). In the long term, childhood undernutrition can increase the likelihood of chronic diseases, including cardiovascular conditions and diabetes (Momberg et al., 2021).

2.5 Burden of childhood undernutrition

The problem of undernutrition during early childhood remains a critical public health issue, particularly for those under the age of five (Zhang et al., 2022). In the year 2020, data revealed that close to 149 million children globally within this age bracket were affected by stunting, representing about 22% of children in that age group. Moreover, around 45 million children, or roughly 7.3%, were afflicted by wasting (WHO, 2021). Shockingly, undernutrition is associated with nearly 45% of mortalities among CU5 years, according to reports from the WHO (WHO, 2021).

The rate of child undernutrition is disproportionately high in LMICs. An analysis conducted by Ssentongo et al. (2021) among some LMICs found that 29% of children under five years were undernourished. Stunting (32%), wasting (7.1%) and underweight (16.3%) were further observed among the children. In SSA, undernutrition continues remains a threat to child survival with one out of every eight under-five years child mortality being linked to malnutrition including undernutrition (Sulaiman et al., 2018). According to the Millennium Development Goals (MDGs) report in 2015, SSA has a disproportionate number of undernourished children globally. This region accounts for one-third of childhood undernutrition cases worldwide (WHO, 2016). Among CU5 years in SSA, about 39% are stunted, 10% are wasted whilst 25% are underweight (WHO, 2016). Similarly, stunting (31.3%), wasting (8.1%) and underweight (17.0%) have been reported in a study among some 32 SSA countries using DHS data from 2010 to 2019 (Aboagye et al., 2022). Moreover, Takele and colleagues in their study noted that 35% of children in SSA are stunted (Takele et al., 2022). Further, WHO estimates show that over 30 million children in 15 countries which are worst affected by undernutrition suffer from wasting (acutely

malnourished). Among these children, about 8 million are severely wasted (the worst type of undernutrition). SSA countries accounted for more than half of these cases (WHO 2023).

Additionally, a cross-sectional survey of 1427 households in Nepal revealed that 55.5% of the children were undernourished (Shrestha et al., 2020). Similarly, an analysis of the Ethiopian DHS shows that 12% of the children below 59 months were acutely malnourished or wasted (van Cooten et al., 2019). The prevalence of undernutrition is about 23.5% (Kenya), 5.3% (Comoros), 9.4% (Ethiopia), 5.7% (Burundi), 4.6% (Madagascar), 5.5% (Malawi), 9.5% (Mozambique), 3.7% (Rwanda), 9.4% (Tanzania), 5.4% (Uganda), 11.3% (Zambia), and 6.8% (Zimbabwe) according to an analysis of DHS data in 12 East African countries. The highest prevalence in this study was found in Kenya (23.5%) whilst Rwanda (3.7%) recorded the lowest (Tesema et al., 2021). Moreover in Northeast Ethiopia, a study reported the prevalence of stunting to be 50.2%, wasting 11.3%, and underweight 28% (Engidaye et al., 2022). Another study in Northern Sudan among children under the age of five reported that 42.5% of the children were stunted, 21% of them were wasted while about 32.7% were underweight (Wasihun et al., 2018). Similarly, a study in Zambia involving families with children aged below five years found the occurrence of stunting in 31.6% of the children. Also, 15.5% of them were underweight while an additional 4.5% were found to be wasted (Mshida et al., 2018).

In Ghana, the rate of childhood undernutrition is still high. An analysis carried out by Boah et al., (2019) in Ghana revealed that 10.4% of children aged below five years are underweight, 5.3% are affected by wasting, and about 18.4% have stunted growth. A similar survey in Nkwanta South Municipality found that 12.5% of children aged below five years were stunted while about 27.5% suffered from wasting (Danso & Appiah, 2023). Additionally, an analysis by Ewusie and friends using Ghana Demography and Health and Survey (GDHS) data set revealed that 27.5 %

of children below five years had stunted growth, 13.8 % were underweight and roughly 8.9 % were suffering from wasting (Ewusie et al., 2017). Furthermore, The prevalence of childhood stunting (28.2%), wasting (9.9%), and underweight (19.3%) were observed from a study in Northern Ghana (Ali et al., 2017).

2.6 Definition and Overview of WASH

"WASH" is an acronym representing Water, Sanitation, and Hygiene. It is a term used broadly within the development community to describe initiatives and strategies focused on improving access to potable water, providing sufficient sanitation infrastructure, and promoting beneficial hygiene behaviors. The integrated nature of these three elements is crucial for sustaining health and mitigating the transmission of infectious diseases (WHO, 2019).

'Water' in the context of WASH refers to access to water that is considered safe for drinking, cooking, cleaning, and other domestic uses. It encompasses the availability of adequate quantities of water that are free from harmful contaminants such as pathogens, chemicals, and other impurities that can be detrimental to human health (WHO, 2019).

Sanitation involves the proper management and disposal of human excreta, including the provision of toilets, sewer infrastructure, and waste management systems. It is a key factor in halting the spread of illnesses, including diarrhea, which is recognized as a leading contributor to the high mortality rates observed in CU5 years of age (CDC, 2021).

Hygiene pertains to the behaviors and practices that support cleanliness leading to the prevention of germs transmission. This includes handwashing, using clean utensils and surfaces for cooking, and maintaining personal hygiene such as bathing regularly (WHO& UNICEF, 2021).

Under MDG 7 (Environmental Sustainability), WHO together with UNICEF through the 'Joint Monitoring Program' (JMP) classified WASH services into two broader categories which are

improved and unimproved WASH services. Even though this categorization has evolved, it is still one of the basic ways of monitoring household WASH services (WHO& UNICEF, 2021).

Improved water refers to water sources free from contamination, and may comprise systems like piped water networks, boreholes, or safeguarded wells. (Okuba, 2022). Improved sanitation access refers to utilizing a facility that effectively isolates human excreta from direct contact with the body, examples of which include toilets or latrines with proper designs (Okuba, 2022). Improved hygiene facilities refer to access to facilities that enable proper hygiene activities such as the availability and use of water and soap for hand cleaning (Okuba, 2022).

Unimproved water refers to contaminated water sources. These include surface water, unprotected wells, or vendors selling water from trucks. Unimproved sanitation refers to facilities that fail to effectively separate human excreta from human contact such as open defecation or pit latrines without proper design and structure. While unimproved hygiene facilities refer to the absence of facilities or inadequate facilities for hygiene practices (Okuba, 2022).

Table 1: JMP categorization of household WASH coverage

Component	Categorization of households	Description for categorization
Drinking Water	Using an unimproved drinking water source	Surface water (rivers, dams, lakes, streams, canals, ponds, irrigation channels), unprotected dug wells, unprotected springs, carts with small tanks or drums, tanker trunks
	Using an improved drinking water source	Public tabs or standpipes, tube wells or boreholes, protected springs, rainwaters, piped water into dwellings, yards or plot

Sanitation	Not using improved sanitation	open defecation, pit latrines without slabs, hanging latrines, and use of improved facilities by more than one household
	Using improved sanitation	Flush or pour-flush to piped sewer or septic tank or latrine pit, ventilated improved pit (VIP) latrine, pit latrine with slab and composting toilet
Hygiene	Using adequate hygiene	Availability of soap and water for hand washing
	Not using adequate hygiene	Absence of soap, water, or both in the hand-washing process

(source: Bartram et al., 2014)

2.7 WASH Situation and Coverage

2.7.1 Water

Water is a crucial resource for sustaining human life. However, nearly 2.2 billion people worldwide lack access to safe water (WHO & UNICEF, 2021). This situation is most severe among developing countries where clean water access is often hampered by several factors including climate change and pollution. Based on information from the JMP, around 44% of individuals in developing nations lack access to drinking water services that are managed safely (WHO & UNICEF, 2021).

Across some 23 SSA countries, coverage of safe household drinking water services stands at approximately 64%, with Chad having the lowest coverage of 41%, while the Gambia and South Africa have the highest coverage of 92% (Rahut et al., 2022).

clean water Access is unevenly distributed, especially in many LMICs with rural and marginalized populations being disproportionately affected (WHO & UNICEF, 2021). An analysis of Nigeria's DHS shows that 66% of families have safe drinking water sources. However, improved water coverage was estimated to be 74% in urban areas and 52% in rural areas (NPC/ICF, 2019). Similarly, research conducted in South Africa revealed a significant disparity in improved water coverage between rural and urban inhabitants (Khabo-Mmekoa & Momba, 2019).

In Ghana, significant improvement has been made in the water sector. As per the latest GSS report 2021, 87.7% of Ghanaian households have safe water systems as against 73% in 2011 (GSS, 2021). Ghana is on track to fulfill the mandate stated in target 6.1 of the SDG goal 6 by 2030 if current efforts in the water sector remain (Monney & Antwi-Agyei, 2018).

Much like numerous other nations, Ghana also experiences notable inequality in water supply between rural and urban communities. According to the GSS (2021), access to basic water is about 96.4% in urban centres compared to 74.4% in rural communities. Ghana's household water coverage problem is affected by the level of water quality. Most underserved rural communities in Ghana obtain their drinking water from unsafe sources such as rivers, streams, springs, lakes, and ponds (Yeboah et al., 2022). Despite Ghana's progress in the water sector, about 8.9 % of households continue to rely on these unimproved drinking water sources (Oppong et al., 2022).

Unimproved drinking water use varied significantly by region, with the Northern region having the highest proportion (20.4%) of households without improved water sources while the Greater Accra region has the lowest coverage (0.3%) (Oppong et al., 2022).

2.7.2 Sanitation

The objective of SDG Target 6.2 is to end open defecation by 2030 and provide equitable and sufficient access to sanitation and hygiene for all. However in 2020, only 54% of the world population had sufficient sanitation facilities (Ritchie & Roser, 2021). Additionally, a whopping 494 million people worldwide engage in open defecation, while close to 2 billion individuals lack essential sanitation facilities (WHO, 2022). In LMICs, the sanitation situation is particularly dire. According to the JMP, 60% of the people in LMICs do not have sanitation services that are considered safe (WHO & UNICEF, 2021).

Countries such as Jordan (98.2%), Turkey (96.6%), Albania (97%), and Tajikistan (96.5%) have made good progress in providing basic sanitation. Almost every household in these countries has a safe sanitation facility (Rahut et al., 2022). On the contrary, only 77.6% of families in Armenia had access to sanitation facilities whilst South and Southeast Asian countries such as India (48.51%), Afghanistan (26.1%), Cambodia (46.11%), Bangladesh (44.1%), and Timor-Leste (51.81%) continue to have the lowest improved sanitation facilities coverage (Rahut et al., 2022).

In 2015, SSA countries failed to meet MDG goals on sanitation. It was reported that this region had the lowest sanitation coverage globally, with roughly 695 million individuals utilizing unimproved sanitation systems (WHO/UNICEF JMP, 2015). Currently, safe sanitation facilities availability among families in this sub-region is still quite low. According to Rahut et al. (2022), the prevalence of basic sanitation coverage among households in SSA countries is only 31

percent. Countries such as Chad and Ethiopia have the lowest household sanitation system coverage in SSA. Sanitation services are only present in 6 out of 100 households (6%) in these two countries. Further, out of 21 SSA countries, 13 had basic sanitation coverage of less than 40%. According to Lawrence and friends, around 44% of individuals in Zambia lack access to safe sanitation systems (Lawrence et al., 2016). Kamara et al. (2017) report that access to safe sanitation is available to 15.4% of the population in Tanzania and this is mostly found in urban communities. Furthermore, Kant et al. (2020) carried out a study in Northern India and noted that improved sanitation access was available to about 85% of the households. In Southern Ethiopia, a study report shows that only 27% of families have safe sanitation services (Afework et al., 2022). Meanwhile in Sierra Leone, Sesay et al. (2022) noted that only 42% of households have improved sanitation systems. In Vietnam, a study reported that 61% of families have improved sanitation services available in their households (Huong et al., 2020).

Similar to many other African nations, Ghana confronts significant hurdles in meeting the demand for sufficient and enhanced sanitation services for both its rural and urban populace. The progress made to enhance households' access to better sanitation systems in the country is less rapid compared to that of basic water supply. Whereas Ghana is on track to achieving universal national basic water supply coverage, the same cannot be said about improved sanitation facilities. As of 2018, improved sanitation services were only available to one in five families in the country (Appiah-Effah et al., 2019). According to GSS (2021), about 17.7% of Ghanaians still practice open defecation. A study by Akpakli et al. (2018) involving 16,353 households found that Improved sanitation facilities were not available to 85.94% of the study participants. Another nationwide survey by Oppong et al. (2022) found that 81.6% of families are utilizing unimproved sanitation systems, and about 15.2% practice open defecation. The study also found

that 92.8% of families in Northern Ghana use inadequate sanitation facilities while about 94.6% in the Upper East region lack access to basic sanitation services (Oppong et al., 2022). The problem of insufficient sanitation amenities is more profound in rural communities. for instance, Akpakli et al. (2018) carried out a study that suggested that 86% of rural households lack safe sanitation systems compared to 70.6% among urban families.

2.7.3 Hygiene

the outbreak of COVID-19 emphasized the benefits of regular hand cleaning with soap and water. This simple act is a cost-effective way of preventing infectious disease transmission. Despite significant progress in improving household hygiene practices in some countries, many other countries such as those in developing countries are still lagging. An analysis in some 29 SSA countries using data from DHS revealed that 66% of homes in these countries have limited hand hygiene facilities on their premises (Endalew et al., 2022). 93% of households in Indonesia have better hygiene services whilst in Guatemala, 80.4% of families have basic hygiene facilities. In Haiti however, around 75% of families do not have better hand-washing facilities. Moreover, only 35.9% of households in Afghanistan, 38.7% in Bangladesh, and 47.1% in Nepal have adequate hand-washing facilities (Rahut et al., 2022). Another study In Bangladesh found that even though 77.6% of the households surveyed had hand hygiene facilities present in their premises, roughly, 16.4% had water and soap available for washing hands (Jubayer et al., 2022). An investigation by Rahut et al. (2022), reported that only 31% of families In the SSA region have adequate hand-washing facilities. The study further highlights that Gambia (12.5%), Burundi (5.3%), and Malawi (10.5%) have the lowest hygiene services coverage. In Sierra Leone, a cross-sectional study by Sesay et al. (2022) among 1002 households found that only 5% of families have adequate hand hygiene services. A demographic and health survey involving

14,156 households by Gaffan et al. (2022) in Benin revealed that only 10% of households in the country have available hygiene facilities. Results of another national demographic and health survey conducted in Nepal indicate that only 37.5% of households practice proper hand hygiene with soap and water on a regular basis (S. K. Shrestha et al., 2020). About 66.4% of households in Kenya, 59.2% in Uganda, 76.4% in Rwanda, and 80.7% in Tanzania have hand hygiene facilities present in their homes (Kisaakye et al., 2021). Furthermore, a study in Ethiopia suggests that only 8% of families have hand-washing facilities in their homes (Odo & Mekonnen, 2021).

In Ghana, surveys on household hand hygiene habits are scarce and the few available are generally very old. According to estimates from the recent GDHS, about 53% of Ghanaian households have designated handwashing stations (GSS), 2015). Among those with designated handwashing stations, 39% have both soap and water available for handwashing, 19% have only water, and about 4% have soap but no water. Further, less than 1% have water and other cleansing agents other than soap. Additionally, water, soap, or any cleaning agent were absent in about 37 percent of these households (GSS), 2015). The Upper East Region was found to have the lowest (18%) number of households with water and soap at designated hand washing locations compared to about 51% in the Greater Accra Region (GSS), 2015). There is however, improvement in the percentage of families with improved hand hygiene services in Ghana. According to reports from the latest Ghana multiple indicator cluster survey, about 48.5% of Ghanaian households have improved hand hygiene facilities on their premises for hand washing (GSS & UNICEF, 2018).

2.8 Determinants of childhood undernutrition

Childhood undernutrition is a multifaceted problem that is caused by the interaction between various factors. These factors are classified into three namely: immediate, underlying, and basic (Kassie & Workie, 2020). The immediate factors involve the child's health and food intake, which depend on the type and amount of food, hygiene, feeding habits, and health care access. The underlying factors are the family and community aspects that influence the food and health resources' availability and use, such as education, income, water supply, sanitation, and gender equity. The basic factors are the structural and systemic aspects that affect the social, economic, and political context, such as culture, climate change, governance, policies, and institutions (Kassie & Workie, 2020). Several epidemiological studies have shown that diseases such as diarrhea, inadequate diet, and socioeconomic status are connected with childhood undernutrition (Lee et al., 2022). In addition, childhood undernutrition is consistently influenced by various factors including the child's age, household wealth index, sex of the child, child birth weight, maternal birth spacing, and birth order, as well as the mother's education, ANC utilization, family structure, and family size. (Boah et al., 2019; Tesema et al., 2021; Hall et al., 2020). Furthermore, children with mothers having multiple births and unmarried are also found to be associated with increased odds of childhood undernutrition (Addo et al., 2023). According to a study by Ali et al. (2017), child feeding practices, children with underweight mothers, and children with low birthweight are linked to undernutrition in children aged under five years. Undernutrition in children is also influenced by the type and quality of household sanitation, housing conditions, unprotected water sources, and female-headed households (Sahiledengle et al., 2022).

2.9 Effect of household access to WASH facilities on childhood undernutrition

2.9.1 Access to clean water and childhood undernutrition

Household-safe water use is a critical determinant of health and nutrition outcomes, particularly among children. Unsafe water consumption can result in waterborne diseases that contribute to childhood undernutrition. A systematic analysis carried out among 49 studies in SSA noted that unsafe drinking water use among families was a consistent risk factor for childhood stunting wasting and underweight (Akombi et al., 2017). A similar investigation in China suggests that unimproved water access increases the odds of stunting in children (Gao et al., 2022). A survey conducted in Tanzania shows that children in families using surface water for domestic purposes had an increased likelihood of being stunted and underweight (Mshida et al., 2018). An analysis of a nationwide DHS data set in Ethiopia shows that families lacking safe drinking water had an increased likelihood of having stunted children compared to those with improved drinking water facilities (Wondimu, 2016). According to Morrison et al. (2020), children from improved water households are less likely to be stunted and underweight compared to families with sufficient water sources. Another study noted that unsafe and inadequate drinking water are linked to increased odds of childhood underweight (Moyeda-Carabaza & Murimi, 2021). In Afghanistan, the risk of acute malnutrition among children was two times higher in households using unprotected water sources compared to their counterparts (Frozanfar et al., 2016). Similarly, previous studies have linked household unsafe water consumption with increased odds of childhood wasting in India and Bangladesh (Harding et al., 2018), and higher odds of stunting among children in Ethiopia (Kwami et al., 2019).

Contrary to these findings, several other studies found no relationship between household unsafe water use and childhood undernutrition. A study conducted in Ethiopia using national DHS data

revealed that household unimproved drinking water is not associated with childhood underweight and wasting (Wondimu, 2016). Consistent with this finding was a cross-sectional study involving 35 LMICs which revealed that underweight in children connected with unsafe drinking water (Li et al., 2020). A study conducted by Sahiledengle and colleagues discovered that children from families utilizing unimproved drinking water have reduced odds of experiencing stunting and wasting (Sahiledengle et al., 2022). A cohort study carried out among households in Ethiopia, Vietnam, India, and Peru observed no statistical relationship between household-improved water access and childhood stunting (Dearden et al., 2017). Furthermore, van Cooten et al. (2019) in their study found no correlation between unsafe household water use and childhood wasting. A similar study conducted in Tanzania reported no evidence between household improved water use and under-five child nutritional status (Khamis et al., 2019). Likewise, a study conducted in rural India revealed no correlation between child nutritional status and household-improved water access (Rah et al., 2015).

2.9.2 Sanitation practices and childhood undernutrition

Access to sanitation facilities is essential for maintaining good health and nutrition. Inadequate sanitation can facilitate the transmission of diseases, potentially contributing to undernutrition. An analysis conducted in rural Ethiopia revealed that an increase in improved toilet facilities use among families is connected with a reduction in the odds of childhood wasting (van Cooten et al., 2019). Another survey conducted among families in Africa and Asia identified reduced odds of undernutrition among CU5 residing in households with sufficient sanitation services (Anand & Roy, 2016). An examination of the Ethiopian DHS data indicates that children from families utilizing unsafe sanitation services were more likely to be stunted (Sahiledengle et al., 2022). Additionally, a cohort study discovered that children from families using improved sanitation

services had a decreased risk of stunting compared to those from households using unimproved sanitation facilities (Dearden et al., 2017). It has been found in another study that stunting is associated with children whose households do not have improved toilets (Novak, 2014). As a result of open defecation among families, the risk of child wasting was about 11 times higher among children in these households compared to those with improved sanitation practices (H. Jung Lee et al., 2022). Furthermore, a survey in Indonesia revealed that improvements in household sanitation facilities led to a 29% reduction in childhood stunting (Rah et al., 2020). Moreover, the risk of child wasting increases among families practicing open defecation In Myanmar (Blankenship et al., 2020) and Northwest Ethiopia (Mulu et al., 2022) compared to those households with proper toilet services. The absence of an improved toilet facility was a critical determinant of severe childhood wasting according to a study in Chad (Dodos et al., 2018). Moreover, evidence from a survey of 34 countries shows that using an improved toilet to dispose of child feces is connected with reduced odds of childhood undernutrition (Bauza & Guest, 2017). According to a study carried out in Nepal, the likelihood of undernutrition is common among children with mothers who practice unsafe disposal of child excreta compared to mothers who did so in a sanitary manner. The same study noted that the likelihood of underweight in children from homes without improved toilets was 46% higher compared to kids who lived in improved sanitation families (Dhital, 2021). Hall and friends in their study reported a significant increase in stunting and underweight among children living in households without improved toilet facilities (Hall et al., 2020). According to Rah et al. (2015), households with safe toilet facilities are associated with reduced odds of childhood stunting.

Contrary to these findings, a survey found no link between child wasting and households that used unsafe sanitation services or practiced open defecation. (Sahiledengle et al., 2022). Similar

to this study, the likelihood of childhood wasting was not predicted by the type of household sanitation facility according to a study in Tanzania (Khamis et al., 2019).

2.9.3 Hygiene practices and childhood undernutrition

Hygiene practices are vital for preventing diseases. Good hygiene habits including hand washing using soap and water is known to prevent infectious disease transmission. Children from households whose mothers have poor hygiene habits are more likely to experience recurrent infections, which can cause poor absorption of nutrients, leading to malnutrition. A case-control study carried out in Chad revealed a significant association between poor hand hygiene practices among child caretakers and severe wasting in children (Dodos et al., 2018). Additionally, the risk of wasting was found to be two times more likely to occur among young children in households that irregularly wash their water-transporting containers (Marshak et al., 2017). In Nepal, wasting is more common among children under five years from households without a permanent handwashing station (Dhital, 2021). The study further revealed that children who live in households where soap and water aren't accessible for handwashing are more likely to be undernourished as against those from households where soap and water are accessible (Dhital, 2021). Furthermore in Ethiopia, the availability of improved handwashing facilities in households is connected with a 17% reduction in childhood underweight (Bekele et al., 2020). According to the survey report by Girma et al. (2019), inadequate maternal handwashing practices are correlated with increased odds of childhood wasting and underweight. In Southern Ethiopia, children with mothers having sub-optimal hand hygiene practices were found to have increased odds of stunting (Woldesenbet et al., 2023). Lower stunting prevalence was found among children whose mothers practice handwashing with water after visiting the toilet (Lee et al. 2022). Congruent to the above findings, maternal handwashing using soap and water strongly

reduced the chances of childhood stunting in rural Ethiopia (Kwami et al., 2019). In India, a decreased risk of childhood stunting was linked with mothers' or caregivers' handwashing practices (Rah et al., 2015). Further, caregivers handwashing practices was a strong predictor of childhood stunting according to a study in North East Ethiopia (Sewenet et al., 2022).

As opposed to the above observations, a survey carried out in Tanzania reported no significant relationship between the presence of handwashing facilities among families and under-five child wasting (Khamis et al., 2019).

2.9.4 Combined WASH practices and childhood undernutrition

The combination of improved WASH components or interventions is shown to be effective in reducing childhood undernutrition. A meta-analysis comprising 10 studies demonstrated that integrated WASH interventions had a more pronounced effect in mitigating under-five child stunting compared to individual WASH components (Gizaw & Worku, 2019). The risk of childhood stunting was shown to decreased by 29% among children residing in households with both improved sanitation and adequate handwashing facilities (Bekele et al., 2020). From a large prospective cohort study carried out in Sudan, children residing in households having safe water and sanitation facilities had reduced odds of stunting (Ngure et al., 2014). Further, a study reports strong correlation between childhood stunting and household personal hygiene practices in combination with either improved water or toilet facilities (Rah et al., 2015). An observational study in rural Bangladesh compared children's growth in different WASH combinations. It was found that children residing in households with enhanced sanitation and hygiene facilities were at a reduced risk of stunting in comparison to those without such facilities (Lin et al., 2013). On the contrary, a review of 44 studies reported no evidence of an effect between WASH interventions and child wasting and underweight (Dangour et al., 2013).

2.10 Conclusion

In conclusion, The effect of household WASH facilities access on undernutrition among CU5 years is unclear from various studies. Whereas some studies show a link, others do not. This topic has not been well-studied in Ghana, especially in the Upper East Region where this research takes place.

CHAPTER THREE

METHODOLOGY

3.1 Study area

The survey took place in Bolgatanga Municipality, the regional capital of the Upper East Region. It covers a 729 sq. km of land area bordering Bongo District to the North, South, and East by Talensi, and Kassena-Nankana District to the West. The district population is estimated at 130890 people. About 26179 (20%) of this population are children within the age range of 11-59 months. Additionally, 31414 (24%) of them are women in their fertility age (WIFA). The dominant tribe is called Frafra, but there are also significant tribes from the Upper East Region and other nearby regions (B.M.H.D, 2021).

The majority of the population are peasant farmers. The basket industry employs 57% of the labor force which is mostly women, while trade and commerce (19%), manufacturing (11.92%), community/social services (7.4%), and other industries have smaller shares (B.M.H.D, 2021).

The municipality has a tropical climate with two seasons. The long dry season, is from October to April, and the wet season is from May to October. The rainfall is 950 mm on average, and the temperatures range from 12 °C in December to 45 °C in March and April. The guinea savannah woodland's native vegetation is made up of short, widely spaced deciduous trees and a ground flora that is burned by fire or scorched by the sun during the protracted dry season. The shea nut, dawadawa, baobab, and acacia trees are the most popular commercial species. The majority of the local water bodies are mostly protected by the municipality's forest reserve (B.M.H.D, 2021).

The municipality has a water supply shortage problem. Most of the existing water bodies dry up during the dry season and bore holes and wells almost cease to function as a result of the falling water table. The municipal water supply system is divided into rural and urban areas. The rural

water supply system mostly comprises rivers, dams, ponds and dugouts, precipitation, dug wells, and some other natural water sources. These sources make up 40% of their water needs even though they are unsafe. A network of piped systems that supply water to consumers makes up the majority of the urban water supply system. The disposal of waste is one of the Municipality's most significant problems. The majority of homes lack bathhouse drains, and those that do have them lack feeder drains to connect them to larger drains. This causes the wastewater from homes to stagnate, which breeds mosquitoes and produces bad odor. Only 15% of the waste produced overall is collected for disposal. In the town, there are about 40 garbage sites, but only 22 refuse bins and two skip loaders are available. As a result, elevated landfills become rat breeding areas (B.M.H.D, 2021).

There are nine (9) sub-districts with 47 medical facilities in the Municipality providing people with various levels of medical care. These include Sumbrungu West, Bolga Central, Sherigu, Bolga North, Kalbeo, Sumbrungu East, Bolga South, and Plaza (B.M.H.D, 2021).

Figure 2: A map of Bolgatanga municipality (Source: Bolgatanga Municipal Health Directorate, 2021).

3.2 Study design

A cross-sectional study design using selected health facilities within the Bolgatanga municipality was carried out. A Cross-sectional study design is a type of observational study where the researcher simultaneously examines the exposures and the outcome variables in the study participants. Cross-sectional designs are useful for conducting population-based surveys and determining exposures' prevalence and outcomes. It is also valuable for establishing preliminary association between exposures and disease outcomes, and for measuring odds ratios (OR). These study types may benefit public health planning, monitoring, and assessment. Using this study design therefore, will help in determining the current prevalence of undernutrition, as well as its WASH determinants. However, this study design cannot be used to determine cause and effect (Setia, 2016).

3.3 Study population

Mother-baby pairs with children aged 0-59 months who visit the child welfare clinic (CWC) at the selected health centers in the Bolgatanga municipal were eligible to be enrolled in the study.

3.4 Sample size calculation

The sample size is based on Cochrane's formula (Cochran, 1977) for determining proportions for a single population given by:

$$n = \frac{Z^2(pq)}{d^2}$$

n = Sample size

z = Z-score at 95% confidence interval = 1.96

p = Proportion of malnourished children in the study area

= 50% = 0.50

q = proportion of children who are not malnourished (1 – p) = 1-0.5 = 0.5

d = margin of error = 5%

$$n = \frac{1.96^2 \; x \; 0.50 \; x \; 0.5}{0.05^2}$$

$$n = \frac{3.8416 \; x \; 0.25}{0.0025}$$

$$n = \frac{0.9604}{0.0025}$$

$$n = 384.16$$

$$n \approx 384$$

The sample size (n=384) was increased by 10% to account for non-responses, incomplete data, and other unexpected issues. The study's final sample was 422.

3.5 Sampling method

There are forty-seven medical facilities across the entire Bolgatanga Municipality. These include three (3) Hospitals, six (6) Health Centre, and thirty-eight (38) CHPS zones. One hospital (regional hospital) was selected for the study. This hospital was chosen because it is located at the Center of the municipality and also serves as a referral facility. In addition, the study selected one health Centre from each of the nine sub-districts. If there were multiple health centres from a sub-district, one health Centre was randomly chosen. In a situation where a sub-district has no health Centre, the referral facility with the highest number of attendants in that sub-district was chosen. One CHPS zone from each of the nine (9) sub-districts was randomly chosen and included in the study. A total of sixteen (19) health facilities out of the forty-seven (47) medical facilities in the municipality were used for this study.

A sampling frame for the selected health facilities was obtained from the DHIMS2 platform in the study area. A proportion to population size (PN) was carried out to dermine the number of

participants to be recruited from each of the selected health facilities. This formula is given by:

$$PN = \frac{\text{number of CWC attendants in the selected health facility}}{\text{Total number of CWC attendants in all the selected health facilities}} \text{ x Sample size}$$

The study sample distribution of the participants based on the proportionate to population size computations is illustrated in below.

Table 2: Number of participants recruited from the selected health facilities

S/N	Health Facility Name	Sub-Municipal	Number of CWC Attendance (N)	Sample size (PN)
1	Regional Hospital, Bolgatanga	Zaare	4501	57
2	Presby Clinic	Zaare	2628	33
3	Zaare West CHPS	Zaare	2320	29
4	Bolgatanga Health Centre	Bolga Central	928	12
5	Tindomolgo CHPS	Bolga Central	2489	31
6	Nyariga Health Centre	Bolga North	1730	22
7	Kunkwa CHPS	Bolga North	1617	20
8	Sokabisi Health Centre	Bolga South	1380	17
9	Yikene CHPS	Bolga South	1657	21
10	Coronation Health Centre	Plaza	3432	43
11	Dapooretindongo CHPS	Plaza	2069	26
12	Sherigu Health Centre	Sherigu	1001	13
13	Dorongo CHPS	Sherigu	1125	14
14	Sumbrungu Health Centre	Sumbrungu East	571	7
15	Aguusi CHPS	Sumbrungu East	1311	17
16	Anateem CHPS	Sumbrungu West	1383	17
17	Kulbia CHPS	Sumbrungu West	1109	14
18	Kalbeo CHPS	Kalbeo	1211	15
19	Tindonsobligo CHPS	Kalbeo	929	12
	Total	**19**	**33391**	**422**

Simple random sampling was used to select the study participants. The number of participants recruited from each health facility was spread across the number of days scheduled for the data collection. This will prevent the recruitment of only a particular group of people who might have been scheduled for a particular CWC session. Each day early in the morning before the commencement of each CWC session at the selected CWC Centre, pieces of paper were cut and numbered to match the exact number of people expected for that particular session using the average CWC attendance for the previous month. These papers were then labeled as "yes" and "no". The total number of papers labeled as "Yes" corresponded to the number of participants needed for the day whilst the rest were labeled "No". Each participant was asked to pick a piece of paper as they came to receive care. Those who picked the piece of paper with "Yes" as the label were enrolled in the study after they had duly consented and signed to partake in the study. Those who did not agree were left out, even if they picked "Yes". This procedure was carried out at each health facility until the necessary sample size was attained.

3.6 Data Sources

The study used data from both primary and secondary sources. Primary data included information on participants' demographic characteristics and household WASH facilities acess and practices. These included child nutritional status, source of drinking water, sanitation practices, hygiene practices, household size, sex of household head, household head educational level, household head employment status, place of residence, household size, child stool management practices, maternal age, maternal level of education, maternal employment status, maternal marital status, parity, maternal anaemia status, maternal BMI status, multivitamins during recent pregnancy, diarrhoea in the past two weeks, fever in the past two weeks, breathing difficulty in the past two weeks, child nutritional supplementation in the past, child birth order,

and gestational age in weeksSecondary data was collected from the maternity record book and child weighing cards using data extraction sheets. The data that was taken included the age of the child, the child's sex, the child's birth weight, , and other health status indicators.

3.7 Data collection method and tool

A standard semi-structured questionnaire on the study variables was adapted and used to obtain primary data from study participants using face-to-face interviews. The questionnaire used for the data collection was pretested with similar respondents from non-selected health facilities in the Bolgatanga Municipality. This checked its validity in the local context and found questions that were unclear or confusing. The questionnaire was corrected after the testing and then used for the real data collection.

The questionnaire was designed using Open Data Kit Collect (ODK) and administered using smartphones via an interview-administer approach (face-to-face). Research assistants were recruited and trained on the study protocol and the data collection process using the ODK collect application for Android to assist in data collection. The research assistants took part in the pretesting of the tool. This helped them learn the tool and techniques for the data collection.

3.8 Study variables

3.8.1 Dependent variables

The dependent variables for this study were based on the indicators for assessing child undernutrition. These variables include stunting, wasting, and underweight.

Stunting: This refers to a low height for age, an outcome of impaired linear growth caused by recurrent or chronic malnutrition.

Wasting: This is defined as low weight for height, an indication of acute malnutrition.

Underweight: It is also known as low weight for age caused by either wasting, stunting, or both.

3.8.2 Independent variables

The main independent variable for the study consisted of household WASH indicators. These include a household main source of drinking water, the presence and type of sanitation facility, the presence or absence of hand hygiene facility in the household, maternal hand hygiene practices, and child stool management practices. The water and sanitation variables were categorized as "improved or unimproved" whilst the hygiene variable was categorized as "adequate or inadequate". These categorizations are based on the indicators by the WHO & UNICEF joint monitoring program on WASH (source: Bartram et al., 2014). Other independent variables are confounding variables of childhood undernutrition such as child's sex, age, birth order, birth weight, birth spacing, diarrhea incidence in the past 2 weeks, and maternal educational attainment, number of ANC visits, maternal age, and marital status. Table three below presents the summary of the variables used in this study.

Table 3: Summary of Study Variables

Name of Variable	Variable Categorization and Description
Nutritional Status	Stunting ("stunted" and "normal"), wasting ("wasted" and "normal"), underweight ("underweight" and "normal").
Source of drinking water	"Improved" and "unimproved". Improved water sources include piped water systems, borehole, or protected wells. Unimproved water sources include surface water, unprotected wells, or vendors selling water from trucks.
Sanitation practices	"Improved" and "unimproved". Unimproved sanitation involves open defecation or the use of pit latrines without proper design and structure.

	Improved sanitation refers to the usage of facilities such as flush or poor flush toilets that separate human waste from body contact.
Hygiene Practices	"Adequate" and "Inadequate" Adequate hygiene practices refer to the presence of water and soap during the hygiene practices. Inadequate hygiene practices refer to the absence of water and soap during the hygiene activity.
Household size	Less than 5, greater than 5, and exactly 5
Sex of household head	Male and Female
Household head educational level	No formal education, Primary, J.H.S, Secondary/S.H. S and Tertiary
household head Employment status	Employed and Unemployed
Place of residence	Urban, Rural
Household size	Less than 5, equal to 5, or greater than 5
Child stool management practices	Sanitary and Unsanitary
Maternal age	15-19, 20-29, 30-39 and 40-49
Maternal level of education	No formal education, Primary, J.H.S, Secondary/S.H. S, and Tertiary
Maternal employment status	Employed and Unemployed
Maternal marital status	Married, Never Married, Separated Widowed
Parity	Primipara and Multipara
Maternal anaemia status	Normal, Mild/moderate, and Severe anaemia
Maternal BMI status	Underweight, Healthy weight, Overweight And Obesity
multivitamins during recent pregnancy	Mother received multivitamins during pregnancy and Mother did not receive multivitamins during pregnancy

Age of child	6-11, 12-23, 24-35 and 36+
Diarrhea in the past two weeks	The child experienced diarrhoea and The child did not experience diarrhoea
Fever in the past two weeks	The child experienced fever and The child did not experience fever
Breathing difficulty in the past two weeks	The child experienced Breathing difficulties and The child did not experience Breathing difficulty
Child nutritional supplementation in the past	The child received nutritional supplementation and Child did not receive nutritional supplementation
Child Sex	Male and Female
Child Birth order	First, Second, Third, Fourth, Fifth, and above
Gestational Age in Weeks	Preterm and Full-term

3.9 Measurement of Anthropometric Indices

3.9.1 Height Measurement

An infantometer was used to take the height measurement of children less than 24 months. The child was laid flat on their back on a firm flat surface. The infantometer's footboard was then slid against the infant's heels. The Headboard of the infantometer was gently lowered to touch the top of the child's head. The child's height in centimeters (cm) was recorded to the nearest 0.1cm. For children more than 24 Months of age, a stadiometer was used to measure their height. The child was asked to stand barefooted on the stadiometer platform while ensuring that they were centered and stood straight. The stadiometer arm was Lowered gently, making sure it touched the top of the child's head. The child's height measurement in centimeters (cm) was recorded three times from the scale on the stadiometer to the nearest 0.1cm and the average was calculated.

3.9.2 Weight Measurement

A hanging scale was used to take the weight measure of children less than 24 months. The scale was suspended securely from a stable point (a hook on the ceiling). A lightweight cloth was hung from the scale's hook. The child was placed in the cloth ensuring that their head was supported. The weight measurement was recorded in kilograms (kg) to the nearest 0.1kg.

The weight of children more than 24 months was measured using a standing weighing scale. The child was dressed lightly and without shoes. The child was asked to stand on the scale, making sure he/she was centered and still. The scale was allowed to stabilize before recording the weight. The child's weight in kg to the nearest 0.1kg was recorded three times and the average was calculated.

3.9.3 Age Measurement

The child's age information was obtained through calculation by using data from the child weighing card. The age was calculated in months.

3.10 Assessment of Nutritional Status

3.10.1 Stunting

Stunting was calculated using the Height-for-Age Z-score (HAZ) growth Standard for assessing population malnutrition. A child whose Z-score is higher than -2SD of the median of normal children was categorized as “normal” whilst those with a Z-score equal to or below -2SD were categorized as “stunted” (WHO, 2022).

3.10.2 Wasting

Wasting was calculated using the Weight-for-Height Z-score (WHZ) growth Standard for assessing population malnutrition. A child whose Z-score is higher than -2SD of the median of

normal children was categorized as “normal” whilst those with a Z-score equal to or below -2SD were categorized as “wasted” (WHO, 2022).

3.10.3 Underweight

Underweight was calculated using the Weight-for-Age Z-score (WAZ) growth Standard for assessing population malnutrition. A child whose Z-score is higher than -2SD of the median of normal children was categorized as “normal” whilst those with Z-score equal to or below -2SD were categorized as “underweight” (WHO, 2022).

3.11 Data Management

Data collected was exported from ODK collect into an excel sheet. It was then imported into Stata (Stata IC) version 17 for cleaning. Continuous and discrete variables were categorized and labeled before analysis.

3.12 Statistical Analysis

3.12.1 Descriptive analysis

Continuous and discrete variables are expressed as weighted means ± standard deviations (± SDs), whilst categorical variables are expressed as weighted proportions. These analyses are presented using graphs, text, and tables.

3.12.2 Multivariate analysis

Binary logistic regression analysis was carried out to determine the strength of the association between predictor and outcome variables while taking into account other factors that could influence the results. The results are presented using tables.

3.13 Ethical considerations

Ethics approval was sought from the Navrongo Health Research (NHRC) Ethics Review Committee. Before the start of the data collection, clearance to enter and interview respondents at the selected health facilities was obtained from the Upper East Regional Health Directorate. Approval was also granted by the district director of health and the facility-based authorities. The informed consent form was explained by the researcher and understood by each participant before being enrolled by signing or thumb printing to confirm approval.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter explores the effect of household access to WASH facilities on childhood stunting, wasting, and underweight through the analysis of field survey data. The findings presented in this chapter consist of three main sections. Section one contains the background characteristics of the study participants. Section two delves into the prevalence of childhood undernutrition whilst section three investigates the impact of household WASH facilities access on childhood undernutrition.

4.2 Background characteristics of study Participants

422 mother-baby pairs were surveyed. Due to incomplete data on key variables, analysis was carried out using 390 mother-baby pairs.

4.2.1 Child background characteristics

Table 1 below presents the results on child background characteristics. The majority (55.6%) of the surveyed children were females and most (52.3%) of them were between the age range of 12-23. Some of these children had experienced health issues in the past two weeks. 16.4% had diarrhea and 5.9% with difficulty in breathing. Also, 36 (9.2%) of the children were having low birth weight. About 44.6% of the children were in the first childbirth order. Most (61.8%) were preterm babies at the time of delivery. Majority (89.0%) had received exclusive breastfeeding.

Table 4: Child background characteristics

Variable	Frequency	Percentage
Age of child		
6-11	103	26.4%
12-23	204	52.3%
24-35	52	13.3%
36+	31	7.9%
Diarrhea in the past two weeks		
Child experienced diarrhoea	64	16.4%
The child did not experience diarrhoea	326	83.6%
Breathing difficulty in the past two weeks		
The child experienced Breathing difficulty	23	5.9%
The child did not experience Breathing difficulty	367	94.1%
Child Sex		
Male	173	44.4%
Female	217	55.6%
Child Birth weight		
Low birth weight	36	9.2%
Normal	354	90.8%
Child Birth order		
First	174	44.6%
Second	112	28.7%
Third	62	15.9%
Fourth	26	6.7%
Fifth and above	16	4.1%
Gestational Age in Weeks		
Preterm	241	61.8%
Full term	149	38.2%

Exclusive breastfeeding		
Children exclusively breastfed	347	89.0%
Children not exclusively breastfed	43	11.0%

4.2.2 Maternal background characteristics

Majority (53.3%) of the surveyed mothers fell within the age range of 20-29. Most (32.1%) of them had a Secondary/S.H. S level of education. A substantial (68.5%) number were fully or partially employed and a higher (85.6%) percentage were married. These results are presented in Table 2 below.

Table 5: Maternal background characteristics

Variable	Frequency	Percentage
Age		
15-19	33	8.5%
20-29	208	53.3%
30-39	122	31.3%
40-49	27	6.9%
Level of education		
No formal education	48	12.3%
Primary	52	13.3%
J.H.S	89	22.8%
Secondary/S.H. S	125	32.1%
Tertiary	76	19.5%
Employment status		
Employed	267	68.5%
Unemployed	123	31.5%
Marital status		
Married	334	85.6%

Never Married	56	14.4%

4.2.3 Household characteristics

A higher percentage (62.1%). of the respondents were urban dwellers About 95 (24.4%) of the household heads had attained a Secondary/S.H.S level of education. Most (83.1%) of the household heads were fully or partially employed. The highest (43.8%) number of the survey respondents lived in households with more than five members. These results are presented in Table 3 below.

Table 6: Household characteristics

Variable	Frequency	Percentage
Household size		
<5	171	43.8%
>=6	138	35.4%
5	81	20.8%
Household head educational level		
No formal education	86	22.1%
Primary	65	16.7%
J.H.S	51	13.1%
Secondary/S.H. S	95	24.4%
Tertiary	93	23.8%
household head Employment status		
Employed	324	83.1%
Unemployed	66	16.9%
Place of residence		
Urban	242	62.1%
Rural	148	37.9%

4.2.4 Objective 1: Proportion of households with access to improved WASH facilities in the Bolgatanga Municipality.

Pipe water was the primary drinking water source for the majority (51.1%) of households. A large proportion (42.6%) of the respondents practiced open defecation. Good sanitary child stool management practices were found in most (63.1%) of the participants. A greater (75.9%) number of the respondents live in households with unimproved latrine facilities. Majority (63.3%) of the households lack designated handwashing facilities whilst adequate hand hygiene practices were observed in most of the survey participants (84.9%). A higher percentage (93.3%) of study respondents had safe sources of drinking water. Table 4 below presents the results on household WASH characteristics.

Table 7: Household WASH characteristics

Variable	Frequency	Percentage
Main source of drinking water		
Piped water	201	51.5%
Borehole	163	41.8%
Protected well	7	1.8%
unprotected well	3	0.8%
Rainwater	1	0.3%
Tanker track	3	0.78%
Sachet water	11	2.8%
Drinking water facility		
Improved	364	93.3%
Unimproved	26	6.7%
Type of household toilet facility		
Flush toilet	158	40.5%
Ventilated improved pit latrine	46	11.8%
Pit latrine with slab	17	4.4%

Pit latrine without slab/open pit	1	0.3%
Open defecation	166	42.6%
other	2	0.5%
Quality of Latrine facility		
Improved	94	24.1%
Unimproved	296	75.9%
Presence of designated handwashing station in the household		
Household has handwashing station	143	36.7%
Household did not have a handwashing station	247	63.3%
Availability of water and soap at handwashing station		
Available	331	84.9%
Not available	59	15.1%
Hygiene practices		
Adequate	331	84.9%
Inadequate	59	15.1%
Child stool management practices		
Sanitary	246	63.1%
Unsanitary	144	36.9%

4.2 Objective 2: Prevalence of childhood undernutrition in the Bolgatanga Municipality.

4.2.1: General prevalence of childhood undernutrition

The prevalence of childhood undernutrition was 48.5% (95% CI: 43.5%, 53.5%). About 28.5% (95% CI: 23.9%, 33.1%) of the children had stunted growth, 20.8% (95% CI: 16.6%, 24.9%) were wasted, whilst 11.3% (95% CI: 8%, 14.6%) were found to be underweight.

4.2.2: Prevalence of Childhood undernutrition by child's age

More children in all age groups were stunted than wasting or underweight. Stunting affected almost half of the children (46.2%) who were 24-35 months old. Wasting was most common (27.5%) among children who were 12-23 months old. About 16.1% of the children who were 36 months or older were underweight. These results are presented in Figure 4 below.

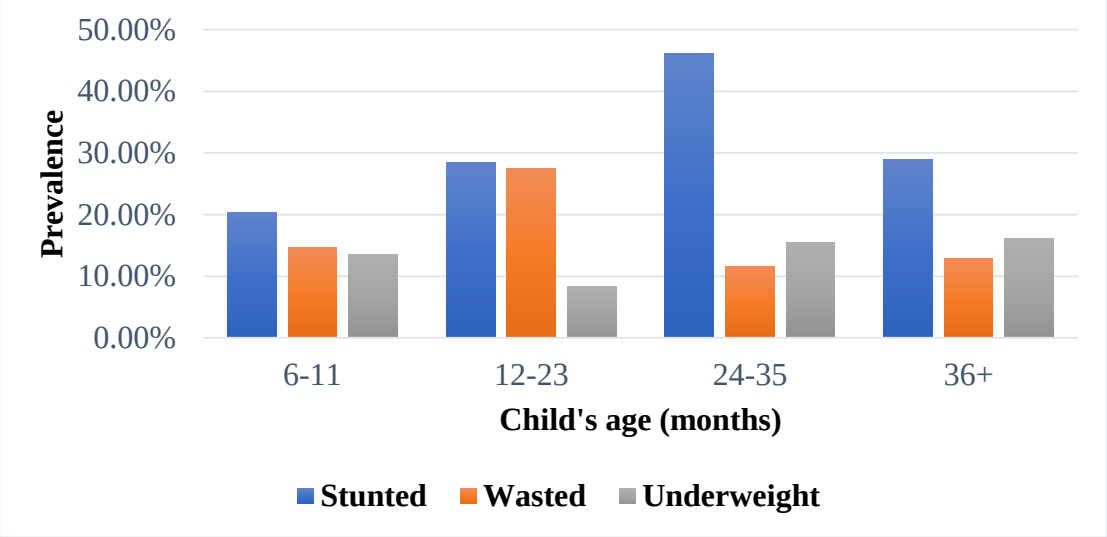


Figure 3: Prevalence of undernutrition by child's age

4.2.3: Prevalence of Childhood undernutrition by child's sex

Stunting, wasting, and underweight were more common in male children compared to females. These results are presented in Figure 5 below.

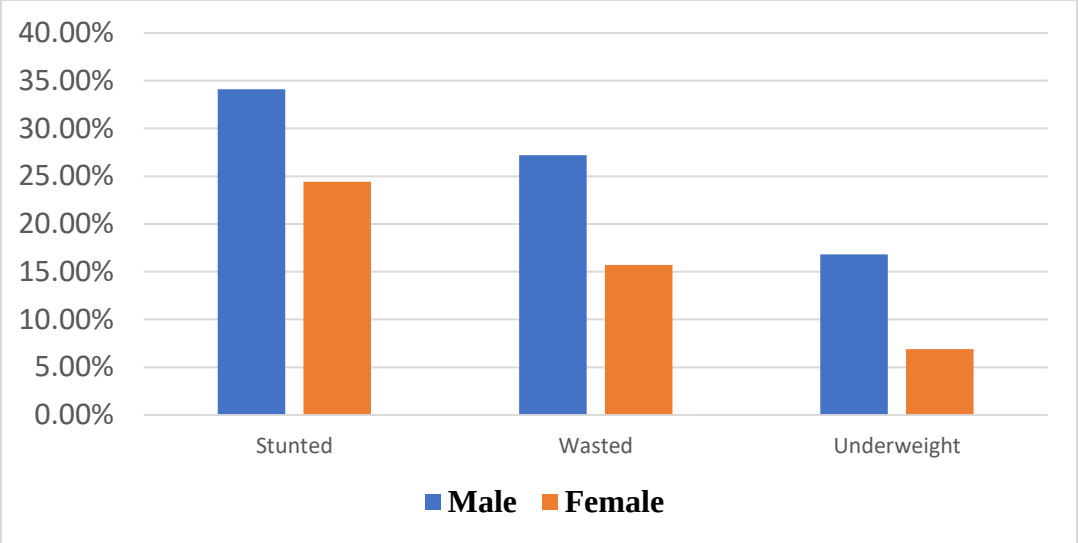


Figure 4: Prevalence of undernutrition by child's sex

Table 8: Prevalence of Childhood undernutrition by child's age and Sex

Variable	Stunting Status		Wasting Status		Underweight Status	
	Stunted n (%)	Normal n (%)	Wasted n (%)	Normal n (%)	Underweight n (%)	Normal n (%)
Sex of Child						
Male	59 (34.1%)	114 (65.9%)	47 (27.2%)	126 (72.8%)	29 (16.8%)	144 (83.2%)
Female	53 (24.4%)	164 (75.6%)	34 (15.7%)	183 (84.3%)	15 (6.9%)	202 (93.1%)
Age of child (months)						
6-11	21 (20.4%)	82 (79.6%)	15 (14.6%)	88 (85.4%)	14 (13.6%)	89 (86.4%)
12-23	58 (28.4%)	146 (71.6%)	56 (27.5%)	148 (72.5%)	17 (8.3%)	187 (91.7%)
24-35	24 (46.2%)	28 (53.8%)	6 (11.5%)	46 (88.5%)	8 (15.4%)	44 (84.6%)
36+	9 (29.0%)	22 (71.0%)	4 (12.9%)	27 (87.1%)	5 (16.1%)	26 (83.9%)

4.3 Objective 3: Effect of household access to WASH facilities on childhood undernutrition

4.3.1: Effect of household access to WASH facilities on childhood stunting

After controlling for confounders, children from households with unimproved sanitation services were 2.2 times more likely to be stunted compared to those who lived in households with improved sanitation services (AOR: 2.20, 95% CI: 1.21 - 4.02, P-value = 0.010). Children who lived in households with unsafe child stool disposal practices were 0.41 times less likely to be stunted compared to those from households where children's stool are disposed of safely (AOR: 0.41, 95% CI: 0.22 - 0.77, P-value = 0.005). Children from households who do not have a handwashing station were 1.31 times more likely to be stunted compared to children from households with a handwashing station but this effect was not significant (AOR: 1.31, 95% CI: 0.67 – 2.59, P-value = 0.43). Inadequate hygiene practices (AOR: 0.54, 95% CI: 0.27 - 1.10, P-value = 0.09) and unimproved drinking water sources (AOR: 0.53, 95% CI: 0.17 - 1.63, P-value = 0.27) had a non-significant negative effect on childhood stunting

Other factors also influence children's growth. The odds of stunting were higher for children whose household heads had tertiary education (AOR: 5.7, 95% CI: 2.07 -15.65, P-value = 0.001), and children who were 24 to 35 months old (AOR: 3.85, 95% CI: 1.23 -12.08, P-value = 0.021). Children who did not have any breathing difficulties in the past two weeks before the survey (AOR: 8.6, 95% CI: 1.01 -73.0, P-value = 0.049), children with mothers aged 40-49 years (AOR: 0.16, 95% CI: 0.03 - 0.77, P-value = 0.022), female children (AOR: 0.54, 95% CI: 0.32 - 0.92, P-value = 0.024) and children with mothers having tertiary education (AOR: 0.24, 95% CI: 0.07 - 0.81, P-value = 0.021) were less likely to be stunted. These results are shown in Table 6 below.

Table 9: Effect of household access to WASH facilities on childhood stunting

Variable	OR (95% CI)	AOR (95% CI)
Sanitation Practices		
Improved	ref	ref
Unimproved	**2.34 (1.30 - 4.22)***	**2.20 (1.21 - 4.02)***
Source of drinking water		
Improved	ref	ref
Unimproved	0.73 (0.29 - 1.87)	0.53 (0.17 - 1.63)
Presence or absence of handwashing facility in the Household		
Household has handwashing station	ref	
Household did not have a handwashing station	1.40 (0.88 - 2.23)	1.31 (0.67 - 2.59)
Hygiene Practices		
Adequate	ref	
Inadequate	0.66 (0.34 - 1.28)	0.54 (0.27 - 1.10)
Child stool management practices		
Sanitary	1.00	
Unsanitary	**0.34 (0.20 - 0.56)***	**0.41 (0.22 – 0.77)***
Place of residence		
Urban	ref	ref
Rural	1.48 (0.95 - 2.31)	1.22 (0.68 - 2.16)
Household head education level		
No education	ref	
Primary	1.43 (0.72 - 2.84)	1.87 (0.82 - 4.26)
J.H.S	0.83 (0.38 - 1.83)	1.07 (0.43 - 2.67)
Secondary/S.H. S	0.57 (0.29 - 1.14)	1.35 (0.56 - 3.27)
Tertiary	1.28 (0.68 - 2.41)	**5.70 (2.07 -15.65)***
Household head Employment status		
Employed	ref	

Unemployed	**2.11 (1.22 - 3.64)***	1.90 (0.90 - 3.99)
Household size		
<5	ref	
>=6	1.32 (0.81 - 2.15)	-
5	0.81 (0.44 - 1.49)	-
Maternal age		
15-19	ref	
20-29	0.73 (0.34 - 1.57)	0.59 (0.22 - 1.56)
30-39	0.68 (0.30 - 1.52)	0.50 (0.16 - 1.53)
40-49	0.40 (0.12 - 1.32)	**0.16 (0.03 - 0.77)***
Maternal education level		
No education	ref	
Primary	0.96 (0.43 - 2.16)	1.01 (0.39 - 2.65)
J.H.S	0.73 (0.35 - 1.52)	0.58 (0.23 - 1.45)
Secondary/S.H. S	0.57 (0.28 - 1.17)	0.46 (0.18 - 1.20)
Tertiary	**0.44 (0.20 - 0.99)***	**0.24 (0.07 - 0.81)***
Maternal employment status		
Employed	ref	
Unemployed	**1.92 (1.21 - 3.04)***	1.81 (0.96 - 3.42)
Maternal marital status		
Never married	1.54 (0.87 - 2.71)	0.51 (0.25 - 1.04)
Married	ref	
Age of child		
6-11	0.63 (0.25 - 1.56)	0.55 (0.19 - 1.62)
12-23	0.97 (0.42 - 2.23)	1.42 (0.53 – 3.80)
24-35	2.10 (0.81 - 5.41)	**3.85 (1.23 – 12.08)***
36+	ref	ref
Child Sex		
Male	ref	
Female	**0.62 (0.40 – 0.97)***	**0.54 (0.32 – 0.92)***

Child Birth weight		
Low birth weight	ref	
Normal	**0.32 (0.16 - 0.64)***	0.47 (0.21 – 1.06)
Child Birth order		
First	ref	ref
Second	0.59 (0.33 – 1.04)	0.84 (0.42 – 1.69)
Third	1.42 (0.77 – 2.62)	1.98 (0.87 – 4.48)
Fourth	0.89 (0.35 – 2.24)	1.15 (0.37 – 3.52)
Fifth and above	**3.10 (1.10 – 8.78)***	2.90 (0.78 – 10.82)
Gestational Age in Weeks		
Preterm	ref	ref
Full term	**1.99 (1.27 – 3.11)***	1.60 (0.93 – 2.76)
Exclusive breastfeeding		
Children exclusively breastfed	ref	
Children not exclusively breastfed	0.73 (0.35 - 1.53)	-
Experience diarrhoea in the past two weeks		
Children who experienced diarrhoea	ref	
Children who did not experience diarrhoea	1.14 (0.62 - 2.08)	-
difficulty in breathing in the past two weeks		
Children who experienced Breathing difficulty	ref	
Children who did not experience Breathing difficulty	**1.27 (9.54 – 71.65)***	**8.60 (1.01 – 73.01)***
*=p<0.05		

4.3.2: Effect of household access to WASH facilities on childhood wasting

Table 7 below presents the results on the determinants of childhood wasting. After controlling for confounders, children from households with unimproved sanitation services (AOR: 0.89, 95% CI: 0.50 - 1.58, P-value = 0.68), with no handwashing facility (AOR: 0.63, 95% CI: 0.37 - 1.04, P-value = 0.07), with unimproved source of drinking water (AOR: 0.73, 95% CI: 0.24 - 2.21, P-value = 0.579) and inadequate hygiene practices (AOR: 0.82, 95% CI: 0.16 - 4.25, P-value = 0.81) were less likely to be wasted but this was not significant. Furthermore, children in households with unsafe child stool disposal practices were 1.27 times more likely to be wasted compared to children from households with safe child disposal practices but this was not also significant (AOR: 1.27, 95% CI: 0.69 - 2.32, P-value = 0.44). Female children were 0.28 times less likely to be wasted compared to males and this was significant (AOR: 0.47, 95% CI: 0.28 - 0.79 P-value = 0.005).

Table 10: Effect of household access to WASH facilities on childhood wasting

Variable	OR (95% CI)	AOR (95% CI)
Sanitation Practices		
Improved	ref	
Unimproved	0.75 (0.43 - 1.31)	0.89 (0.50 - 1.58)
Source of drinking water		
Improved	ref	
Unimproved	0.68 (0.23 - 2.03)	0.73 (0.24 - 2.21)
Presence of handwashing facility in the Household		
Household has handwashing station	ref	
Household did not have a handwashing station	**0.58 (0.35 - 0.96)***	0.63 (0.37 - 1.04)
Hygiene Practices		

Adequate	ref	
Inadequate	0.65 (0.30 - 1.38)	0.82 (0.16 - 4.25) -
Child stool management practices		
Sanitary	ref	ref
Unsanitary	**1.69 (1.03 - 2.78)***	1.27 (0.69 - 2.32)
Place of residence		
Urban	ref	
Rural	0.78 (0.46 - 1.30)	-
Household head education level		
No education	ref	
Primary	0.77 (0.35 - 1.69)	-
J.H.S	0.85 (0.37 - 1.95)	-
Secondary/S.H. S	0.99 (0.50 - 1.95)	-
Tertiary	0.50 (0.23 - 1.08)	-
Household head Employment status		
Employed	ref	
Unemployed	1.41 (0.76 - 2.61)	-
Household size		
<5	ref	
>=6	0.98 (0.57 - 1.68)	1.48 (0.75 - 2.93)
5	0.53 (0.26 - 1.10)	0.54 (0.24 - 1.25)
Maternal age		
15-19	ref	ref
20-29	**0.43 (0.19 - 0.97)***	0.53 (0.21 - 1.38)
30-39	0.54 (0.23 - 1.26)	0.64 (0.23 - 1.79)
40-49	0.70 (0.23 - 2.16)	0.62 (0.17 - 2.30)
Maternal education level		
No education	ref	ref
Primary	0.80 (0.29 - 2.16)	0.96 (0.32 - 2.89)
J.H.S	0.96 (0.40 - 2.29)	1.20 (0.45 - 3.20)

Secondary/S.H. S	0.95 (0.42 - 2.16)	1.14 (0.44 - 2.94)
Tertiary	1.27 (0.53 - 3.02)	1.35 (0.52 - 3.51)
Maternal employment status		
Employed	ref	
Unemployed	1.11 (0.66 - 1.87)	-
Maternal marital status		
Never married	1.52 (0.82 - 2.82)	1.39 (0.65 - 2.95)
Married	ref	ref
Age of child		
6-11	1.15 (0.35 - 3.76)	1.24 (0.33 - 4.64)
12-23	2.55 (0.86 - 7.630	2.23 (0.68 - 7.29)
24-35	0.88 (0.23 - 3.40)	0.85 (0.21 - 3.51)
36+	ref	ref
Child Sex		
Male	ref	
Female	**0.50 (0.30 - 0.82)***	**0.47 (0.28 - 0.79)***
Child Birth weight		
Low birth weight	ref	
Normal	1.69 (0.64 - 4.51)	-
Child Birth order		
First	ref	
Second	1.37 (0.78 - 2.42)	-
Third	0.79 (0.37 - 1.72)	-
Fourth	1.52 (0.59 - 3.90)	-
Fifth and above	0.59 (0.13 - 2.71)	-
Gestational Age in Weeks		
Preterm	ref	
Full term	0.67 (0.39 - 1.12)	1.02 (0.54 - 1.95)
Exclusive breastfeeding		
Children exclusively breastfed	ref	

Children not exclusively breastfed	1.36 (0.65 - 2.83)	-
Experience diarrhoea in the past weeks		
Children who experienced diarrhoea	ref	
Children who did not experience diarrhoea	1.32 (0.65 - 2.66)	-
difficulty in breathing in the past weeks		
Children who experienced Breathing difficulty	ref	ref
Children who did not experience Breathing difficulty	2.88 (0.66 -12.55)	3.34 (0.72 -15.54)
*=p<0.05		

4.3.3: Effect of household access to WASH facilities on childhood underweight

Table 8 below presents the results for determinants of childhood underweight. After controlling for confounders, children from households with unimproved sanitation services were 3.25 times more likely to be underweight compared to children in families with improved sanitation facilities (AOR: 3.25, 95% CI: 1.22 - 8.68, P-value = 0.018). Family drinking water sources and hygiene practices do not show any effect on childhood underweight. Children from families with no handwashing facility were 0.25 times less likely to be underweight compared to children from households with handwashing services (AOR: 0.49, 95% CI: 0.25 - 0.95, P-value = 0.034).

Besides the WASH factors, children in families with household size greater than or equal to six (AOR: 3.08, 95% CI: 1.11-8.54, P-value = 0.031) and with unemployed household head (AOR: 2.64, 95% CI: 1.13 - 6.13 P-value = 0.024) were more likely to be underweight. Furthermore, children with mothers with secondary/SHS education (AOR: 0.21, 95% CI: 0.06 - 0.75, P-value

= 0.016) and female children (AOR: 0.25, 95% CI: 0.12 - 0.55, P-value = 0.001) were less likely to be underweight.

Table 11: Effect of household access to WASH facilities on childhood underweight

Variable	OR (95% CI)	AOR (95% CI)
Sanitation Practices		
Improved	ref	ref
Unimproved	**2.70 (1.03 - 7.07)***	**3.25 (1.22 - 8.68)***
Source of drinking water		
Improved	ref	-
Unimproved	1.00	-
Presence of handwashing facility in the Household		
Household has handwashing station	ref	ref
Household did not have a handwashing station	0.60 (0.32 - 1.12)	**0.49 (0.26 - 0.95)***
Hygiene Practices		
Adequate	ref	
Inadequate	0.87 (0.35 - 2.17)	-
Place of residence		
Urban	ref	
Rural	0.83 (0.43 - 1.60)	-
Household head education level		
No education	ref	
Primary	1.39 (0.56 - 3.44)	-
J.H.S	1.08 (0.39 - 3.00)	-
Secondary/S.H. S	0.71 (0.28 - 1.82)	-
Tertiary	0.47 (0.17 - 1.33)	-
Household head Employment status		
Employed	ref	ref

Unemployed	**4.30 (2.19 - 8.43)***	**2.64 (1.13 - 6.13)***
Household size		
<5	ref	ref
>=6	**3.22 (1.57 - 6.63)***	**3.08 (1.11 - 8.54)***
5	0.87 (0.30 - 2.56)	1.05 (0.30 - 3.72)
Maternal age		
15-19	ref	ref
20-29	0.51 (0.20 - 1.29)	1.10 (0.32 - 3.81)
30-39	**0.30 (0.10 - 0.87)***	0.83 (0.17 - 4.15)
40-49	0.46 (0.11 - 2.00)	1.46 (0.19 -11.48)
Maternal education level		
No education	ref	ref
Primary	0.67 (0.23 - 1.98)	0.95 (0.27 - 3.32)
J.H.S	0.61 (0.23 - 1.60)	0.43 (0.13 - 1.41)
Secondary/S.H. S	**0.30 (0.11 - 0.82)***	**0.21 (0.06 - 0.75)***
Tertiary	0.58 (0.21 - 1.59)	0.82 (0.24 - 2.82)
Maternal employment status		
Employed	ref	ref
Unemployed	**1.97 (1.04 - 3.72)***	1.09 (0.47 - 2.53)
Maternal marital status		
Never married	1.39 (0.63 - 3.06)	-
Married	ref	
Age of child		
6-11	0.82 (0.27 - 2.48)	0.64 (0.17 - 2.49)
12-23	0.47 (0.16 - 1.39)	0.30 (0.08 - 1.10)
24-35	0.95 (0.28 - 3.20)	0.48 (0.11 - 2.03)
36+	ref	ref
Child Sex		
Male	ref	ref
Female	**0.37 (0.19 - 0.71)***	**0.25 (0.12 - 0.55)***

Child Birth weight		
Low birth weight	ref	
Normal	0.48 (0.20 - 1.18)	0.38 (0.13 - 1.11)
Child Birth order		
First	ref	ref
Second	**0.30 (0.12 - 0.74)***	0.44 (0.12 - 1.57)
Third	0.46 (0.17 - 1.24)	0.44 (0.11 - 1.84)
Fourth	0.95 (0.30 - 2.96)	0.88 (0.19 - 4.07)
Fifth and above	0.35 (0.04 - 2.74)	0.22 (0.02 - 2.73)
Gestational Age in Weeks		
Preterm	ref	
Full term	1.02 (0.54 - 1.94)	-
Exclusive breastfeeding		
Children exclusively breastfed	ref	
Children not exclusively breastfed	0.79 (0.27 - 2.32)	-
Experience diarrhoea in the past two weeks		
Children who experienced diarrhoea	ref	-
Children who did not experience diarrhoea	0.63 (0.29 - 1.35)	-
difficulty in breathing in the past two weeks		
Children who experienced Breathing difficulty	ref	
Children who did not experience Breathing difficulty	0.84 (0.24 - 2.94)	-
Note: *=p<0.05		

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This chapter presents an in-depth discussion of the results from chapter four. To provide context to the results obtained in this study, I compared my findings with previous studies and literature that are relevant to my research. Finally, the limitations and strengths of the study are presented.

5.2 Background characteristics of the study participants

The survey revealed significant insights about the study participants' health and demographic characteristics. About 9.2% of the children were affected by low birth weight. This is congruent with the research findings in Gabon (Zoleko-Manego et al., 2021) where few (12.7%) of the survey children had low birthweight. Most (61.8%) of the children were preterm babies at the time of delivery. This is higher than what has been reported (5.5%) by Zoleko-Manego and colleagues (Zoleko-Manego et al., 2021). These results highlights the potential challenges with child health and interventions seeking to address this menace are warranted. Most (89.0%) of the children were exclusively breastfed. This supports what Samuel et al. (2022) found in Ethiopia where exclusive breastfeeding was very common. This observation suggests a highly prevalent practice of exclusive breastfeeding within the studied population. Regarding child health conditions, diarrhea (16.4%) and difficulty in breathing (5.9%) were experienced by the children two weeks before the survey. The prevalence of these health conditions are slightly lower than what has been reported by Samuel and friends in Ethiopia (Samuel et al., 2022). The levels of diarrhea (16.4%) raise concerns on water and sanitation conditions and therefore emphasizing the relevance for adequate hygiene habits. Difficulty in breathing (5.9%) among the studied children is a possible indication of respiratory infections. This raises concerns about

environmental conditions such as air pollution and indoor allergens. interventions to address and prevent respiratory issues in the community are needed.

Regarding maternal characteristics, about 53.3% of the surveyed mothers fell within the age range of 20-29 and a higher proportion (85.6%) were married. These observations are consistent with the survey findings of a study in Nkwanta South Municipality (Danso & Appiah, 2023). These observations suggests that a substantial portion of the surveyed mothers are in their childbearing years are in a marital relationship. This is relevant for assessing family structure and may have implications for the social and economic support available to the mothers and their children. Most (32.1%) of the mothers had a Secondary/S.H.S level of education and a higher proportion (68.5%) were fully or partially employed. This is similar to the survey findings by Gaffan et al. (2023) in Benin. Educated mothers tend to have proper health behaviours such as longer breastfeeding duration, better child-rearing practices, and effective use of health services. Moreover, mothers who are employed, either fully or partially, may have access to resources, potentially influencing their ability to access healthcare, education, and other essential services for themselves and their children (Mensch et al., 2019). Majority (43.8%) of the children were living in families with an average household size greater than five members. These findings support a previous survey in Nigeria (Ashagidigbi et al., 2022). The higher family size may negatively affect the child nutritional status especially when the household has limited resources to meet many demands (Ashagidigbi et al., 2022). A higher proportion (24.4%) of the household heads had Secondary/S.H.S level education. This contradicts the findings of Ashagidigbi and friends (Ashagidigbi et al., 2022). Having literate household heads ensures easy accessibility to important information. This may help in making decisions that will improve their children's nutritional status (Ashagidigbi et al., 2022).

5.3 Household access to WASH facilities

Improved WASH is essential for maintaining good health and preventing the spread of infectious diseases (WHO, 2019). Out of the 390 households surveyed, about 93.3% of them had improved sources of drinking water. The prevalence of improved household water access in the study area is similar to the finding of a previous survey by GSS which showed that 87.7% of Ghanaian households have improved drinking water sources (GSS, 2021). This finding is not also different from the global average of 90% access to basic drinking water services (WHO, 2021). Contrary to these findings, a DHS in Ethiopia showed that only 69.94% of households have access to improved water sources (Andualem et al., 2021). Similarly, about 64% of households in Benin have improved water facilities (Gaffan et al., 2022) whilst in Zambia, only 64.5% of households enjoy improved water supply (Mulenga et al., 2017). The fact that 93.3% of the studied households have improved water sources is encouraging and this may suggest progress in ensuring access to clean and safe drinking water in the study area. However, the sustainability of such water sources including their maintenance and protection from contamination, is essential for continued public health benefits.

About 75.9% of the households surveyed do not have improved sanitation facilities. This finding is consistent with a previous survey by GSS which reported that only 25.3% of Ghanaian households have access to improved sanitation. Similarly, a nationwide cross-sectional study by Oppong et al. (2022) found that 94.6% of households in the Upper East Region rely on unimproved sanitation facilities. Achieving the sanitation goal by 2030 seems to be a challenging objective due to several factors. These include the government's failure to establish sufficient solid waste disposal facilities, lack of enforcement of sanitation regulations, population growth, insufficient funding for sanitation projects, rural-to-urban migration, substandard sanitation

infrastructure, and a lack of sanitation technologies, among other issues. These factors collectively contribute to the prevalent poor sanitation conditions in Ghana (Oppong et al., 2022).

Hand cleaning with soap and water is an effective approach to reduce the spread of infections and maintain good health. This simple action can help prevent the spread of germs and viruses which can be transmitted by touching contaminated surfaces and objects or by direct contact with an infected person (CDC, 2021). The percentage (84.9%) of families with access to adequate hand hygiene facilities was observed to be relatively higher compared to a recent Ghana multiple indicator cluster survey which revealed that only 48.5% of Ghanaian households have improved hand hygiene facilities in their premises for hand washing (GSS & UNICEF, 2018). An explanation for this observation could be attributed to the public health campaigns and educational programs that have emphasized the significance of handwashing in preventing COVID-19 infections. These initiatives may have heightened awareness and enhanced hand hygiene practices in the study area (S. Lee et al., 2020). Additionally, since access to clean water sources is a crucial component of hand hygiene, a 93.3% coverage in the improved water supply might have positively impacted access to adequate hand hygiene practices as observed in the study area. Economic Constraints such as affordability could be a possible factor for the remaining households who lack access to adequate hand-washing facilities. This is because low-income households may struggle to afford soap and other hygiene products, making it difficult to maintain proper hand hygiene practices (Fielmua et al., 2023). Even though there is significant access to adequate hand hygiene facilities (75%), challenges still exist in ensuring universal access. Therefore, continuing efforts to improve infrastructure, education, and awareness, along

with addressing economic disparities, will be essential in achieving higher levels of access to adequate hand hygiene facilities in the study area.

5.4 Prevalence of childhood undernutrition

Nearly half (48.5%) of the children studied were affected by undernutrition. This rate is lower compared to a cross-sectional survey in Nepal which revealed that 55.5% of the children were undernourished (A. Shrestha et al., 2020). However, the rate of undernutrition in the studied area is higher compared with previous findings of studies in some African countries (Tesema et al., 2021). The study also observed that 28.7% of the children had stunted growth, 20.8% were suffering from wasting, and about 11.3% were underweight. The rates of childhood stunting and underweight in the studied area are lower, whilst the prevalence of wasting is slightly higher compared to previous estimates in some African countries (Engidaye et al., 2022; Wasihun et al., 2018; & Mshida et al., 2018). The high prevalence of undernutrition in the studied area suggests that a substantial number of children are currently facing nutritional deficiencies which may lead to impaired cognitive development and physical health making them more vulnerable to illnesses (Miller et al., 2016; Boah et al., 2019). Several factors may account for the prevalence of undernutrition in the study area including poverty, limited access to healthcare, inadequate nutrition, and poor sanitation practices as indicated in several research findings (Lee et al., 2022).

The prevalence of stunting was highest across all age groups compared to wasting and underweight. Stunting is an indication of chronic malnutrition resulting from prolonged nutritional deficiencies (Ersado, 2022). The high prevalence of stunting across all age groups suggests persistent challenges in meeting children's long-term nutritional needs. Addressing

stunting necessitates long-term, sustainable interventions focusing on improving overall nutritional quality, sanitation, and access to essential nutrients.

The prevalence of stunting (28.5%), wasting (20.8%) and underweight (11.3%) were high in male children compared to females. This corresponds to a survey in Benin (Addo et al., 2023) and Ethiopia (Sahiledengle et al., 2023). Tailoring strategies to address the distinct challenges faced by boys can lead to more effective and equitable approaches. Currently in Ghana, there are ongoing initiatives aimed at improving maternal and child health. These efforts include the provision of free antenatal care services, iron and folate supplementation for expectant mothers, vitamin A supplementation for young children, and the implementation of school feeding programs (Boah et al., 2019). These initiatives may have played a significant role in decreasing the occurrence of undernutrition.

5.5 Effect of household access to WASH facilities on childhood undernutrition

Children from households with insufficient sanitation services were 2.2 times more likely to be sunted compared to those in households with improved services (AOR: 2.20, 95% CI: 1.21 - 4.02, P-value = 0.010). This finding aligns with a survey in Ethiopia which demonstrate that children exposed to unimproved sanitation services face an increased risk of stunting (Sahiledengle et al., 2022). Similarly, a survey in Benin reveals a higher likelihood of stunting in children from families without sanitation facilities, emphasizing the importance of basic sanitation (Gaffan et al., 2023). A cohort study indicate that children residing in families with improved sanitation services were less likely to be stunted (Dearden et al., 2017). In Indonesia, a study among children under three years associates improved sanitation facilities with a 29% reduction in the odds of stunting (Rah et al., 2020). These findings collectively emphasize the

critical role of safe sanitation services in mitigating childhood stunting, advocating for global efforts to enhance sanitation infrastructure and practices.

Children living in households with inadequate sanitation services were 3.25 times more likely to be underweight compared to those in households with improved services (AOR: 3.25, 95% CI: 1.22 - 8.68, P-value = 0.018). This finding is consistent with a study in Nepal, which revealed that children from households with unsafe sanitation services were 46% more likely to be underweight than those in households with improved sanitation services (Dhital, 2021). Hall et al. (2020) stress that children living in households lacking improved toilet facilities had higher odds of stunting and being underweight compared to those in families with improved sanitation services. Rah et al. (2015) further support this by highlighting that households with safe toilet facilities are less likely to have stunted children.

This study found no significant relationship between the type of household sanitation facility and childhood wasting. Similarly, a survey by Sahiledengle et al. (2022) did not find any connection between household type of sanitation facility and childhood wasting. In addition, a study in Tanzania found no association between the type of household sanitation facility and childhood wasting (Khamis et al., 2019). In contrast, H. Jung Lee et al. (2022) conducted a survey in Ethiopia which revealed that children in families practicing open defecation had higher odds of wasting compared to those in households with improved sanitation practices. Moreover, the absence of an improved toilet facility in households was identified as a significant factor for severe wasting among CU5 years in a study conducted in Chad (Dodos et al., 2018).

These findings highlight the importance of safe sanitation services within households for child health. Exposure to fecal-oral pathogens can result from poor sanitation and hygiene, which can

cause diarrhea and other infections that interfere with nutrient absorption and utilization and lead to child undernutrition (Gaffan et al., 2023). Acute factors such as recent illnesses or food shortages are the main drivers of wasting. This may explain why the study found no effect between household access to sanitation services, personal hygiene practices, and wasting (Sahiledengle et al., 2022).

Children in households with unsanitary child stool management practices were 0.41 times less likely to be stunted compared to those in households with good sanitary child stool management practices, and this was statistically significant (AOR: 0.41, 95% CI: 0.22 - 0.77, P-value = 0.005). This observation is different from a study in Nepal which reported that children of mothers who disposed of their children's feces in a sanitary manner had lower odds of stunting than children of mothers who did so in an unhygienic way (Dhital, 2021). Stunting mainly reflects prolonged nutritional deficiencies rather than immediate factors. It is a multifaceted issue influenced by various factors including insufficient access to food, poor childcare practices, limited maternal education, inadequate healthcare services, absence of clean water, sanitation, and poor hygiene practices (Woldesenbet et al., 2023). In this study, several reasons may have accounted for these findings. One reason is that other factors that modify the relationship between child stool management practices and stunting may not have been accounted for in this study. Another possible explanation is inadequate nutrition. a lack of access to nutritious food can still result in stunting despite good sanitary child stool management practices (Gizaw et al., 2022).

Children in families with no handwashing facility were 0.49 times less likely to be underweight compared to children in families with handwashing facilities and this was statistically significant (AOR: 0.49, 95% CI: 0.25 - 0.95, P-value = 0.034). This finding contradicts a study in Ethiopia

that reported that improved handwashing facilities in households reduced underweight by 17% in children under five years (Bekele et al., 2020). Families with no dedicated handwashing facilities may resort to alternative methods for hygiene practices. They may use alternative methods such as alcohol-based hand sanitizers or ashes which are equally effective in preventing the spread of diseases (Gizaw et al., 2023). In addition, adequate hand hygiene practice is driven by people's knowledge and as a result, having hand washing facilities doesn't guarantee proper use. Families with such facilities may not consistently use them, whereas families without them might be more diligent in their hand hygiene practices (Omari et al., 2022).

This study observed that household sources of drinking water did not affect childhood stunting, wasting, or underweight. Similar to this finding, a study conducted in Ethiopia using a nationwide DHS data set revealed that underweight and wasting were not significantly associated with household unimproved drinking water (Wondimu, 2016). Consistent with this finding was a cross-sectional study involving 35 LMICs which revealed that underweight in children was not associated with unsafe water (Li et al., 2020). According to a study by Sahiledengle and friends, lower odds of child stunting and wasting are not predicted by the quality of household water sources (Sahiledengle et al., 2022). Similarly, a cohort study found no relationship between household-improved water sources and childhood stunting (Dearden et al., 2017). The results of this study however, contradict with prior analysis of 49 SSA studies, which found that a family's unclean drinking water source was associated with a higher risk of childhood stunting, wasting, and underweight (Akombi et al., 2017). A similar study in China suggests that unsafe water use is linked to higher odds of stunting among young children (Gao et al., 2022). In Tanzania, a survey showed that children in families using surface water for domestic purposes had an increased odds of stunting and underweight (Mshida et al., 2018). An analysis of a nationwide

DHS data set in Ethiopia showed that households with unsafe drinking water systems had an increased likelihood of having stunted children compared to those with improved drinking water facilities (Wondimu, 2016). According to Morrison et al. (2020), children residing in safe water households are less likely to be stunted and underweight compared to families with unimproved water. Another study noted that lack of safe and inadequate drinking water are both connected with underweight in children (Moyeda-Carabaza & Murimi, 2021). Evidence from Myanmar showed that unsafe household drinking water utilization is correlated with higher odds of childhood stunting (Blankenship et al., 2020). In Afghanistan, the risk of acute malnutrition among children was two times higher in households using unprotected water sources compared to their counterparts (Frozanfar et al., 2016). Similarly, lack of safe water sources for domestic purposes is associated with childhood wasting in India and Bangladesh (Harding et al., 2018). These research findings are contrary to what has been observed in this study. Several factors may have accounted for the non-significant association between household water access and childhood undernutrition. This finding could be due to the high coverage (93.3%) in improved water access in the study area.

This study found no effect between household hygiene practices and childhood stunting, wasting, or underweight. On the contrary, previous studies elsewhere suggest that maternal handwashing with soap and water at critical moments strongly predicts childhood undernutrition (Dodos et al., 2018; Dhital, 2021; Woldesenbet et al., 2023 & Lee et al. 2022).

5.6 Limitations of the study

There are several limitations associated with this study. Firstly, due to the type of study design used (cross-sectional study), causality cannot be established. As a result, it was unclear whether inadequate sanitation practices led to childhood undernutrition or if childhood undernutrition led to poor sanitation practices as observed in the study. Secondly, the study sample might not reflect the general population, since it only targets those who seek CWC services, potentially leaving out those who have barriers to utilizing such services. Thirdly, participants were asked to recall past events or behaviors and this may have led to a possible recall bias. Furthermore, this study couldn't account for all potential confounding variables and this may have had an influence on the study findings. Lastly, respondents were asked to provide answers to questions related to their hygiene practices which may have been over-exaggerated.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION

6.1 Summary of Findings

This study measured the prevalence of childhood undernutrition and household access to WASH facilities in the Bolgatanga Municipality of the Upper East Region of Ghana. The effect of household access to WASH infrastructure on childhood undernutrition was also assessed. The prevalence of childhood undernutrition was 48.5% with stunting, wasting and underweight being 28.7%, 20.8%, and 11.3% respectively. Most (75.9%) of respondents live in households with unimproved latrine facilities. Adequate hand hygiene practices were found in the majority (84.9%) of the survey participants. A higher percentage (93.3%) of the study respondents lived in households with improved sources of water for domestic purposes.

The likelihood of stunting was found to be 2.2 times higher among children from households with insufficient sanitation services compared to those with improved facilities. Children living in households with unsafe child stool disposal practices were 0.41 times less likely to experience stunting than those with safe practices. Children in households with unimproved sanitation services were 3.25 times more likely to be underweight than those with improved services. Children from families without handwashing facilities were 0.25 times less likely to be underweight than those with handwashing facilities. The study found no correlation between WASH services and childhood wasting and therefore rejecting the null hypothesis that household access to WASH facilities had an effect on childhood wasting. The source of household drinking water and hygiene practices did not correlate with childhood stunting and underweight.

6.2 Conclusion

The study highlights a significant link between household WASH conditions and childhood undernutrition in Bolgatanga Municipality. Despite a high prevalence of childhood undernutrition (48.5%), characterized by stunting (28.7%), wasting (20.8%), and underweight (11.3%), the findings suggest that inadequate sanitation and hygiene practices contribute more to chronic forms of undernutrition, such as stunting and underweight, than to acute forms like wasting. WASH interventions should prioritize sanitation improvements to reduce stunting and underweight prevalence.

6.3 Recommendations

Based on the study findings of this study, the following recommendations are proposed for each objective:

Objective 1: To determine the proportion of households with access to improved WASH facilities in the Bolgatanga Municipality.

Recommendations:

It is recommended for the government and NGOs to Invest in constructing water and sanitation facilities such as boreholes, piped water systems, and hygienic latrines to increase household access to improved WASH services. In addition, I recommend for the Bolgatanga municipal assembly and NGOs in the WASH sector to Implement CLTS programs. This will encourage communities to eliminate open defecation and adopt improved sanitation practices.

Objective 2. To determine the prevalence of child undernutrition in the Bolgatanga Municipality.

Recommendations:

I recommend for the Bolgatanga Municipal Health Directorate to develop and execute nutrition-specific interventions focusing on children under five to address underweight, wasting, and stunting. It is further recommended for the Bolgatanga Municipal Health Directorate to provide educational programs for mothers and caregivers on proper sanitation and hygiene practices especially, during post-natal periods to improve child nutrition outcomes.

Objective 3: To assess the effect of household access to WASH facilities on childhood undernutrition in the Bolgatanga Municipality.

Recommendations:

I recommend for the Bolgatanga Municipal Health Directorate to design and implement integrated programs that address both WASH and nutrition to tackle the interconnected issues of poor sanitation and undernutrition. I further recommend for them to educate communities on the

importance of hygiene practices, such as handwashing with soap, to prevent infections that contribute to undernutrition. Lastly, there is the need to conduct further studies to understand the specific pathways through which WASH access influences child nutrition. This will enable the development of more targeted interventions.

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APPENDICES

Appendix I: Participant information sheet

TITLE OF RESEARCH STUDY: Assessing the effect of household access to water sanitation and hygiene facilities on childhood undernutrition in the Bolgatanga Municipality of the Upper East Region of Ghana.
Category of participants: Mother-baby-pairs

Introduction

I am John Baptist K. Dorzie, a Master of Public Health student in the Department of Environmental and Occupational Health at the University for Development Studies. We cordially invite you to participate in a research study. The objective of this research is to assess the impact of household access to WASH facilities on undernutrition among children under the age of five years in the Upper East Region of Ghana, specifically in the Bolgatanga Municipality. Your participation is crucial as we believe you can provide the information necessary for us to delve into this subject. Your involvement in this study is voluntary, and you are under no obligation to state a reason if you choose not to participate.

Procedures

Should you decide to participate in this research, you will be required to respond to questions regarding your household's WASH services and provide information on various health indicators concerning both you and your child. Additionally, we will measure your child's height and weight to evaluate his/her nutritional status. Completing the questionnaire should take approximately thirty minutes.

Voluntary Participation

Your participation in this study is entirely voluntary. You have the freedom to decline participation and withdraw at any point without facing any charges or consequences.

Benefits

While you or your child may not directly benefit from partaking in this study, your involvement will contribute to the advancement of our knowledge on this topic. The outcomes of this research could be instrumental in shaping programs and policies aimed at enhancing the nutrition and overall well-being of children. Furthermore, the findings may be disseminated through publication to benefit other researchers.

Risks

The risks associated with participating in this study are minimal. You may be asked personal questions that could evoke memories you would rather not revisit or make you feel uneasy. You are at liberty to refrain from answering any questions that make you uncomfortable without the need for justification.

Confidentiality and anonymity

All information collected in this study will be kept confidential. Your name will not be used in any reports or publications. Your information will be assigned a study number and will be kept in a secure location. People may see you talking with me and want to know from you what we talked about. You can decide to tell them or refuse to tell them. However, no information

collected from you will be shared with anyone outside the research team. There will also be no way of tracing any information back to you.

Contact Information

You can ask any questions you may have at this time regarding this study. If you would like to inquire later, you can reach Dr. Michael Boah at 0244876056, Dr. Stephen Apanga Wewuta at 0207742503, or me at 0592122087. The Navrongo Health Research Center's Institutional Review administrator can also be reached at 0591152102.

Appendix II: Consent form

I, [respondent's name], hereby acknowledge that I have been fully informed about the study. I am aware of its objectives, potential risks, benefits, and procedures. I understand that my participation in this research is entirely voluntary, and I have the right to withdraw at any time without facing any consequences. All my questions regarding the study have been addressed satisfactorily, and I have been allowed to seek clarification on any aspect. I acknowledge that my data will be kept confidential and solely used for this research purpose. I provide my voluntary consent to participate in this study and authorize the researchers to gather and utilize my data for analysis. I am aware that there will be no compensation for my participation. By signing below, I confirm my decision to take part in this study.

Participant's Signature/thump print: Date: _____

Witness Confirmation (For those who cannot read)

I, [Name of the Witness], affirm that I read the information about the study out loud to [Respondent's Name], in a language that he/she understand. I also answered their questions to their satisfaction and explained to them that their participation is voluntary. I confirm that [respondent's name] fully understood the information provided and gave his/hervoluntary consent to participate in this study.

Witness Name: _____

Investigator's Signature: _____ Date: _____

Investigator Affidavit

I certify that I have explained the nature and purpose of the study, the potential benefits, and possible risks associated with the participation in this research project to the above individual(s). I have addressed any questions that have been raised, and I have witnessed the above signature on the date indicated below.

Investigator's Name: _____

Investigator's Signature: _____Date: _____

Appendix III: Questionnaire

Introduction

Dear Participant,

We are excited to have you participate in our study on assessing the effects of household access to WASH facilities on child undernutrition. Your participation is crucial to helping us better understand the link between poor WASH practices and child undernutrition.

Your responses are important to us and will be utilized exclusively for research purposes. We ensure that your responses will be treated with confidentiality and anonymity, and no identifying data will be gathered. Your participation is voluntary, and you are free to withdraw at any point. Thank you for your time and willingness to participate in this study. We appreciate your contribution to our research.

Questionnaire Identifiable information		
S/N	**Question**	**Response**
	Health Facility name	
	Health facility code	
	Respondent ID	
Section A: Maternal Background Characteristics		
1	What was your age at last birthday?	**Please record**
2	What is your highest level of education?	1. No education 2. Primary 3. J.H.S 4. Secondary/S.H. S

		5. Tertiary
3	What is your current employment status?	1. Employed full-time 2. Employed part-time 3. Self-employed 4. Unemployed
4	What is your current marital status?	1. Married 2. Never Married 3. Divorced 4. Separated 5. Widowed
5	How many children have you ever given birth to (both alive and dead)?	Please record
6	Did you receive antenatal care during your most recent pregnancy?	1. Yes 2. No 3. Don't know
7	If yes, how many times did you receive antenatal care during your most recent pregnancy?	Please record
8	Record the mother's haemoglobin level before delivery (Hint: Check from maternity book)	Please record
9	Please check and record maternal height (in cm)	
10	Please check and record maternal weight (in kg) at ANC before 12 weeks	
11	mother's BMI during the third trimester of pregnancy	**To be calculated**
12	Did you receive multivitamins and other supplements (iron, folic acid, dewormer) during your recent pregnancy?	1. Yes 2. No 3. Don't know

Section B Part I: Household Characteristics		
S/N	**Question**	**Response**

13	What is the total number of people living in your household?	**Please record**
14	What is the gender of the household head?	1. Male 2. Female
15	What is the highest level of education attained by the household head?	1. No education 2. Primary 3. J.H.S 4. Secondary/S.H. S 5. Tertiary
16	What is the employment status of the household head?	1. Employed full-time 2. Employed part-time 3. Self-employed 4. Unemployed
17	Is the household located in an urban or rural area?	1. Urban 2. Rural
Section B Part II: Household Water Access		
18	What is the main source of drinking water for your household?	1. Piped water 2. Piped into a dwelling 3. Piped to yard/plot 4. Public tap/standpipe 5. Tube well or borehole 6. Dug well 7. Protected well 8. Unprotected well 9. Water from spring 10. Protected spring 11. Unprotected spring 12. Rainwater 13. Tanker truck 14. Cart with small tank 15. Surface water (river/dam/ 16. Lake/pond/stream/canal/ 17. Irrigation channel)

		18. Bottled water 19. Sachet water 20. Other please specify…
Section B Part III: Household Sanitation Practices		
19	What type of toilet facility do you have in your household?	1. Flush or pour-flush toilet 2. Flush to a piped sewer 3. System 4. Flush to septic tank 5. Flush to pit latrine 6. Flush, don't know where 7. Pit latrine 8. Ventilated improved pit latrine 9. Pit latrine with slab 10. Pit latrine without slab/open pit 11. Bucket toilet 12. Hanging toilet/hanging latrine 13. No facility/bush/field 14. Other (specify)
20	Do you share this TOILET facility with other household members?	1. Yes 2. No 3. Don't know
21	The last time (NAME OF CHILD) passed stool, what was done to dispose of the stool?	1. Child used the toilet or latrine 2. Put/rinsed into toilet or latrine 3. Put/rinsed into a drain or ditch

		4. Thrown into a garbage 5. Buried 6. Left in the open 7. Other
22	How do you dispose off your household waste?	1. Collected by a municipal service 2. Burned 3. Buried 4. Other (please specify)
Section B Part IV: Household Hygiene Practices		
23	Do you have a designated handwashing station in your household?	1. Yes 2. No 3. Don't know
24	If yes, do you have water available at this station for handwashing?	1. Yes 2. No 3. Don't know
25	Do you have any soap or detergent (or other locally used cleansing agents) in your household for washing hands?	1. Yes 2. No 3. Don't know
26	At what moments do you wash your hands with soap and water?	Select all that apply 1. Before eating 2. After using the toilet 3. Before and after preparing food 4. After handling garbage or waste 5. After sneezing, coughing, or blowing your nose 6. Other (please specify) ___
Section C: Child characteristics		

S/N	Question	Response
27	What is the gender of the child?	1. Male 2. Female
28	What is the child's birth weight? (Please check from the weighing card)	**Please record**
29	What is the childbirth order?	**Please record**
30	Check and record the gestational age at delivery (in weeks)	**Please record**
31	How long after delivery, was [NAME OF CHILD] put to the breast?	**PLEASE RECORD**
32	Is [NAME OF CHILD] still breastfeeding?	1. Yes 2. No 3. Don't know
33	If no, at what age in months did [NAME OF CHILD] stopped breastfeeding?	**Please record**
34	Was [NAME OF CHILD] exclusively breastfed?	1. Yes 2. No 3. Don't know
	Child Illness History	
35	Did [NAME OF CHILD] experience any diarrhoea in the past 2 weeks prior to this survey?	1. Yes 2. No 3. Don't know
36	Did [NAME OF CHILD] experience any difficulty in breathing (proxy for Respiratory tract infection) in the past 2 weeks prior to this survey?	1. Yes 2. No 3. Don't know
37	Has the child ever taken any nutritional supplements in the past? (e.g., Vitamin A, plumpy nuts etc.)	1. Yes 2. No 3. Don't know
	Child Anthropometric Characteristics	
38	When was [NAME CHILD] born?	Day_____

		Month_____ Year_____
39	Measure and record the child's height in Centimetres	**Please record_____**
40	Measure and record the child's weight in kilograms	**Please record_____**

ASSESSING THE EFFECT OF HOUSEHOLD ACCESS TO WATER SANITATION AND HYGIENE FACILITIES ON CHILDHOOD UNDERNUTRITION IN THE BOLGATANGA MUNICIPALITY OF THE UPPER EAST REGION OF GHANA

by Dorzie K. John Baptist

Assessing the Effect of Household Access to Water Sanitation and Hygiene Facilities on Childhood Undernutrition in the Bolgatanga Municipality of The Upper East Region of Ghana

ORIGINALITY REPORT

11%	8%	7%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Nicolas Gaffan, Alphonse Kpozehouen, Cyriaque Degbey, Yolaine Glele Ahanhanzo, Moussiliou Noël Paraïso. "Effects of the level of household access to water, sanitation and hygiene on the nutritional status of children under five, Benin", BMC Nutrition, 2023 Publication	1%
2	www.ncbi.nlm.nih.gov Internet Source	1%
3	Kamagate, Ouda. "Water/Sanitation, Hygiene, and Risk Factors Associated with Under-5 Mortality in Côte D'Ivoire", Walden University, 2022 Publication	<1%
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My Ref: Wash Practices /06/2023
Your Ref:

Navrongo Health Research Centre
Institutional Review Board
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E-mail: irb@navrongo-hrc.org
2nd June 2023

Mr. Dorzie K. John Baptist
University for Development Studies
Department of Environmental and Occupational Health
P.O Box 1883
Tamale

ETHICS APPROVAL ID: NHRCIRB528

Dear Mr Dorzie,

Approval of Protocol titled "Assessing the effect of household access to water sanitation and hygiene facilities on childhood undernutrition in the Bolgatanga Municipality of the Upper East Region"

I write to inform you that the Navrongo Health Research Centre Institutional Review Board (NHRCIRB) has reviewed your protocol and is happy to grant you approval. The following documents were reviewed and approved;

- Study Protocol version 2.0 dated 2nd June, 2023
- Participant Information Sheet and Informed Consent Form version 2.0 dated 2nd June, 2023
- Questionnaire version 2.0 dated 2nd June, 2023
- CV of Investigators (Mr Dorzie K. John Baptist, Dr. Apanga Stephen)

Please, note that any amendment to these approved documents must receive prior NHRCIRB approval before implementation. This approval expires on **1st June 2024.**

The Board wishes you all the best in your study.

Sincerely,

Dr. Nana Akosua Ansah

(Vice-Chair, NHRCIRB)

Cc: The Director, NHRC - Navrongo

UNIVERSITY FOR DEVELOPMENT STUDIES

DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH

STUDENT LEDGER

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Date	Academic Year	Billing	Payment	Naration
14-Apr-2023	2022/2023		4,418.00	PAYMENT: MASTER OF PUBLIC HEALTH
30-Mar-2023	2022/2023		3,397.00	PAYMENT: 2022/2023 DAAD SCHOLARSHIP AWARD
31-Jan-2023	2022/2023	7,580.00		BILLING: MPH ENVIRONMENTAL HEALTH
18-Jan-2023	2022/2023		2,785.00	PAYMENT: DAAD Scholrship 2021/2022
13-Jun-2022	2022/2023		1,000.00	PAYMENT: MASTER OF PUBLIC HEALTH
02-Jun-2022	2022/2023		3,500.00	PAYMENT: MASTER OF PUBLIC HEALTH
15-Dec-2021	2021/2022	7,520.00		BILLING: MPH ENVIRONMENTAL HEALTH
Total		**15,100.00**	**15,100.00**	
Balance		**0.00**		