PREVALENCE AND FACTORS ASSOCIATED WITH ACUTE WATERY DIARRHOEA IN CHILDREN AGED UNDER-FIVE YEARS WITH SEVERE MALNUTRITION AT GULU REGIONAL REFERRAL HOSPITAL, GULU CITY, UGANDA.

BY

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23/U/0722/MPK/PS

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A DISSERTATION SUBMITTED TO THE FACULTY OF MEDICINE IN PARTIAL FULFILMENT FOR THE AWARD OF MASTER'S DEGREE OF PUBLIC HEALTH OF GULU UNIVERSITY

MAY, 2026

DECLARATION

I, Tadeo Ssemwogerere, declare that the information contained in this study, "*Prevalence and factors associated with acute watery diarrhoea in children aged under five years with severe malnutrition at Gulu Regional Referral Hospital, Gulu City, Uganda*" is my own work and has not previously been submitted to any university or other tertiary institution for the purpose of obtaining an academic qualification.

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APPROVALS

This dissertation, titled "*Prevalence and factors associated with acute watery diarrhoea in children aged under five years with severe malnutrition at Gulu Regional Referral Hospital, Gulu City, Uganda*," has been submitted with our approval as the appointed supervisors from Gulu University.

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ACKNOWLEDGEMENT

I am deeply grateful to the Almighty for granting me good health, the opportunity to pursue the program, and the ability to conduct this study.

I thank my supervisors for their guidance and insightful comments in completing this research report.

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ABBREVIATIONS

aPR	Adjusted Prevalence Ratio
AWD	Acute Watery Diarrhoea
CI	Confidence Interval
cPR	Crude Prevalence Ratio
GRRH	Gulu Regional Referral Hospital
GUREC	Gulu University Research and Ethics Committee
IQR	Interquartile Range
MoH	Ministry of Health
MUAC	Mid-Upper Arm Circumference
PR	Prevalence Ratio
ReSoMal	Rehydration Solution for Malnutrition
SAM	Severe Acute Malnutrition
SD	Standard Deviation
SDG	Sustainable Development Goal
UBOS	Uganda Bureau of Statistics
UNCST	Uganda National Council for Science and Technology
UNEPI	Uganda National Expanded Programme on Immunisation

VIF Variance Inflation Factor

WASH Water, Sanitation and Hygiene

WHO World Health Organization

OPERATIONAL DEFINITIONS

Acute watery diarrhoea (AWD): The passage of three or more loose or watery stools in a 24-hour period on any day during the two weeks before the interview, as reported by the caregiver. A child who had such an episode at any time in the two-week period, including a child whose diarrhoea had stopped by the day of the interview, was classified as having AWD. AWD was recorded as a binary variable (yes or no).

Severe acute malnutrition (SAM): A weight-for-height (or weight-for-length) Z-score below -3 standard deviations (SD) of the WHO Child Growth Standards, a mid-upper arm circumference (MUAC) below 11.5 cm in children aged 6–59 months, or the presence of bilateral pitting oedema. MUAC was not used for infants below six months of age.

Dehydration: A clinical diagnosis made at recruitment by a trained nutritionist using WHO signs adapted for children with SAM (history of watery stools, recent onset of sunken eyes, thirst and ability to drink, skin pinch and level of consciousness), and graded as mild, moderate or severe as described under 'Assessment and classification of dehydration' in Chapter Three.

Shock: A lethargic or unconscious child with cold hands and either a capillary refill time longer than three seconds or a weak, fast pulse (WHO).

Immunisation status: The caregiver's report of whether the child had been immunised according to the Uganda National Expanded Programme on Immunisation (UNEPI) schedule for his or her age, recorded as immunised (yes) or not immunised (no).

Hand washing at Five Critical Times: A mother or caregiver is considered to have fully practiced proper hand washing if they wash their hands prior to meals, prior to food preparation, prior feeding a child, after cleaning a child, and following toilet use. If any of these five actions

were missed, the practice is classified as "incomplete adherence to recommended hand-washing practices."

Safe household waste management refers to the appropriate handling of household waste, which includes methods such as burning, burying in a pit, storing in a container, or composting. However, discarding waste in open fields was classified as improper disposal.

Unimproved water source: This refers to situations where individuals use water for drinking from sources such as rivers, ponds, wells, or unprotected springs.

ABSTRACT

Background: Diarrhoea remains a leading cause of death among children under five years, and the risk is highest in children with severe acute malnutrition (SAM). This study determined the prevalence of acute watery diarrhoea (AWD) and its associated factors, and the prevalence of dehydration and shock, among children under five years with SAM at Gulu Regional Referral Hospital (GRRH), Uganda.

Methods: A hospital-based cross-sectional study was conducted among 425 children under five years admitted with SAM at GRRH between July and September 2025. Every second eligible child was selected by systematic random sampling. Data were collected from caregivers using an interviewer-administered questionnaire, and dehydration was assessed at recruitment by a trained nutritionist. AWD was defined as three or more loose or watery stools in 24 hours on any day in the two weeks before the interview. Data were analysed using Stata version 18. Modified Poisson regression with robust standard errors was used to estimate crude and adjusted prevalence ratios (aPR). Variables with $p<0.20$ at bivariable analysis, together with child age, sex and maternal age, were entered into the multivariable model, and $p<0.05$ was considered statistically significant.

Results: The median age of the children was 15 months (IQR: 8–25) and 52.5% (n=223) were female. The prevalence of AWD was 45.6% (95% CI: 40.9–50.4). Use of wells as the main source of drinking water (aPR: 1.31, 95% CI: 1.01–1.70) and caregiver-reported immunisation (aPR: 1.62, 95% CI: 1.03–2.54) were independently associated with AWD. Maternal education was associated with AWD at bivariable analysis but not after adjustment (p=0.063). Dehydration was present in 13.2% (95% CI: 9.9–16.4) of all children and in 28.4% of those with AWD; moderate dehydration was the most common grade (44.6%). Shock was not recorded separately from dehydration, so its prevalence could not be estimated.

Conclusions: Nearly half of the children admitted with SAM had AWD and about one in eight was dehydrated. Drinking water from wells was the main modifiable factor associated with AWD. Every child with SAM should be screened for recent diarrhoea, dehydration and shock at admission, and household water safety should be part of caregiver counselling. The positive association with immunisation most likely reflects care-seeking behaviour and selection into the hospital sample rather than an effect of vaccines.

Keywords: Acute Watery Diarrheal disease, dehydration, severe acute malnutrition, under-five children, prevalence, associated factors, Uganda.

CHAPTER ONE: INTRODUCTION

Background

Globally, diarrhoea is one of the leading causes of mortality among children under five years of age, and is defined as the passage of three or more loose or liquid stools within 24-hour period due to increased fluid content in the stool or an abnormal rise in stool frequency (WHO, 2017). Worldwide, Acute Watery Diarrhoea (AWD) is among the major causes of child deaths, contributing to approximately 446,000 deaths annually among children under five, despite the availability of simple, effective treatment options in many countries (Troeger *et al*., 2018).

In Uganda, diarrhoea remains among the top five leading causes of under-five mortality, accounting for 8% of the estimated 85,000 annual deaths in this group (Liu *et al*., 2015). Findings from the Uganda Demographic and Health Survey (2022) show that diarrhoea prevalence among under-five children stood at 11% across the country, increasing to 17% in the Acholi sub-region (UBOS, 2022). In addition to diarrhoea, Uganda continues to face a high burden of undernutrition, where approximately 30% of children under five are stunted, and about 3.5% experience wasting (WHO & UNICEF, 2023). The situation is particularly severe among children diagnosed with Severe Acute Malnutrition (SAM), in whom diarrhoea is not just a common illness but a condition that can rapidly become life-threatening (Acosta *et al*., 2014; Walson & Berkley, 2018). This is because the synergistic relationship between malnutrition and infection creates a vicious cycle; malnutrition impairs intestinal barrier and immune function, increasing susceptibility to and severity of diarrhoeal pathogens, while diarrhoea, in turn, exacerbates nutrient losses and worsens the nutritional status (Acosta *et al*., 2014; Walson & Berkley, 2018).

Diarrhoea is a strong predictor of mortality among children with complicated severe acute malnutrition (Grenov *et al*., 2019). A mutually reinforcing relationship exists between malnutrition and diarrhoeal disease (Schlaudecker *et al*., 2011). Undernutrition weakens immune defense, increasing susceptibility to intestinal and other infections, while these infections further worsen nutritional status through nutrient loss and impaired absorption(Walson & Berkley, 2018). Repeated enteric infections over time may result in impaired linear growth (stunting) and reduced cognitive development outcomes (Morales *et al*., 2024; Walson & Berkley, 2018). Finally, diarrhoea and malnutrition interact in a way that amplifies the risk of death from either condition. The immediate life-threatening consequences of diarrhoea arise from excessive fluid loss, which can lead to dehydration, electrolyte imbalance, shock, and eventually death (Williams & Berkley, 2018). Diarrhoea illness among this population is largely influenced by poor Water, Sanitation, and Hygiene (WASH) practices, including reliance on unsafe water sources, open defecation, and a critical lack of handwashing facilities with soap (Mapingure *et al*., 2024; UBOS, 2022). These risks are further amplified by socioeconomic determinants such as household overcrowding, poverty, and low maternal education, which limit the adoption of protective health behaviours (Mapingure *et al*., 2024). Several determinants contribute to the detrimental effect of diarrhoea on nutrition. Malnutrition and diarrhoeal mortality are bidirectionally associated. Malnutrition causes immune deficiency and increased susceptibility to infections such as diarrhoea. Diarrhoea, in turn, causes malnutrition through reduced food appetite, energy intake, nutrient loss, and malabsorption (Kyu *et al*., 2025).

Limited research data exist on prevalence and factors associated with acute watery diarrhoea in under 5 severely malnourished children in the Acholi sub-region despite the known impacts of both conditions. Understanding the prevalence, along with the factors that contribute to or

exacerbate this condition in severely malnourished children, is critical for designing targeted interventions and effective public health strategies. Addressing this knowledge gap is essential for healthcare providers, policymakers, and public health professionals to develop evidence-based solutions aimed at reducing the burden of diarrhoea among severely malnourished children and improving their survival and overall health outcomes. Therefore, this study focused on assessing the prevalence of acute watery diarrhoea and examining its associated factors among under-five children with severe malnutrition at Gulu Regional Referral Hospital, Gulu City, Uganda.

Problem statement

Diarrhoea and severe acute malnutrition (SAM) are two of the most important, and most closely linked, causes of illness and death among children under five years. Globally, SAM affects an estimated 16 million children under five, and a child with SAM is about nine times more likely to die than a well-nourished child (United Nations Children's Fund, World Health Organization, 2018). Diarrhoea is common in these children and is a strong predictor of death, largely because dehydration and electrolyte disturbances are more frequent, harder to recognise and more dangerous to treat in a malnourished child (Grenov *et al.*, 2019; Williams & Berkley, 2018).

In Uganda, both conditions remain common. Diarrhoea is among the top five causes of death in children under five years (Liu *et al.*, 2015), and its prevalence in the Acholi sub-region is above the national average (UBOS, 2022). Undernutrition is also concentrated in northern Uganda, where poverty, food insecurity and limited access to safe water and sanitation persist (Maniragaba *et al.*, 2023; Ojuka & Tumwebaze, 2022). In Gulu District, stunting, wasting and underweight remain substantial among young children (Ssenyondo *et al.*, 2022), and about one in five children treated for SAM in outpatient programmes in northern Uganda defaults from care

(Kamulegeya *et al.*, 2026), which leaves many children at risk of relapse and of complications such as diarrhoea.

Gulu Regional Referral Hospital admits a large number of children with SAM from the Acholi sub-region, and health workers there frequently manage diarrhoea and dehydration in these children. However, there is no local estimate of how many children with SAM present with acute watery diarrhoea, how many are dehydrated or in shock, or which household and care factors are linked to diarrhoea in this group. Most available Ugandan data describe diarrhoea in the general under-five population (UBOS, 2022; Ssekandi, 2022) and cannot be applied directly to children with SAM, whose presentation and treatment differ. Without these data, it is difficult to plan triage, staffing, supplies of rehydration solution for malnutrition (ReSoMal) and caregiver counselling for this high-risk group. This study therefore determined the prevalence of acute watery diarrhoea and its associated factors, and the prevalence of dehydration and shock, among children under five years with SAM at Gulu Regional Referral Hospital.

Justification of the study

By measuring the burden of acute watery diarrhoea and dehydration among children with SAM and identifying the factors associated with diarrhoea, this study provides local evidence for integrating diarrhoea prevention and management into nutrition care at GRRH. The findings can guide clinical triage, caregiver counselling and water, sanitation and hygiene (WASH) programmes in northern Uganda, and contribute to national efforts towards the Sustainable Development Goal target of reducing under-five mortality to 25 per 1,000 live births or lower (United Nations, 2016).

Study objectives

General objective

To determine the prevalence of acute watery diarrhoea and its associated factors among children under five years with severe acute malnutrition at Gulu Regional Referral Hospital, Gulu City, Uganda.

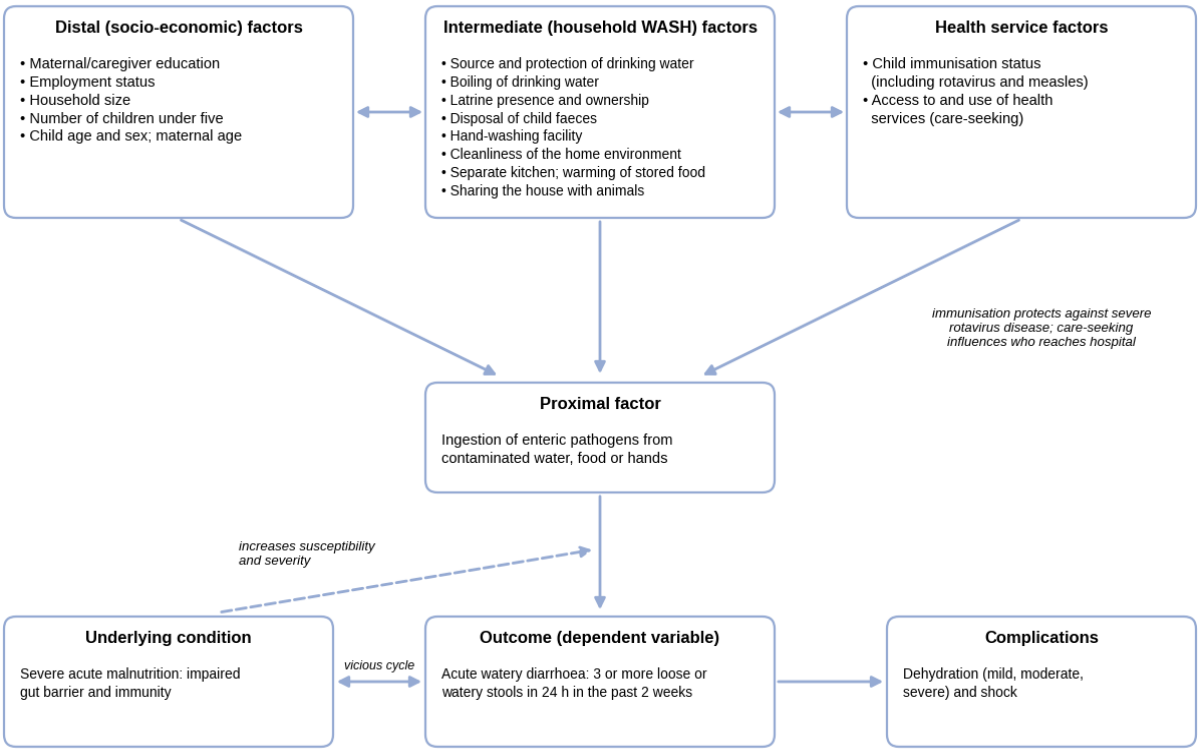
Specific objectives

1. To determine the prevalence of acute watery diarrhoea among children under five years with severe acute malnutrition at Gulu Regional Referral Hospital, Gulu City, Uganda.
2. To identify the factors associated with acute watery diarrhoea among children under five years with severe acute malnutrition at Gulu Regional Referral Hospital, Gulu City, Uganda.
3. To determine the prevalence of dehydration and shock among children under five years with severe acute malnutrition at Gulu Regional Referral Hospital, Gulu City, Uganda.

Research questions

1. What is the prevalence of acute watery diarrhoea among children under five years with severe acute malnutrition at Gulu Regional Referral Hospital, Gulu City, Uganda?
2. What factors are associated with acute watery diarrhoea among children under five years with severe acute malnutrition at Gulu Regional Referral Hospital, Gulu City, Uganda?
3. What is the prevalence of dehydration and shock among children under five years with severe acute malnutrition at Gulu Regional Referral Hospital, Gulu City, Uganda?

Conceptual framework



Source: Adapted with modification from Mapingure *et al*., (2024)

Figure 1: Conceptual framework

Description of the conceptual framework

The conceptual framework (Figure 1) shows how the study variables are expected to relate to each other and to the outcome. Distal socio-economic factors, such as maternal education, employment and household size, shape the water, sanitation and hygiene conditions of the household and its use of health services. These intermediate factors in turn determine the proximal cause of acute watery diarrhoea, which is the ingestion of enteric pathogens from contaminated water, food or hands. Health service factors act in two ways: immunisation, particularly against rotavirus and measles, reduces the risk of severe diarrhoea, while the care-seeking behaviour of caregivers influences which sick children reach the hospital. Severe acute malnutrition lies alongside this pathway. It weakens the gut barrier and the immune response,

making infection more likely and more severe, while diarrhoea in turn worsens nutritional status, creating a vicious cycle. Acute watery diarrhoea is the main outcome of the study, and dehydration and shock are its immediate complications. In the analysis, the distal factors and child characteristics (age, sex and maternal age) were treated as potential confounders of the relationship between the intermediate or health service factors and acute watery diarrhoea.

CHAPTER TWO: LITERATURE REVIEW

Introduction

Acute watery diarrhoea continues to pose a major challenge to public health worldwide, especially in low-resource settings where access to safe water, proper sanitation, and quality healthcare is limited. The condition disproportionately affects vulnerable populations, particularly children living in economically disadvantaged areas, while significantly contributes to both morbidity and mortality. Among children under the age of five, it is one of the leading causes of preventable deaths worldwide(Ferdous *et al*., 2013). The risk is even greater for children suffering from severe malnutrition, as diarrhoeal episodes further compromise their health and substantially increase the likelihood of death.

Prevalence of Acute Watery Diarrhoea among Children under 5 years of age with SAM

The World Health Organization (WHO) estimates that diarrhoeal diseases are responsible for around 446,000 child deaths each year, making up 8% of total mortality among children in this age category. While treatment options like oral rehydration therapy and zinc supplementation have made significant progress, acute watery diarrhoea continues to be a major public health issue (World Health Organization (WHO), 2023). This problem is especially severe in low- and middle-income countries (LMICs), where limited access to clean water, sanitation, and healthcare services greatly increases the burden of acute watery diarrhoea, putting millions of children at risk. Globally, more than 150 million children suffer from undernutrition, which manifests as stunting and wasting each year. This clearly confirms the importance of malnutrition in shaping the global effects of diarrhoeal illnesses, where severe malnutrition increases the severity of diarrhoea and the risk of mortality. Diarrhoea also contributes to malnutrition by interfering with nutrient absorption, increasing nutrient loss, and reducing appetite. The bidirectional relationship between malnutrition and diarrhoea

exacerbates each condition, creating a vicious cycle that affects the most vulnerable populations. According to (Kyu *et al*., 2025), over 1,500 deaths among children younger than five years are attributed to diarrhoea worldwide every day, and severely malnourished children have nine times higher odds of death from diarrhoeal disease than their adequately nourished peers. Recent studies indicate that climate change will likely exacerbate the global burden of acute watery diarrhoea, increasing temperatures and weather extremes, including floods, lead to contamination of water sources and increased waterborne disease transmission. Socioeconomic inequalities, especially in low-income areas, restrict access to preventive measures like clean drinking water and proper sanitation, worsening the impact of acute watery diarrhoea in malnourished children. The patterns of burden also highlight the need for targeted, life-course interventions that address both diarrhoea prevention and the drivers of nutritional vulnerability. Diarrhoea and malnutrition are major causes of childhood mortality in sub-Saharan Africa, contributing to nearly 50% of global under-five diarrhoeal deaths. The region faces significant challenges, including weak health systems, poor sanitation, and high levels of malnutrition. Additionally, stunting (34%) and wasting (7%), both key indicators of undernutrition, are prevalent in sub-Saharan Africa. Diarrhoea plays a significant role in contributing to both stunting and wasting, and the incidence of acute watery diarrhoea among malnourished children in the region remains alarmingly high. A study from Ethiopia by (Demoze *et al*., 2025) found that 31.43% of children under five who were admitted to hospitals with diarrhoea and malnutrition experienced bidirectional effects (diarrhoea happening first then malnutrition at 20.0% and vice versa, malnutrition at 11.43%. These findings speak to the complex interaction between malnutrition and diarrhoea in this part of the globe, where poverty and unfavourable environmental conditions, including inadequate sanitation facilities and limited access to safe drinking water sources further exacerbate the burden of diseases. Studies conducted in Kenya, specifically in Kisumu

County, have shown that children from households lacking access to treated drinking water are 1.8 times more likely to suffer from diarrhoea. The Uganda Demographic and Health Survey revealed that around 20% of children under younger than five years had suffered an episode of diarrhoea in the 14 days preceding data collection, underscoring the continued impact of the disease and the need for improved prevention and treatment strategies (UBOS, 2022). Yet the rates of under-five deaths are higher in northern Uganda, including in the Acholi sub-region, where poverty is lingering, malnutrition levels are high, and access to healthcare and sanitation services is inadequate. Research in Uganda underscores the overlapping impacts of diarrhoea and malnutrition, especially noteworthy among poor households with limited access to healthcare services. Access to healthcare was found to be delayed for many families, contributing to worse outcomes. Children seeking treatment over 24 hours after the onset of diarrhoea symptoms had a twofold increased mortality risk. This underlines the need for prompt interventions and enhanced healthcare access to curb the impact of acute watery diarrhoea among malnourished young people. In northern Uganda's Gulu City, children under five years bear a large burden of acute watery diarrhoea and malnutrition. Severely malnourished children suffering from diarrhoea is a common theme at Gulu Regional Referral Hospital, a motif that captures the interrelatedness of the two maladies. Although there is no specific data available about the prevalence of acute watery diarrhoea among severely malnourished children in Gulu, preliminary data from Gulu Regional Referral Hospital indicate that the prevalence can be as high as 60%, consistent with trends seen in other high-burden regions in northern Uganda. A study by Grenov *et al*. (2019) in Uganda found that children who suffer from both malnutrition and diarrhoea are two and a half times more likely to die than well-nourished children (Grenov *et al*., 2019). The research also highlighted that improved access to healthcare services and therapeutic feeding programs significantly reduced mortality rates. These findings underscore the critical

need for targeted interventions in resource-limited settings such as Gulu, where the co-existing challenges of malnutrition and diarrhoea remain a pressing public health concern.

Factors associated with Acute Watery Diarrhoea among Children under 5 years of age with SAM

Acute watery diarrhoea (AWD) among under-five children with severe acute malnutrition (SAM) is influenced by a complex interaction of socioeconomic, nutritional, environmental, and healthcare-related factors. In low-resource settings such as northern Uganda, these determinants often coexist and worsen child vulnerability to both diarrhoeal disease and malnutrition. Evidence from Sub Saharan Africa consistently demonstrates that diarrhoea and malnutrition are closely interrelated conditions that significantly contribute to under-five morbidity and mortality (Chama *et al*., 2024; Liu *et al*., 2015).

Socio-economic factors

Socioeconomic and demographic factors are major determinants of acute watery diarrhoea (AWD) among under-five children with severe acute malnutrition (SAM). Low household income, poor caregiver education, overcrowding, and inadequate access to sanitation and healthcare increase children's exposure to diarrhoeal diseases. Kyu *et al*., (2025) reported that children whose caregivers whose highest educational attainment was primary school had 57.58% greater likelihood of experiencing AWD than children whose caregivers had higher educational attainment. Similarly, Ssekandi, (2022) identified poverty, low maternal education, and poor sanitation as key contributors to diarrhoeal illness among Ugandan children under five years. Although caregiver education is generally associated with improved childcare practices, Ngure *et al*. (2014) argued that education alone may not sufficiently reduce diarrhoeal risk where environmental sanitation and hygiene conditions

remain poor. In northern Uganda, persistent poverty and food insecurity continue to contribute to high levels of childhood undernutrition and recurrent infections despite improvements in healthcare access (Maniragaba *et al*., 2023; Ssenyondo *et al*., 2022). These findings suggest that socioeconomic inequalities remain important drivers of AWD among children with SAM.

Nutritional factors

Nutritional deficiencies are strongly associated with the occurrence and severity of AWD among children with SAM. Malnutrition weakens immune function, impairs intestinal integrity, and increases susceptibility to enteric infections and dehydration. Ferdous *et al*., (2013) reported that children with moderate-to-severe diarrhoea had a 50% greater likelihood of developing malnutrition than children without diarrhoeal illness, demonstrating the bidirectional relationship between diarrhoea and malnutrition. Chama *et al*., (2024) further emphasized that SAM significantly increases vulnerability to severe infections, dehydration, electrolyte imbalance, and mortality. Micronutrient deficiencies, particularly zinc and vitamin A deficiencies, are important contributors because they impair mucosal recovery and immune response. Evidence from Galvao *et al*., (2013) showed that zinc supplementation reduced diarrhoeal episodes by approximately 18%, with a relative risk reduction ranging from 0.68 to 0.88. In Uganda, Muwanguzi *et al*., (2021) reported poor treatment outcomes among severely malnourished children admitted to Lacor Hospital and Gulu Regional Referral Hospital, especially among children with coexisting infections and dehydration. Similarly, Nduhukire *et al*., (2020) identified dehydration and infections as major predictors of mortality among under-five children with SAM in Uganda. These findings demonstrate the strong interaction between nutritional status and diarrhoeal disease severity.

Environmental and WASH factors

Environmental and water, sanitation, and hygiene (WASH) factors are among the strongest predictors of AWD among under-five children with SAM. Inadequate availability of safe drinking water, inadequate sanitation infrastructure, open defecation, and suboptimal personal hygiene behaviors increase exposure to enteric pathogens. Ngure *et al*. (2014) explained that poor WASH conditions contribute to environmental enteropathy, impaired nutrient absorption, and recurrent infections, all of which worsen malnutrition. In northern Uganda, Ojuka & Tumwebaze, (2022) found that under-five diarrhoea prevalence was strongly linked to inadequate availability of safe drinking water and appropriate sanitation services. Similarly, Kombat *et al*. (2024) reported that children from households without treated drinking water were significantly more likely to develop diarrhoea. Comparable findings were reported by Owusu *et al*., (2024), who identified unsafe water sources and poor sanitation as major determinants of diarrhoeal diseases among children under five years in West Africa. Bastaraud *et al*., (2020) further demonstrated that unimproved water sources such as shallow wells commonly harbour enteric pathogens including Escherichia coli, Vibrio cholerae, and rotavirus, which are major causes of AWD in low-income countries. Seasonal flooding and poor drainage systems common in northern Uganda further increase contamination of water sources and disease transmission. These findings highlight the critical need for strengthened WASH infrastructure in communities affected by high rates of malnutrition and diarrhoeal diseases.

Health system and behavioural factors

Health system and behavioural factors also play an important role in determining AWD outcomes among children with SAM. Delayed healthcare-seeking behaviour, inadequate caregiver knowledge, poor utilization of oral rehydration solution (ORS), and limited access to integrated management services contribute to increased disease severity and mortality.

Muwanguzi *et al*., (2021) reported that severely malnourished children who presented late for treatment had approximately twice the risk of mortality compared to those who received timely care. Similarly, Nduhukire *et al*., (2020) identified delayed treatment, dehydration, and coexisting infections as major predictors of in-hospital mortality among children with SAM. Yaya *et al*., (2021) found that caregivers' decisions to seek medical care for common childhood diseases in Sub Saharan Africa was strongly influenced by maternal education, household wealth, and accessibility to healthcare facilities. In many low-resource settings, caregivers often delay seeking formal treatment until diarrhoea becomes severe, increasing the risk of dehydration and shock. Rahman, (2020) also reported that severe dehydration among malnourished children was strongly associated with fatal outcomes if prompt management was not initiated. Omoke *et al*., (2021) further observed that dehydration in malnourished children is frequently under-recognized because clinical signs may be atypical, complicating diagnosis and treatment. Narra *et al*., (2026) additionally highlighted challenges in fluid management among severely malnourished children with dehydration due to concerns about cardiac dysfunction and fluid overload. These findings emphasize the need for improved caregiver education, early healthcare access, strengthened integrated management of childhood illnesses, and enhanced training of healthcare workers in the management of AWD and SAM.

Prevalence of Dehydration and Shock among Children under 5 years of age with SAM

Severe acute malnutrition (SAM) remains a major global child health problem, with an estimated 19 million children under five affected worldwide, with the highest concentration of cases occuring in Sub Saharan Africa and South Asia (Chama *et al*., 2024). In these settings, dehydration and shock are among the most dangerous complications, especially when SAM is combined with diarrhoeal disease. Evidence shows that diarrhoea is a major

contributor to severe outcomes in SAM children. In Uganda, Grenov *et al*., (2019) reported that children with complicated SAM and diarrhoea had extremely poor outcomes, with mortality reaching up to 60% in the most severe cases. The same study highlighted that dehydration was a key driver of these deaths, rather than diarrhoea alone. This makes dehydration a central clinical concern in SAM management.

Hospital based studies further show the magnitude of mortality associated with SAM and its complications. Nduhukire *et al*., (2020) found that in hospital mortality among under five children with SAM in South Western Uganda was high, with case fatality rates reported around 11% to 18% depending on severity and associated complications. Diarrhoea and dehydration were among the strongest predictors of death in these children. In Kenya, Omoke *et al*., (2021) reported that dehydration was present in a substantial proportion of hospitalized children, including those without diarrhoea, showing that clinical dehydration in malnutrition is often underestimated. Although exact percentages varied across sites, the study highlighted that fluid imbalance was common enough to influence routine paediatric admissions and treatment decisions.

At a global level, Liu *et al*. (2015) estimated that diarrhoeal diseases accounted for about 9% of all under five deaths globally, making it one of the top five causes of child mortality. This is particularly important in SAM children, where dehydration rapidly progresses to shock due to reduced physiological reserves. Diagnostic challenges also influence reported prevalence. Liu *et al*., (2015) note that traditional clinical signs of dehydration such as sunken eyes and poor skin turgor are unreliable in SAM, leading to both underestimation and misclassification of cases. This means that reported hospital figures likely underestimate the true prevalence of dehydration and shock in this group. Regarding shock, Narra *et al*., (2026) highlight that although precise prevalence is not well established, clinical evidence suggests it occurs mainly in severely dehydrated SAM children, especially those with diarrhoea or sepsis, and is

a major contributor to mortality due to the risks associated with fluid resuscitation in this group.

Overall, the literature consistently shows that mortality in SAM children with diarrhoea and dehydration can be extremely high, reaching up to 60% in severe cases (Grenov *et al*., 2019), while hospital case fatality rates in SAM commonly range between 10% and 20% depending on severity and comorbidities (Nduhukire *et al*., 2020). These figures confirm that dehydration and shock are not only common complications but also major drivers of mortality among under-five children affected by severe acute malnutrition.

Gaps as well as Limitations in Existing Literature

A critical synthesis of the literature reveals several significant gaps and limitations, which this study aims to address. Firstly, there is a pronounced scarcity of localized, precise data relevant to the specific objectives of this research. While the high burden of diarrhoea and malnutrition in Northern Uganda is well-documented, robust epidemiological figures on the prevalence of acute watery diarrhoea specifically among under-five children with severe acute malnutrition at Gulu Regional Referral Hospital are lacking. The available prevalence rate of 60% is often cited as preliminary, highlighting the need for rigorous, primary data collection to establish a definitive baseline. Furthermore, a critical and often overlooked gap exists concerning the prevalence of life-threatening complications, specifically dehydration and shock, in this vulnerable population. The challenging physiology of severely malnourished children makes clinical assessment difficult, and the absence of local quantitative data on these complications hinders the development of effective triage and emergency fluid management protocols at the hospital level.

Secondly, the existing literature suffers from methodological and conceptual limitations that reduce its utility for targeted intervention planning. Many studies, including broad national

surveys, often report on "diarrhoea" in the general under-five population, thereby lacking the necessary specificity to understand the unique aetiology, progression, and management needs of Acute Watery Diarrhoea in the high-risk subgroup of severely malnourished children. Additionally, while various risk factors like poor WASH conditions and low caregiver education are identified in isolation, there is a lack of research that quantitatively analyses these factors specifically in the context of the AWD-SAM comorbidity. The relative importance and potential interrelationship among these socio-demographic and economic, nutritional, as well as environmental variables driving the prevalence of AWD at GRRH remain underexplored through multivariate analysis.

Finally, significant contextual and health systems gaps persist. The review identifies delayed healthcare access as a key problem, but there is insufficient in-depth analysis of the specific barriers such as financial constraints, transportation costs, cultural beliefs, or perceived quality of care that prevent caregivers of severely malnourished children from seeking timely treatment for acute watery diarrhoea. Understanding these localized barriers is essential for designing effective community-based interventions. Moreover, while policy recommendations often mention interventions like zinc supplementation and the integrated community-Based care for Acute Malnutrition (CMAM), evidence remains lack of critical, operational investigation on the specific implementation challenges and clinical effectiveness of integrating acute watery diarrhoea management within the established SAM treatment protocols at GRRH. Addressing these gaps is crucial for strengthening the ability of the healthcare system to break lethal cycle between undernutrition, diarrhoea in this vulnerable population.

CHAPTER THREE: METHODS

Study Design

This was a hospital-based cross-sectional study to determine the prevalence of acute watery diarrhoea and its associated factors, and the prevalence of dehydration and shock, among children under five years with severe acute malnutrition admitted to Gulu Regional Referral Hospital, Gulu City, Uganda.

Study Setting

The study was conducted at Gulu Regional Referral Hospital located in northern Uganda. This institution serves a broad catchment area that includes both urban and rural populations. The hospital also caters to patients from neighbouring countries such as South Sudan and the Democratic Republic of Congo. As major teaching hospital, it is affiliated with Gulu University and participate in regional training programs, including the East, Central, and Southern Africa College of Obstetrics and Gynaecology (ECSACOG) fellowship. Additionally, they provide diploma and certificate level training for healthcare workers, contributing significantly to medical capacity-building in the region. Gulu Regional Referral Hospital attends to approximately 120,000 patients annually, offering a range of medical services. The institution features specialized departments led by experienced consultants affiliated with Gulu Regional Referral Hospital and Gulu University's Faculty of Medicine.

The Nutrition Ward and Acute Care Unit at Gulu Regional Referral Hospital operates within a hospital that has an estimated capacity of about 370 to 397 beds (Namakula *et al*., 2017; Uganda Ministry of Health, 2020). Despite this capacity, the facility experiences consistently high patient pressure due to its role as a major referral centre in northern Uganda. Staffing in the nutrition and paediatric units includes medical officers, intern doctors, clinical officers, registered nurses, and nutritionists, with nurses forming the largest cadre responsible for daily

care and monitoring of children with severe acute malnutrition (SAM) (Muwanguzi *et al*., 2021; Kamulegeya *et al*., 2026). However, staffing gaps remain significant, with some reports indicating that only about 29% of approved positions are filled, contributing to workload strain. The hospital manages a heavy paediatric workload, with approximately 5,774 admissions of children aged 0–5 years annually, equivalent to about 480–500 admissions per month (Namakula *et al*., 2017). Nutrition services also handle around 690 outpatient SAM cases per year (about 55 per month), excluding inpatient admissions (Kamulegeya *et al*., 2026). Bed occupancy has been reported at about 70% to 74%, with average inpatient stays of 4 to 5 days, although congestion often exceeds capacity during peak periods.

Study population

The study targeted children under five years of age with severe acute malnutrition who were receiving care in the acute care units at Gulu Regional Referral Hospital, Gulu City, Northern Uganda.

Target population

The target group included all severely malnourished children under five years old within the geographic and demographic area covered by the study.

Accessible population

The accessible population consisted of all severely malnourished children under the age of five years who were admitted to either the acute care unit or the nutrition ward and met the study's eligibility criteria.

Eligibility criteria

Inclusion criteria

Children were included in the study if they met all the following requirements:

i. Those aged below five years (0–59 months).

ii. Those diagnosed with severe acute malnutrition according to WHO criteria: weight-for-height or weight-for-length Z-score below -3 SD, MUAC below 11.5 cm (children aged 6–59 months), or bilateral pitting oedema.

iii. Those who were admitted to the Nutrition Ward or Acute Care Unit at Gulu Regional Referral Hospital within the duration of the study.

iv. Informed consent to participate in the study was secured from the child's biological parents or legal guardian.

Exclusion criteria

Mothers or caregivers who were unable to provide informed consent were excluded from the study.

Sample size calculation

Using the Kish Leslie formula

$$n = \frac{Z^2 xpq}{d^2}$$

Where p is the prevalence of acute watery diarrhoea (Assumption made at 50%), at a 95% confidence interval and 5% margin of error, the sample size was calculated as follows: n = $(1.96)^2$ (0.5*0.5) / $(0.05)^2$; thus n = 384. After accounting for an estimated 10% non-response rate, the final adjusted sample size was 384/0.9 = 427 participants.

Of the 427 caregivers approached, two declined to take part, so 425 children were enrolled and included in the analysis (response rate 99.5%). The shortfall of two participants is within the 10% allowance for non-response, and the final sample still exceeded the minimum of 384 required for the planned precision.

Variables

Dependent variable

The dependent variable was acute watery diarrhoea (AWD), defined as the passage of three or more loose or watery stools in a 24-hour period on any day during the two weeks before the interview, as reported by the caregiver (Appendix 2, Section D). The two-week recall period was chosen because it is the standard period used in the Demographic and Health Surveys and it captures recent episodes that may have contributed to the current admission. A child who had such an episode at any time during the two weeks, including a child whose diarrhoea had stopped by the day of the interview, was classified as having AWD. AWD was therefore analysed as a binary variable (yes = 1, no = 0), not as a count of episodes. The secondary outcome was dehydration, assessed and classified as described under 'Assessment and classification of dehydration' below.

Independent variables

The independent variables covered child, caregiver, household and health service characteristics. Child variables were age in months and sex. Caregiver variables were the caretaker's relationship to the child (mother or other), maternal age in years, highest level of education (informal, primary, secondary or tertiary), employment status (employed or unemployed) and, for employed mothers, average monthly income in Uganda shillings. Household variables were the number of household members, the number of children under five years, the main source of drinking water (borehole, piped water or well), whether the source was protected, boiling of drinking water, presence and ownership (shared or private) of a latrine, disposal of child faeces, availability of a hand-washing facility, cleanliness of the home environment, availability of a separate kitchen, warming of stored food before feeding, and sharing of the house with domestic animals. The health service variable was the child's immunisation status.

Assessment and classification of dehydration

Dehydration was assessed at recruitment, before rehydration was started, by a trained nutritionist working with the study team. The assessment followed WHO guidance for children with SAM, in whom the usual signs of dehydration are less reliable because wasting alone can cause sunken eyes and a slow skin pinch. The nutritionist therefore combined the caregiver's history of recent watery stools and fluid intake with the clinical signs of thirst and ability to drink, dryness of the mouth, sunken eyes of recent onset (confirmed with the caregiver), skin pinch and level of consciousness. Dehydration was classified as mild when there was a history of fluid loss with thirst or a dry mouth, but no recent sunken eyes and a normal level of consciousness; moderate when, in addition, the eyes had recently become sunken or the child was restless or irritable, with a slow skin pinch; and severe when the child was lethargic or unconscious, unable to drink or drinking poorly, with a very slow skin pinch. The findings were recorded on the data collection tool (Appendix 2, Section E) as present or absent and, where present, by grade.

Shock was defined, following WHO guidance, as a lethargic or unconscious child with cold hands and either a capillary refill time longer than three seconds or a weak, fast pulse. Although the protocol planned to report shock, the clinical data did not separate children in shock from those with severe dehydration, because the dehydration variable recorded dehydration or shock together. The prevalence of shock on its own could therefore not be estimated (sections 4.4 and 5.6).

Assessment of immunisation status

Immunisation status was included because vaccines given under the Uganda National Expanded Programme on Immunisation (UNEPI), especially rotavirus and measles vaccines, protect against diarrhoea or its severe forms, and because being up to date with immunisation is also a marker of a family's contact with health services. Status was assessed by asking the caregiver whether the child had been immunised according to the schedule for his or her age

(Appendix 2, question 24). A child was classified as immunised if the caregiver reported that the child had received the vaccines due for age, and as not immunised otherwise. The information was based on caregiver report, and its limitations are discussed in section 5.6.

Study Procedure

The nutritionist of Gulu Regional Referral Hospital helped to identify eligible children using the WHO criteria for severe acute malnutrition: a weight-for-height or weight-for-length Z-score below -3 SD, a MUAC below 11.5 cm (for children aged 6–59 months), or bilateral pitting oedema. Children below five years of age who met any of these criteria during the study period were assessed for inclusion.

Recruitment of study participants

Participants were recruited by systematic random sampling, using the daily admission register of the nutrition ward and acute care unit as the sampling frame. The sampling interval (k) was obtained by dividing the expected number of eligible admissions during the data collection period by the required sample size. The expected number of eligible admissions was about twice the 427 children required, which gave k = 2. The first child was selected at random from the first two eligible admissions, and thereafter every second eligible child was selected. This interval spread recruitment evenly across days and weeks, so that the sample was not dominated by children admitted at particular times, and it removed the choice of which child to approach from the research team, which reduces selection bias. Using this procedure, 427 children were selected, and the caregivers of 425 gave consent (Figure 2). Screening and eligibility assessment were done by the principal investigator and trained research assistants. After confirming eligibility, the team explained the study objectives, procedures, risks and benefits to the child's parent or legal guardian, and written informed consent was obtained before any study procedure. Only children whose caregivers gave consent were enrolled.

Data collection

Data were collected through face-to-face interviews with caregivers and a review of clinical records at Gulu Regional Referral Hospital between July and September 2025. A structured pre-tested questionnaire was used to gather information on socio-demographic details, hygiene and sanitation practices, feeding habits, and the child's history of diarrhoeal illnesses. The data collection team consisted of trained research assistants with at least a diploma in nursing or clinical medicine, and prior experience in paediatric care and research. Before the start of data collection, a two-day training session was conducted to orient the team on the study protocol, ethical procedures, data collection instruments, and standardized techniques for nutritional assessment. To ensure data quality, several control measures were implemented. These included the use of standardized and pre-tested tools, daily supervision of data collection by the principal investigator, and real-time verification of completed questionnaires. Any inconsistencies or incomplete data were addressed immediately during data collection. All data were securely stored and handled in a manner that ensures both confidentiality and participant privacy.

Data management

Completed questionnaires were securely stored under lock and key while electronic data were password-protected after entry into Microsoft Excel. All questionnaires were checked for completeness then coded and entered into Microsoft Excel 2021 for cleaning and processing.

Data analysis plan

Flow Diagram showing participants recruitment and analysis

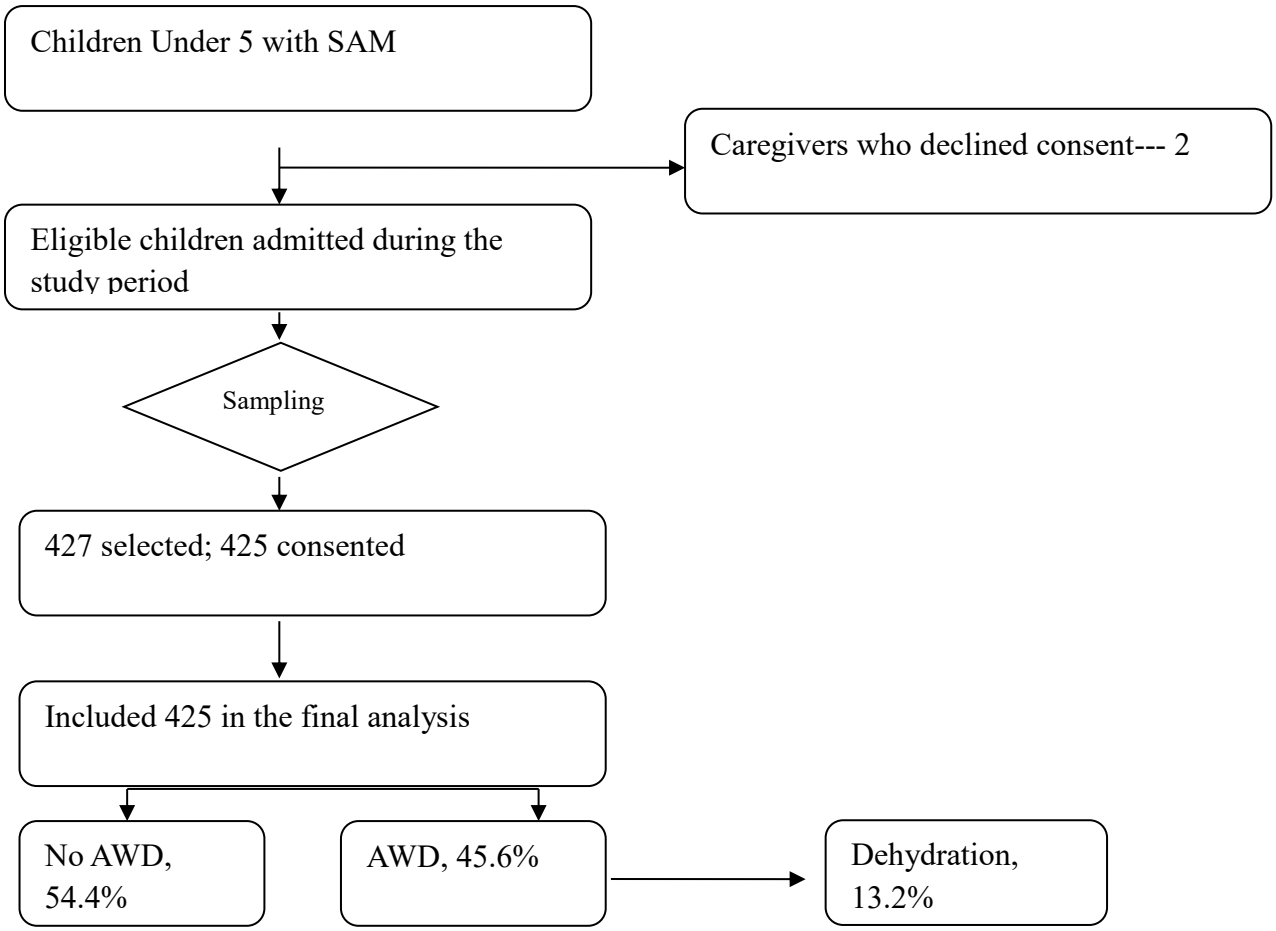


Figure 2: Flow diagram of participant recruitment and analysis

Cleaned data were imported into STATA MP version 18.0 for analysis. For descriptive analysis, numerical data were summarized as medians with corresponding interquartile ranges while categorical data were summarized as frequencies with corresponding proportions.

Prevalence of acute watery diarrhoea, dehydration and shock

The prevalence of acute watery diarrhoea was calculated as the number of children with AWD divided by the total number of participants, expressed as a percentage with its 95%

confidence interval. The prevalence of dehydration, overall and by grade (mild, moderate or severe), and among children with and without AWD, was calculated in the same way.

Factors associated with acute watery diarrhoea

Associations between the independent variables and AWD were first examined using bivariable modified Poisson regression, that is, Poisson regression with robust (sandwich) standard errors, which estimates prevalence ratios (PR) directly. This approach was preferred to logistic regression because AWD was common, and when an outcome is common the odds ratio overstates the prevalence ratio. Variables for the multivariable model were selected using both statistical and conceptual criteria. All variables with $p<0.20$ at bivariable analysis were considered. In addition, child age, sex and maternal age were entered as a priori confounders regardless of their p-values, because the conceptual framework and previous studies link them to both the exposures and diarrhoea. Where two variables measured the same exposure (source of drinking water and protection of the source), only one was retained to avoid over-adjustment; the source of water was kept because it identified the specific type of source involved. For education, the lowest category (informal education) was used as the reference group, which is the usual choice for an ordered variable, and the overall significance of education was tested using a Wald test. Adjusted prevalence ratios (aPR) with 95% confidence intervals were reported, and $p<0.05$ was considered statistically significant.

Model diagnostics were checked before the final model was accepted. Multicollinearity was assessed using variance inflation factors (VIF); all values were below 2 (highest 1.80), showing no important collinearity. Model fit was assessed using the Hosmer–Lemeshow test on deciles of predicted risk, which showed no evidence of poor fit ($\chi^2 = 8.80$, 8 degrees of freedom, $p = 0.359$). Because a Poisson model can predict probabilities above one, the fitted values were inspected: only one of the 425 predicted probabilities exceeded one, and

repeating the analysis without this observation did not change the results. The same procedure was used for the secondary analysis of factors associated with dehydration (highest VIF 1.92; Hosmer–Lemeshow p = 0.696). AWD was not entered into the dehydration model because all but one of the dehydrated children had AWD (quasi-complete separation), which produces unstable estimates; its relationship with dehydration is therefore reported descriptively.

Ethical consideration

Ethical approval was obtained from the Gulu University Research and Ethics Committee, (Approval number: GUREC-2025-1170:) and administrative clearance from GRRH was obtained. The study adhered to the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from each caregiver prior to participation. Confidentiality and privacy of all participants were strictly maintained throughout recruitment, data collection and analysis.

CHAPTER FOUR: RESULTS

4.1 Socio-demographic characteristics of the study participants

A total of 425 children under five years of age with SAM were enrolled, with a median age of 15 months (interquartile range [IQR]: 8–25). Slightly more than half were female (52.5%, n=223), and most were cared for by their mothers (90.1%, n=383). The median age of the mothers was 27 years (IQR: 23–30), and the median household size was 4 members (IQR: 3–5). Most caregivers had only one child under five years (74.6%, n=317). Educational attainment was generally low: 37.6% (n=160) had informal education and 30.1% (n=128) primary education, while 21.4% (n=91) had secondary and 10.8% (n=46) tertiary education. About two-thirds of the mothers were unemployed (64.5%, n=274). Among the 145 employed mothers who reported their income, the median monthly income was 300,000 Uganda shillings (IQR: 200,000–500,000) (Table 1).

4.2 Water, sanitation, hygiene and health-related characteristics

Boreholes were the main source of drinking water (63.3%, n=269), followed by piped water (22.4%, n=95) and wells (14.4%, n=61). Most water sources were protected (88.9%, n=378). Almost all households had a latrine (99.1%, n=421); 64.5% (n=274) shared a latrine with other households and 35.5% (n=151) had a private one. Child faeces were disposed of in a latrine by 80.2% (n=341) of households, and most homes were judged to be clean (91.3%, n=388). However, 61.4% (n=261) of households had no hand-washing facility, and only 12.9% (n=55) boiled their drinking water.

Most households did not share their house with domestic animals (81.9%, n=348). Stored food was warmed before feeding by 71.3% (n=303) of caregivers, and 40.7% (n=173) of

households had a separate kitchen. According to caregiver report, 89.9% (n=382) of the children had been immunised for their age (Table 1).

Table 1: Baseline characteristics of children under five years with SAM (N=425)

	Frequency	Percentage
Child age in months, median (IQR)	15 (8–25)	
Sex		
Male	202	47.5
Female	223	52.5
Caretaker		
Mother	383	90.1
Other	42	9.9
Number of children under 5 years old		
One	317	74.6
Two or more	108	25.4
Mother's age in years, median (IQR)	27 (23–30)	
Level of education (mother/caregiver)		
Informal	160	37.6
Primary	128	30.1
Secondary	91	21.4
Tertiary	46	10.8
Employment status		
Unemployed	274	64.5
Employed	151	35.5
Monthly income of employed mothers (n=145), median (IQR), UGX	300,000	200,000–500,000
Number of household members, median (IQR)	4	3–5
Main source of drinking water		
Borehole	269	63.3
Piped water	95	22.4
Well	61	14.4
Water source nature		
Protected	378	88.9
Unprotected	47	11.1
House shared with domestic animals		
Yes	77	18.1
No	348	81.9
Child faeces disposed of in latrine		
Yes	341	80.2
No	84	19.8
Latrine present		
Yes	421	99.1
No	4	0.9
Latrine ownership		
Shared	274	64.5

Private	151	35.5
Clean home environment		
Yes	388	91.3
No	37	8.7
Hand washing facility		
Yes	164	38.6
No	261	61.4
Separate kitchen		
Yes	173	40.7
No	252	59.3
Warms stored food before feeding		
Yes	303	71.3
No	122	28.7
Boils drinking water		
Yes	55	12.9
No	370	87.1
Child immunised (caregiver report)		
No	43	10.1
Yes	382	89.9

4.3 Prevalence of acute watery diarrhoea among children under five years with SAM

Of the 425 children, 194 had acute watery diarrhoea during the two weeks before the interview, giving a prevalence of 45.6% (95% CI: 40.9–50.4) (Figure 3).

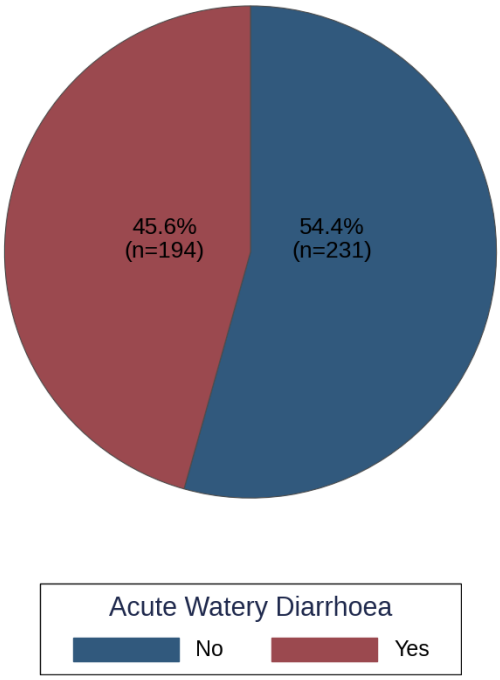


Figure 3: Prevalence of acute watery diarrhoea among the participants (N=425)

4.4 Prevalence of dehydration and shock among children under five years with SAM

Dehydration was present in 56 of the 425 children, a prevalence of 13.2% (95% CI: 9.9–16.4) (Figure 4). Almost all dehydrated children had AWD (55/56, 98.2%), and among the 194 children with AWD the prevalence of dehydration was 28.4% (95% CI: 22.0–34.7). Of the 56 dehydrated children, 16 (28.6%) had mild, 25 (44.6%) moderate and 15 (26.8%) severe dehydration (Figure 5), so severe dehydration affected 3.5% of all children enrolled. Shock was not recorded as a separate clinical finding. Children with signs of shock were captured within the dehydration assessment, and the data did not allow them to be distinguished from other children with dehydration. The prevalence of shock on its own could therefore not be estimated.

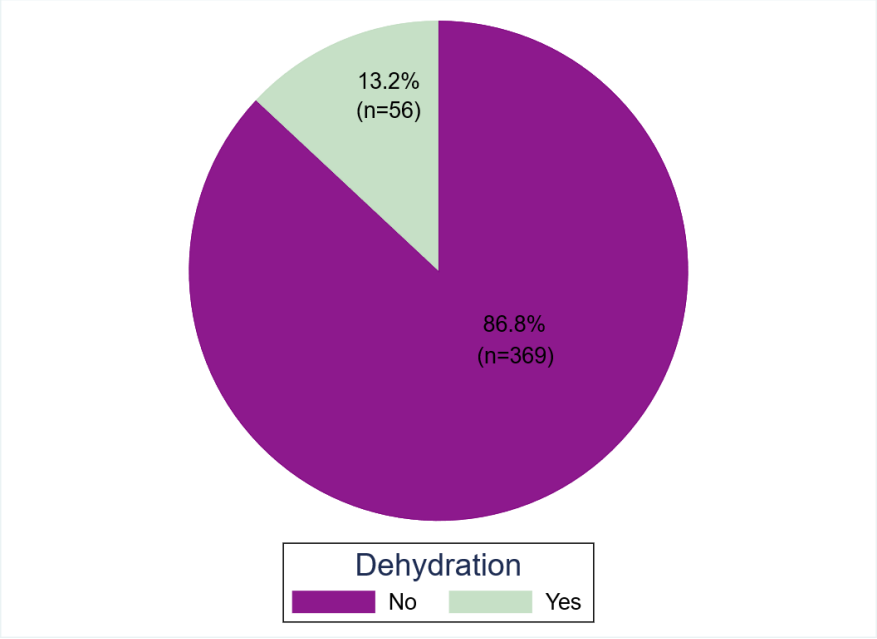


Figure 4: Proportion of participants with dehydration (N=425)

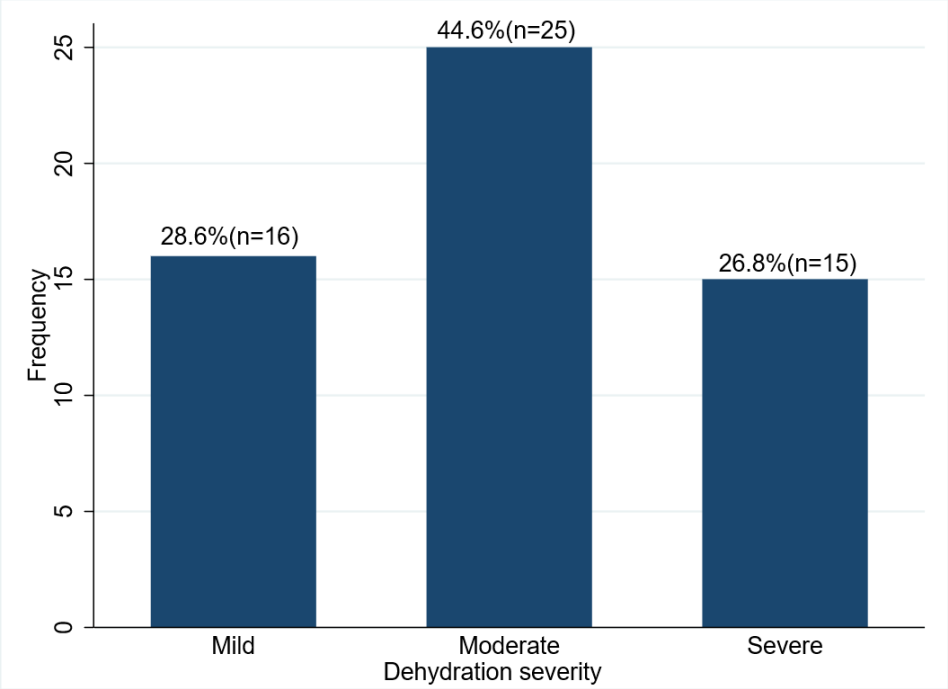


Figure 5: Severity of dehydration among dehydrated participants (n=56)

4.5 Bivariable analysis of factors associated with acute watery diarrhoea

At bivariable analysis (Table 2), AWD was more common among children whose mothers had tertiary education than among those whose mothers had informal education (cPR: 1.40, 95% CI: 1.08–1.81, p=0.010), and education was associated with AWD overall (Wald p<0.001). AWD was also associated with use of wells as the main source of drinking water compared with boreholes (cPR: 1.37, 95% CI: 1.06–1.77, p=0.018), an unprotected water source (cPR: 1.36, 95% CI: 1.04–1.76, p=0.022), an unclean home environment (cPR: 1.41, 95% CI: 1.07–1.86, p=0.014) and not warming stored food before feeding (cPR: 1.34, 95% CI: 1.09–1.65, p=0.006). Child age, household size, employment status and immunisation status had p-values below 0.20 and were also considered for the multivariable model.

Table 2: Bivariable modified Poisson regression of factors associated with acute watery diarrhoea among children under five years with SAM (N=425)

Characteristics	All N=425 n (%)	Acute Watery Diarrhea		Crude PR (95% CI)	p value
		No N=231 n (%)	Yes N=194 n (%)		
Age, months	15 (8–25)	13 (7–22)	17 (10–26)	1.007 (0.999–1.015)	0.089
Sex					
Male	202 (47.5)	107 (46.3)	95 (49.0)	Reference	
Female	223 (52.5)	124 (53.7)	99 (51.0)	0.94 (0.77–1.16)	0.586
Caretaker					
Mother	383 (90.1)	211 (91.3)	172 (88.7)	Reference	
Other	42 (9.9)	20 (8.7)	22 (11.3)	1.17 (0.86–1.59)	0.329
Number of children under five years					
One	317 (74.6)	175 (75.8)	142 (73.2)	Reference	
Two or more	108 (25.4)	56 (24.2)	52 (26.8)	1.07 (0.85–1.35)	0.540
Mother's age, years	27 (23–30)	27 (24–30)	27 (23–30)	1.007 (0.992–1.023)	0.344
Level of education					
Informal	160 (37.6)	83 (35.9)	77 (39.7)	Reference	
Primary	128 (30.1)	74 (32.0)	54 (27.8)	0.88 (0.68–1.14)	0.319
Secondary	91 (21.4)	59 (25.5)	32 (16.5)	0.73 (0.53–1.01)	0.056
Tertiary	46 (10.8)	15 (6.5)	31 (16.0)	1.40 (1.08–1.81)	0.010
Employment status					
Unemployed	274 (64.5)	140 (60.6)	134 (69.1)	Reference	
Employed	151 (35.5)	91 (39.4)	60 (30.9)	0.81 (0.64–1.02)	0.078
Number of household members	4 (3–5)	4 (3–5)	4 (3–6)	1.052 (0.998–1.109)	0.060
Main source of drinking water					
Borehole	269 (63.3)	156 (67.5)	113 (58.2)	Reference	
Piped water	95 (22.4)	49 (21.2)	46 (23.7)	1.15 (0.90–1.48)	0.267
Well	61 (14.4)	26 (11.3)	35 (18.0)	1.37 (1.06–1.77)	0.018
Nature of water source					
Protected	378 (88.9)	212 (91.8)	166 (85.6)	Reference	
Unprotected	47 (11.1)	19 (8.2)	28 (14.4)	1.36 (1.04–1.76)	0.022
House shared with domestic animals					
Yes	77 (18.1)	39 (16.9)	38 (19.6)	1.10 (0.85–1.42)	0.460
No	348 (81.9)	192 (83.1)	156 (80.4)	Reference	
Child faeces disposed of in latrine					
Yes	341 (80.2)	180 (77.9)	161 (83.0)	1.20 (0.90–1.60)	0.212
No	84 (19.8)	51 (22.1)	33 (17.0)	Reference	
Latrine present					
Yes	421 (99.1)	228 (98.7)	193 (99.5)	1.83 (0.33–10.06)	0.485
No	4 (0.9)	3 (1.3)	1 (0.5)	Reference	
Latrine ownership					
Shared	274 (64.5)	148 (64.1)	126 (64.9)	1.02 (0.82–1.27)	0.851
Private	151 (35.5)	83 (35.9)	68 (35.1)	Reference	
Clean home environment					
Yes	388 (91.3)	217 (93.9)	171 (88.1)	Reference	
No	37 (8.7)	14 (6.1)	23 (11.9)	1.41 (1.07–1.86)	0.014
Hand-washing facility					
Yes	164 (38.6)	91 (39.4)	73 (37.6)	Reference	

No	261 (61.4)	140 (60.6)	121 (62.4)	1.04 (0.84–1.29)	0.711
Separate kitchen					
Yes	173 (40.7)	100 (43.3)	73 (37.6)	Reference	
No	252 (59.3)	131 (56.7)	121 (62.4)	1.14 (0.92–1.41)	0.243
Warms stored food before feeding					
Yes	303 (71.3)	177 (76.6)	126 (64.9)	Reference	
No	122 (28.7)	54 (23.4)	68 (35.1)	1.34 (1.09–1.65)	0.006
Boils drinking water					
Yes	55 (12.9)	33 (14.3)	22 (11.3)	Reference	
No	370 (87.1)	198 (85.7)	172 (88.7)	1.16 (0.83–1.64)	0.389
Child immunised					
No	43 (10.1)	30 (13.0)	13 (6.7)	Reference	
Yes	382 (89.9)	201 (87.0)	181 (93.3)	1.57 (0.98–2.50)	0.059

4.6 Multivariable analysis of factors associated with acute watery diarrhoea

After adjustment for child age, sex, maternal age and the other variables in the model (Table 3), two factors remained independently associated with AWD. Children from households that used wells as their main source of drinking water had a 31% higher prevalence of AWD than those using boreholes (aPR: 1.31, 95% CI: 1.01–1.70, p=0.039). Children reported to be immunised had a higher prevalence of AWD than those not immunised (aPR: 1.62, 95% CI: 1.03–2.54, p=0.037). Maternal education was no longer significantly associated with AWD (overall p=0.063). Compared with informal education, the aPR was 1.34 (95% CI: 0.98–1.82, p=0.063) for tertiary, 0.79 (95% CI: 0.54–1.15, p=0.224) for secondary and 0.89 (95% CI: 0.67–1.17, p=0.408) for primary education. The model showed no important multicollinearity (all VIF below 2) and an adequate fit (Hosmer–Lemeshow p=0.359).

Table 3: Multivariable modified Poisson regression of factors associated with acute watery diarrhoea among children under five years with SAM (N=425)

Variable	Crude PR (95% CI)	P value	Adjusted PR (95% CI)	P value
Age, months	1.007 (0.999–1.015)	0.089	1.005 (0.997–1.013)	0.224
Number of household members	1.052 (0.998–1.109)	0.060	1.026 (0.971–1.085)	0.362
Level of education				

Informal	Reference		Reference	
Primary	0.88 (0.68–1.14)	0.319	0.89 (0.67–1.17)	0.408
Secondary	0.73 (0.53–1.01)	0.056	0.79 (0.54–1.15)	0.224
Tertiary	1.40 (1.08–1.81)	0.010	1.34 (0.98–1.82)	0.063
Employment status				
Unemployed	Reference		Reference	
Employed	0.81 (0.64–1.02)	0.078	0.97 (0.74–1.26)	0.821
Main source of drinking water				
Borehole	Reference		Reference	
Piped water	1.15 (0.90–1.48)	0.267	1.26 (0.97–1.65)	0.083
Well	1.37 (1.06–1.77)	0.018	1.31 (1.01–1.70)	0.039
Clean home environment				
Yes	Reference		Reference	
No	1.41 (1.07–1.86)	0.014	1.23 (0.92–1.65)	0.158
Warms stored food before feeding				
Yes	Reference		Reference	
No	1.34 (1.09–1.65)	0.006	1.17 (0.94–1.47)	0.162
Child immunised				
No	Reference		Reference	
Yes	1.57 (0.98–2.50)	0.059	1.62 (1.03–2.54)	0.037

Adjusted for child age, sex and maternal age and for all other variables shown. Sex (female vs male, aPR: 0.97, 95% CI: 0.79–1.19) and maternal age (aPR: 0.997, 95% CI: 0.980–1.014) were not associated with AWD. Overall p-value for education = 0.063 (Wald test). Highest VIF = 1.80; Hosmer–Lemeshow p = 0.359. PR: prevalence ratio; CI: confidence interval.

4.7 Bivariable analysis of factors associated with dehydration

At bivariable analysis (Table 4), dehydration was more common among children from households with two or more children under five years (cPR: 1.76, 95% CI: 1.07–2.89), households with an unprotected water source (cPR: 1.97, 95% CI: 1.09–3.53), houses shared with domestic animals (cPR: 2.32, 95% CI: 1.41–3.81), shared latrines (cPR: 2.54, 95% CI:

1.32–4.88), an unclean home environment (cPR: 2.56, 95% CI: 1.45–4.52), no hand-washing facility (cPR: 1.89, 95% CI: 1.06–3.34) and no separate kitchen (cPR: 2.52, 95% CI: 1.37–4.63), and among children whose stored food was not warmed before feeding (cPR: 3.56, 95% CI: 2.18–5.82). Dehydration was less common where child faeces were disposed of in a latrine (cPR: 0.57, 95% CI: 0.34–0.95) and among children of mothers with secondary education compared with informal education (cPR: 0.18, 95% CI: 0.06–0.58). Dehydration occurred almost only in children with AWD: 55 of the 194 children with AWD (28.4%) were dehydrated, compared with 1 of the 231 children without AWD (0.4%).

4.8 Multivariable analysis of factors associated with dehydration

In the multivariable model (Table 5), only failure to warm stored food before feeding remained independently associated with dehydration (aPR: 2.51, 95% CI: 1.48–4.24, p=0.001). Maternal education was associated with dehydration overall (Wald p=0.038), but none of the individual education levels differed significantly from the informal group. Because 55 of the 56 dehydrated children had AWD, AWD was not included in this model; its strong link with dehydration is shown in Table 4. With only 56 dehydrated children, this model has limited power and its results should be regarded as exploratory.

Table 4: Bivariable modified Poisson regression of factors associated with dehydration among children under five years with SAM (N=425)

Variable	All N=425 n (%)	Dehydration		Crude PR (95% CI)	p value
		No N=369 n (%)	Yes N=56 n (%)		
Age, months	15 (8–25)	15 (8–24)	17 (11–25)	1.007 (0.992–1.021)	0.356
Sex					
Male	202 (47.5)	172 (46.6)	30 (53.6)	Reference	
Female	223 (52.5)	197 (53.4)	26 (46.4)	0.79 (0.48–1.28)	0.333
Caretaker					
Mother	383 (90.1)	332 (90.0)	51 (91.1)	Reference	
Other	42 (9.9)	37 (10.0)	5 (8.9)	0.89 (0.38–2.12)	0.799
Number of children under five years					
One	317 (74.6)	282 (76.4)	35 (62.5)	Reference	
Two or more	108 (25.4)	87 (23.6)	21 (37.5)	1.76 (1.07–2.89)	0.025
Mother's age, years	27 (23–30)	27 (23–30)	28 (24–29)	1.009 (0.967–1.053)	0.673
Level of education					
Informal	160 (37.6)	131 (35.5)	29 (51.8)	Reference	
Primary	128 (30.1)	115 (31.2)	13 (23.2)	0.56 (0.30–1.03)	0.064
Secondary	91 (21.4)	88 (23.8)	3 (5.4)	0.18 (0.06–0.58)	0.004
Tertiary	46 (10.8)	35 (9.5)	11 (19.6)	1.32 (0.72–2.43)	0.375
Employment status					
Unemployed	274 (64.5)	233 (63.1)	41 (73.2)	Reference	
Employed	151 (35.5)	136 (36.9)	15 (26.8)	0.66 (0.38–1.16)	0.150
Number of household members	4 (3–5)	4 (3–5)	4 (3–6)	1.071 (0.936–1.225)	0.319
Main source of drinking water					
Borehole	269 (63.3)	232 (62.9)	37 (66.1)	Reference	
Piped water	95 (22.4)	87 (23.6)	8 (14.3)	0.61 (0.30–1.27)	0.187
Well	61 (14.4)	50 (13.6)	11 (19.6)	1.31 (0.71–2.42)	0.387
Nature of water source					
Protected	378 (88.9)	333 (90.2)	45 (80.4)	Reference	
Unprotected	47 (11.1)	36 (9.8)	11 (19.6)	1.97 (1.09–3.53)	0.024
House shared with domestic animals					
Yes	77 (18.1)	58 (15.7)	19 (33.9)	2.32 (1.41–3.81)	<0.001
No	348 (81.9)	311 (84.3)	37 (66.1)	Reference	
Child faeces disposed of in latrine					
Yes	341 (80.2)	302 (81.8)	39 (69.6)	0.57 (0.34–0.95)	0.031
No	84 (19.8)	67 (18.2)	17 (30.4)	Reference	
Latrine present					
Yes	421 (99.1)	366 (99.2)	55 (98.2)	0.52 (0.09–2.91)	0.459
No	4 (0.9)	3 (0.8)	1 (1.8)	Reference	
Latrine ownership					
Shared	274 (64.5)	228 (61.8)	46 (82.1)	2.54 (1.32–4.88)	0.005

Private	151 (35.5)	141 (38.2)	10 (17.9)	Reference	
Clean home environment					
Yes	388 (91.3)	343 (93.0)	45 (80.4)	Reference	
No	37 (8.7)	26 (7.0)	11 (19.6)	2.56 (1.45–4.52)	0.001
Hand-washing facility					
Yes	164 (38.6)	150 (40.7)	14 (25.0)	Reference	
No	261 (61.4)	219 (59.3)	42 (75.0)	1.89 (1.06–3.34)	0.030
Separate kitchen					
Yes	173 (40.7)	161 (43.6)	12 (21.4)	Reference	
No	252 (59.3)	208 (56.4)	44 (78.6)	2.52 (1.37–4.63)	0.003
Warms stored food before feeding					
Yes	303 (71.3)	280 (75.9)	23 (41.1)	Reference	
No	122 (28.7)	89 (24.1)	33 (58.9)	3.56 (2.18–5.82)	<0.001
Boils drinking water					
Yes	55 (12.9)	49 (13.3)	6 (10.7)	Reference	
No	370 (87.1)	320 (86.7)	50 (89.3)	1.24 (0.56–2.75)	0.599
Child immunised					
No	43 (10.1)	38 (10.3)	5 (8.9)	Reference	
Yes	382 (89.9)	331 (89.7)	51 (91.1)	1.15 (0.48–2.72)	0.754
Acute watery diarrhoea					
No	231 (54.4)	230 (62.3)	1 (1.8)	Reference	
Yes	194 (45.6)	139 (37.7)	55 (98.2)	65.5 (9.1–470.0)†	<0.001

†Very wide interval because only one child without AWD was dehydrated (quasi-complete separation); AWD was therefore not entered into the multivariable model for dehydration.

Table 5: Multivariable modified Poisson regression of factors associated with dehydration among children under five years with SAM (N=425)

Variable	Crude PR (95% CI)	p value	Adjusted PR (95% CI)	p value
Number of children under five years				
One	Reference		Reference	
Two or more	1.76 (1.07–2.89)	0.025	1.37 (0.80–2.34)	0.251
Level of education				
Informal	Reference		Reference	
Primary	0.56 (0.30–1.03)	0.064	0.68 (0.36–1.31)	0.250
Secondary	0.18 (0.06–0.58)	0.004	0.37 (0.11–1.21)	0.099
Tertiary	1.32 (0.72–2.43)	0.375	1.62 (0.82–3.22)	0.169
Employment status				
Unemployed	Reference		Reference	
Employed	0.66 (0.38–1.16)	0.150	1.22 (0.70–2.13)	0.478
Nature of water source				
Protected	Reference		Reference	
Unprotected	1.97 (1.09–3.53)	0.024	1.13 (0.56–2.28)	0.727
House shared with domestic animals				
Yes	2.32 (1.41–3.81)	<0.001	1.46 (0.87–2.45)	0.152
No	Reference		Reference	
Child faeces disposed of in latrine				
Yes	0.57 (0.34–0.95)	0.031	0.83 (0.47–1.45)	0.507
No	Reference		Reference	
Latrine ownership				
Shared	2.54 (1.32–4.88)	0.005	1.23 (0.58–2.65)	0.590
Private	Reference		Reference	
Clean home environment				
Yes	Reference		Reference	
No	2.56 (1.45–4.52)	0.001	1.17 (0.58–2.35)	0.662
Hand-washing facility				
Yes	Reference		Reference	
No	1.89 (1.06–3.34)	0.030	0.91 (0.49–1.67)	0.756
Separate kitchen				
Yes	Reference		Reference	
No	2.52 (1.37–4.63)	0.003	1.63 (0.85–3.13)	0.142
Warms stored food before feeding				
Yes	Reference		Reference	
No	3.56 (2.18–5.82)	<0.001	2.51 (1.48–4.24)	<0.001

Adjusted for child age, sex and maternal age and for all other variables shown. AWD was not included because 55 of the 56 dehydrated children had AWD. Overall p-value for education = 0.038 (Wald test). Highest VIF = 1.92; Hosmer–Lemeshow p = 0.696.

CHAPTER FIVE: DISCUSSION

This study found that nearly half (45.6%) of children under five years admitted with SAM at GRRH had acute watery diarrhoea in the two weeks before the interview. Use of wells as the main source of drinking water and caregiver-reported immunisation were independently associated with AWD, while the association with maternal education seen at bivariable analysis did not persist after adjustment. Dehydration affected 13.2% of all children and 28.4% of those with AWD, and was independently associated with not warming stored food before feeding. The prevalence of shock could not be determined because shock was not recorded separately from dehydration.

5.1 Prevalence of acute watery diarrhoea among children under five years with SAM

The prevalence of AWD among children with SAM in this study was 45.6%, meaning that almost one in every two children admitted with SAM had recently had acute watery diarrhoea. This figure is comparable with findings from other hospital-based studies of children with SAM in East Africa. In Kilifi, Kenya, Talbert *et al.* (2012) found that 49% of children admitted with SAM had diarrhoea at admission, and in a Ugandan cohort of children with complicated SAM, diarrhoea was common and strongly linked with dehydration and death (Grenov *et al.*, 2019). The similarity of these figures suggests that the burden observed at GRRH is typical of referral settings in the region rather than an unusual local finding. The prevalence is, however, several times higher than the two-week prevalence of diarrhoea reported for the general under-five population in Uganda and in the Acholi sub-region (UBOS, 2022). This difference is expected, because SAM damages the intestinal barrier and weakens cellular immunity, which makes these children more susceptible to enteric infection, and because diarrhoea is itself a common reason for bringing a malnourished child to hospital (Walson & Berkley, 2018; Williams & Berkley, 2018). The high prevalence is also consistent

with the poor water, sanitation and hygiene conditions and high levels of poverty in northern Uganda (Ojuka & Tumwebaze, 2022; Tickell & Denno, 2016). Differences in the definition of diarrhoea should be kept in mind when comparing studies: this study used a two-week recall period, which captures more episodes than studies that record diarrhoea only on the day of admission.

5.2 Factors associated with acute watery diarrhoea among children under five years with SAM

Two factors were independently associated with AWD among children with SAM at GRRH: use of wells as the main source of drinking water and caregiver-reported immunisation. Maternal education was associated with AWD at bivariable analysis but not after adjustment.

Maternal education showed an uneven pattern. The prevalence of AWD was lowest among children of mothers with secondary education (35.2%) and highest among children of mothers with tertiary education (67.4%), with the informal (48.1%) and primary (42.2%) groups in between. Informal education, the lowest level of schooling, was used as the reference group, as is usual for an ordered variable; using the group with the lowest prevalence (secondary) as the reference would have exaggerated the apparent effect of the other levels. With informal education as the reference, tertiary education was associated with AWD at bivariable analysis (cPR: 1.40), but the association weakened and was no longer statistically significant after adjustment (aPR: 1.34, 95% CI: 0.98–1.82), and education as a whole was not significantly associated with AWD (p=0.063). Secondary education was not a risk factor. If anything, the prevalence of AWD tended to be lower in this group (aPR: 0.79, 95% CI: 0.54–1.15), which is in line with the protective effect of maternal education reported in other studies (Kyu *et al.*, 2025; Ssekandi, 2022). The higher crude prevalence among

children of mothers with tertiary education should be interpreted with caution. This group was small (n=46), and the finding may reflect care-seeking rather than risk: better-educated mothers are more likely to use formal health services and to bring a child with diarrhoea to a referral hospital (Yaya *et al.*, 2021), and they are more likely to work outside the home and to leave the child with other carers. Education on its own may also offer little protection where household water and sanitation remain poor (Ngure *et al.*, 2014). Overall, this study does not provide evidence that maternal education, at any level, increases the risk of AWD among children with SAM.

Use of wells as the main source of drinking water was associated with a 31% higher prevalence of AWD compared with boreholes (aPR: 1.31, 95% CI: 1.01–1.70). This finding is consistent with existing evidence linking unimproved water sources to increased diarrhoeal disease among under-five children. Wells, particularly shallow and unprotected wells, are highly vulnerable to faecal contamination from nearby pit latrines and surface runoff, especially during rainy seasons common in northern Uganda (Ngure *et al*., 2014; Kombat *et al*., 2024). Ojuka and Tumwebaze (2022), in a study conducted in northern Uganda, similarly reported that inadequate access to clean drinking water coupled with suboptimal sanitation facilities significantly increased diarrhoea prevalence among under-five children. Comparable findings were reported by Owusu *et al*. (2024) in West Africa, where unsafe water sources and poor environmental sanitation were major determinants of childhood diarrhoeal disease. Bastaraud *et al*. (2020) further demonstrated that unprotected water sources in low-income settings commonly harbour enteric pathogens such as *Escherichia coli*, *Vibrio cholerae*, and rotavirus, all of which contribute substantially to paediatric diarrhoeal morbidity. Among children with SAM, exposure to contaminated water is particularly dangerous because malnutrition weakens immunity and increases susceptibility to severe dehydration and electrolyte imbalance (Chama *et al*., 2024; Grenov *et al*., 2019).

Children reported to be immunised had a higher prevalence of AWD than those who were not (aPR: 1.62, 95% CI: 1.03–2.54). This finding needs considerable caution and should not be read as evidence that vaccines cause diarrhoea. Several explanations are more likely. First, the study was hospital-based, and families who keep up with immunisation are usually those with better access to, and greater use of, health services. They are therefore more likely to bring a child with diarrhoea to a referral hospital, while unimmunised children with diarrhoea may be managed at home or at lower-level facilities and never reach GRRH (Yaya *et al.*, 2021). Second, the cross-sectional design means that reverse causality cannot be excluded, since a child with recurrent illness has more contact with health workers and more opportunities to be vaccinated. Third, immunisation status was based on caregiver report, so some misclassification is likely, and only 43 children were reported as not immunised, which makes the estimate imprecise. Finally, the available vaccines, including rotavirus vaccine, protect mainly against severe rotavirus disease, while SAM itself impairs immune responses and leaves children vulnerable to many other enteric pathogens (Chama *et al.*, 2024; Nduhukire *et al.*, 2020). Immunisation therefore did not appear to protect children with SAM from AWD in this sample, but the positive association most likely reflects confounding by care-seeking behaviour and selection into the hospital sample rather than a true effect of immunisation. Immunisation remains an essential preventive measure, and this finding should not be used to discourage it.

Overall, the findings of this study reinforce the important role of environmental and socioeconomic determinants in the occurrence of AWD among children with SAM. Unsafe water sources, gaps in WASH infrastructure, persistent undernutrition, and variations in healthcare-seeking behaviour continue to contribute significantly to diarrhoeal disease burden among under-five children in northern Uganda (Ngure *et al*., 2014; Ojuka & Tumwebaze, 2022; Maniragaba *et al*., 2023). These results underscore the need for integrated interventions

that combine nutritional rehabilitation with strengthened WASH programs, caregiver education, and improved access to child health services.

5.3 Prevalence of dehydration and shock among children under five years with SAM

Dehydration was found in 13.2% of all children with SAM and in 28.4% of those with AWD. Among dehydrated children, 44.6% had moderate and 26.8% severe dehydration, and 3.5% of all children admitted with SAM were severely dehydrated. In practical terms, more than one in four children with SAM and recent diarrhoea arrived at the hospital dehydrated.

These figures matter because dehydration is harder to recognise and more dangerous to treat in children with SAM than in well-nourished children. Wasting alone can cause sunken eyes and a slow skin pinch, so the classical signs tend to overestimate dehydration, while these children have little physiological reserve and are prone to hypoglycaemia, electrolyte imbalance and heart failure if rehydrated too quickly (Tickell & Denno, 2016; Williams & Berkley, 2018). For this reason, WHO guidelines recommend slow oral rehydration with ReSoMal for most children with SAM and reserve intravenous fluids for those in shock (Tickell & Denno, 2016). In this study, dehydration was assessed by a trained nutritionist at recruitment, who relied on the history of watery stools, recent change in the child's eyes as reported by the caregiver and the level of consciousness, rather than on skin pinch alone. Even so, some misclassification is possible, particularly between the mild and moderate grades. The strong link between AWD and dehydration (55 of the 56 dehydrated children had AWD) supports the validity of the assessment. The independent association between not warming stored food and dehydration probably reflects the same pathway, since food kept at room temperature and fed cold is a common vehicle for enteric pathogens that cause more severe, dehydrating episodes of diarrhoea. The fact that the prevalence of shock could not be

estimated is an important gap, because shock carries the highest risk of death among children with SAM and diarrhoea (Grenov *et al.*, 2019; Narra *et al.*, 2026).

5.4 Implications for clinical practice

The findings have several implications for the care of children with SAM at GRRH and similar hospitals. First, because almost half of the children had recent AWD and more than one in four of these were dehydrated, every child admitted with SAM should be asked about diarrhoea in the previous two weeks and assessed for dehydration and shock at triage, using criteria adapted for SAM. Second, the high proportion of moderate and severe dehydration means that the nutrition ward needs a reliable supply of ReSoMal, staff trained in slow oral or nasogastric rehydration with close monitoring for fluid overload, and clear criteria for recognising shock. Third, shock should be recorded as a separate diagnosis in the clinical notes and admission register so that its burden can be monitored. Finally, caregiver counselling at admission and discharge should cover safe drinking water, particularly for families who use wells, and the warming of stored food before feeding.

5.5 Contribution of the study

To the best of the author's knowledge, this is the first study in the Acholi sub-region to measure the prevalence of AWD and dehydration specifically among children with SAM, rather than in the general under-five population. It provides a local baseline (45.6% for AWD and 13.2% for dehydration) against which future interventions at GRRH can be measured, in place of the unverified figure of up to 60% that was previously cited. It shows that, in this population, the household water source is the main modifiable factor associated with AWD, and that failure to warm stored food is associated with dehydration. It also shows that factors which are usually protective in community surveys, such as maternal education and immunisation, may appear as risk factors in hospital samples of children with SAM because

of care-seeking and selection. This is an important point for the interpretation of hospital-based studies in this field.

5.6 Limitations of the study

The findings should be interpreted in the light of several limitations. First, this was a hospital-based study, so the findings may not apply to children with SAM in the community, many of whom do not reach a referral hospital. Selection into the hospital sample is also the most likely explanation for the positive associations with immunisation and, at bivariable level, with tertiary education. Second, the cross-sectional design does not allow conclusions about cause and effect, and reverse causality cannot be excluded. Third, AWD was based on caregiver recall over two weeks, and immunisation status on caregiver report; both are subject to recall and reporting bias. Fourth, shock was not recorded separately from dehydration, so the prevalence of shock, which formed part of the third objective, could not be estimated. Fifth, clinical signs of dehydration are less reliable in children with SAM, and some misclassification of the grade of dehydration is possible. Sixth, the number of dehydrated children (n=56) was small, which limited the power of the multivariable analysis for this outcome. Finally, no laboratory tests were done to identify the organisms causing diarrhoea, which would have helped to guide treatment and prevention.

5.7 Conclusion and recommendations

Acute watery diarrhoea is common among children under five years admitted with SAM at Gulu Regional Referral Hospital, affecting nearly half of them. About one in eight children with SAM, and more than one in four of those with AWD, is dehydrated at admission, most often moderately or severely. Use of wells as the main source of drinking water was the main modifiable household factor associated with AWD, and failure to warm stored food before feeding was associated with dehydration. The positive associations with immunisation and, at

bivariable level, with tertiary maternal education are best explained by care-seeking and selection into the hospital sample rather than by harmful effects. These findings call for routine screening for diarrhoea, dehydration and shock among children with SAM, together with counselling on household water safety and food hygiene for their caregivers.

Recommendations

Based on the findings of this study, the following are recommended:

Screen all children with SAM for diarrhoea, dehydration and shock at admission.

Because 45.6% of the children with SAM had AWD and 28.4% of these were dehydrated, GRRH should include a standard question on diarrhoea in the previous two weeks and a SAM-specific assessment of dehydration and shock in the admission checklist of the nutrition ward and acute care unit.

Record shock as a separate diagnosis.

Because the prevalence of shock could not be estimated in this study, the hospital should record shock separately from dehydration in clinical notes and in the admission register, so that this high-risk complication can be monitored.

Strengthen the management of dehydration in children with SAM.

Since 71.4% of the dehydrated children had moderate or severe dehydration, the nutrition ward should keep a steady supply of ReSoMal and train nurses and nutritionists in the WHO protocol for rehydrating children with SAM, including monitoring for fluid overload.

Promote safe drinking water in households that use wells.

Because use of wells was independently associated with AWD, caregiver counselling at admission and discharge should include household water treatment (boiling or chlorination)

and safe storage. The health and water departments of Gulu City and the surrounding districts should give priority to protecting wells and improving water supply in the communities served by GRRH.

Include food hygiene in nutrition counselling.

Because failure to warm stored food before feeding was associated with a 2.5-fold higher prevalence of dehydration, nutrition counselling should advise caregivers to reheat stored food thoroughly and to prepare fresh feeds where possible.

Continue to promote and verify immunisation.

The positive association between immunisation and AWD reflects care-seeking and selection rather than harm. Health workers should continue to check and complete the immunisation status of every child with SAM, including rotavirus and measles vaccines, and should verify it against the child health card.

Conduct further research.

Community-based and longitudinal studies are needed to measure the burden of AWD and dehydration among children with SAM who do not reach hospital, to verify immunisation status using vaccination records, to record shock separately, and to identify the organisms responsible for diarrhoea in this population.

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APPENDICES

APPENDIX 1: INFORMED CONSENT FORM FOR MOTHERS/CAREGIVERS

Introduction

You are being asked to volunteer for a research study. This study is being conducted in Gulu Regional Referral Hospital, Gulu District.

The Principal Investigator for this study is: Ssemwogerere Tadeo.

There is no funding for this study.

Purpose of the study

To determine the prevalence and factors associated with acute watery diarrhoea among children under five years with severe acute malnutrition at Gulu Regional Referral Hospital, Gulu City, Uganda.

Duration of the interview

Your involvement in this study is expected to take approximately 45 minutes.

Where the study will be conducted and expected number of participants

The research will be carried out at Gulu Regional Referral Hospital in Gulu City. A total of about 427 caregivers are expected to take part in the study.

Study Procedures

Before you take part in this research, the purpose and procedures of the study will be explained to you, and you will have an opportunity to ask any questions before deciding whether to take part. If you agree to take part on behalf of your child, you will be asked to sign this consent form. You will receive a copy of the signed consent form for your records.

Potential risks of participation

This study does not involve any medical or invasive procedures. Therefore, no physical harm is expected from your participation. However, if you feel any discomfort or ill-health during the interview, the research team will ensure they provide first aids and immediate referral for further medical attention.

Compensation for participants

Participants will receive a reimbursement of UGX 10,000 to compensate for the time spent taking part in the study.

Potential benefits of participation

Although there may be no immediate personal benefit from taking part in the study, the information obtained may enhance understanding of the prevalence and determinants of acute watery diarrhoea among severely malnourished children under five years of age.

Voluntary participation

Your involvement in this research is entirely optional. You may choose not to take part or discontinue participation at any stage without any consequences. Should you choose to withdraw, you are encouraged to inform the research team. The researcher may also discontinue your participation if it is considered necessary for your welfare or if study requirements are not followed. In the event that any health-related concerns arise, the researcher will determine whether continued participation is appropriate.

Confidentiality of information

All information collected during this study will be treated with strict confidentiality. However, authorized personnel, including representatives from the Uganda National Council for Science and Technology (UNCST), may access study records for monitoring purposes.

Members of the Gulu University Research and Ethics Committee (GUREC) may also review relevant study documents. Any reports or publications resulting from this research will not contain information that could identify you personally.

Contact information for Questions about the Study

If you need further information about this study, please contact Ssemwogerere Tadeo at 0761494454/0754218180. If you have any concerns regarding your rights as a research participant, you may contact the chairperson of the Gulu University Research and Ethics Committee Dr. Juliana A. Obika on telephone Number 0772964491 or by email: j.obika@gu.ac.ug. You may also contact the Uganda National Council for Science and Technology, located at plot 6 Kimera Road, Ntinda, Kampala via telephone number 0414705500.

Confirmation of consent

I confirm that ..... has clearly explained the purpose of this study, the procedures that will be followed, the potential risks and benefits, and my rights as a participant. I have had the opportunity to ask questions and have received satisfactory responses.

I understand that participation in this study is entirely voluntary and that my decision whether or not to participate will not affect the services or care that I receive. I am aware that all information collected from me will be treated with strict confidentiality and that my personal identity will not be disclosed in any reports or publications arising from this study.

I understand that I may choose to discontinue my participation at any point without providing a reason and without experiencing any negative consequences. By signing this form, I acknowledge that I have been adequately informed about the study and willingly agree to participate. I further understand that signing this consent form does not result in the loss of any of my legal rights. A copy of this signed consent form will be provided to me for future reference.

Participant's name: .....

Signature/thumbprint: .....

Date: .....

Witness name: .....

Signature: .....

Date: .....

Interviewer/Research Assistant name: .....

Signature: .....

Date: .....

Appendix 2: Data collection tool

Section A: Socio-demographic characteristics of the participants

1. Age (in months)

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2. Sex of the child/baby?

   a) Male

   b) Female

3. Caretaker?

   a) Mother

   b) Others

4. Number of children at home under 5 years of age?

   a) One

   b) Two or more

Section B: Background information of the mother/ care giver and household

5. How old are you?..... (years)
6. What is the highest level of education you have completed?

   a) Completed Primary Education.

   b) Completed Secondary Education.

   c) Attained Tertiary/Post-secondary Education

   d) Informal

7. What is your current work status?

   a) Currently Employed

   b) Not currently Employed

8. If you are working, please specify your main occupation?

   ……

9. What is your estimated monthly income?

   ……Ugandan shillings

10. Number of household members ….…….

11. Source of drinking water?
    a) Borehole
    b) Piped water
    c) Wells
12. What is the nature of water source?
    a) Protected
    b) unprotected
13. House shared with domestic animals.
    a) Yes
    b) No
14. How are the child's faeces disposed of?
    a) In latrine/toilet
    b) Outside latrine/toilet

Section C: Household characteristics

15. Is there latrine or toilet?
    a) Yes
16. What is the ownership of the latrine
    a) Shared
    b) Private
17. What is the environmental cleanliness around home?
    a) Clean/safe
    b) Unclean/unhygienic
18. Do you have hand washing facilities?
    a) Yes
    b) No
19. Availability of separate kitchen?
    a) Yes
    b) No
20. Warming of cold food?

a) Yes

b) No

21. Boiling of drinking water?

    a) Yes

    b) No

22. Age at which child started complementary feeds?..... (in months)

23. Child weaning time ……. (in months

24. Has your child been immunised according to the schedule for his/her age?

    a) Yes

    b) No

Section D: acute diarrhoea characteristics

25. In the past two weeks, has your child passed loose or watery stools three or more times in a day?

    a) Yes

    b) No

26. Were the stools watery?

    a) Yes

    b) No

Section E: Clinical assessment of dehydration (by the nutritionist)

27. History of fluid loss (watery stools or vomiting) with thirst or dry mouth?

    a) Yes

    b) No

28. Sunken eyes of recent onset (confirmed with the caregiver)?

    a) Yes

    b) No

29. Restless or irritable, with slow skin pinch?

    a) Yes

    b) No

30. Lethargic or unconscious, unable to drink or drinking poorly?

    a) Yes

b) No

31. Dehydration present?

a) Yes

b) No

32. If dehydrated, grade of dehydration

a) Mild

b) Moderate

c) Severe

Appendix 3: Budget Plan

Budget for a study to determine the prevalence and factors associated with acute watery diarrhoea among under-five children with severe acute malnutrition at Gulu Regional Referral Hospital, Gulu District						
S/No	**Budget Item/ Cost Category**	**Unit**	**No. of Days**	**Unit Cost UGX**	**Total Cost UGX**	**Justification**
1	Stationary	Lumpsum	1	500	3,000	Printing and documentation services
	Sub-total				**352,500**	
12	Remuneration for supervisor for field visit	1	14	30,000	420,000	Remuneration
13	Participant's compensation for their time during the interview	427	14	10,000	4,270,000	compensation
14	communication bundles	1	14	10,000	140,000	data and airtime bundles
	Sub-total				**4,830,000**	
15	Field facilitation for the author of the study	1	16	50,000	800,000	refreshment and inland travels
	Sub-total				**800,000**	
	Overall total					**5,982,500**

Appendix 4: Work Plan

Research Project Timeline	**May 2025 – May 2026**				
	5-6/25	7-9/25	10/25	11-12/25	1-5/26
Operations Research and Data Collection					
Obtain IRB approval					
Data collection					
Data analysis					
Data management					
Data analysis					
Review data					
Reporting and Dissemination					
Submission of a manuscript to a journal for publication					