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Sanitation Facilities, Diaper Disposal, And Prevalence of Diarrhoea Among Children Under Five Years in Gulu District, Uganda

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Abstract:
The disruption of the faecal-oral transmission pathway, a primary contributor to childhood illness, depends on pervasive and entrenched sanitation practices. Diarrhoea remains a significant public health concern among children in Uganda. This study aimed to investigate the relationships between sanitation facilities, diaper disposal methods, and the prevalence of diarrhoea in children under five years in Gulu district, Uganda. A convergent parallel cross-sectional design was employed, prioritising quantitative and qualitative data collection and analysis methods. A structured questionnaire was administered to 317 household caregivers with children under five years, while interview guides facilitated four Focus Group Discussions with community members and 10 key informant interviews with health practitioners. Data analysed using SPSS, Jamovi, and QDA Miner Lite software to provide descriptive statistics, factor analysis, structural equation modelling, logistic regression, and thematic analysis. The study found a 62.7% prevalence of diarrhoea among children under five. As 24.9% of households practised open defecation, 23% had improved latrines, and only 20.5% had access to handwashing facilities. 62.5% of household caregivers used cloth diapers, and 36% disposed of diapers in pit latrines. Regression analysis indicated that access to sanitation made children 3 times less likely to have diarrhoea (56% with access vs. 82% without). Inadequate diaper disposal and poor hygiene worsened the risk of diarrhoea. The study revealed significant relationships between the predictor and the outcome of diarrhoea. Households without improved sanitation facilities and those practising open diaper disposal were more likely to have children with diarrhoea. Implementing guidelines on child sanitation can help raise awareness in both rural and urban settings.

Keywords: Sanitation facilities, diaper disposal, child health, diarrhoea, Gulu district, Uganda. Word Count: 9690. Clinical Trial Not Applicable
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I. INTRODUCTION

Globally, children under five should ideally survive and grow up in a clean environment, free from the consequences of poor sanitation, inadequate hygiene and harmful cultural practices. Unfortunately,

diarrhoea claims 1.4 million children each year, with Sub-Saharan Africa facing the most significant challenges (WHO & UNICEF, 2023). The problem is further complicated because 1.5 billion people lack access to basic sanitation, with Sub-Saharan Africa carrying 42% of the burden.

In low- and middle-income countries, children under five are ten times more likely to die from preventable causes than their peers in wealthier nations. This disparity highlights a significant public health crisis requiring urgent attention (WHO, 2025). The ongoing sanitation crisis in East Africa accounts for 64% of the elevated child mortality rates (WHO, 2025). Poor sanitation obstructs progress towards achieving Sustainable Development Goal 6, which aims for universal sanitation and eradicating open defecation.

From the Ugandan perspective, inadequate access to sanitation facilities exacerbates the spread of diseases, primarily through the faecal-oral route. This significantly contributes to the alarming statistic of 33 child deaths every day, mainly due to high rates of diarrhoea among children, who constitute 20.5% of the population (Ministry of Health, 2023; WHO & UNICEF, 2023). Currently, around 14 million Ugandans still practise open defecation, and only 36% have access to basic sanitation facilities, with just 24% in rural areas compared to 47.9% in urban settings. Regarding handwashing, only 35.8% of individuals in rural areas and 53.8% in urban areas adhere to the recommended hygiene practices, according to the Ministry of Health in the Daily Monitor on March 13, 2023. Unfortunately, the social and health system factors contributing to the severity of these issues are still poorly understood (Nyande et al., 2022). The lack of proper sanitation facilities and deeply ingrained sociocultural norms sustain these challenges.

In Gulu District, the challenges persist, with a staggering 28% open defecation (OD), inadequate diaper disposal practices, and limited access to safe water potentially exacerbating the situation. These issues significantly impede child growth and development (DHO, 2023; Omona et al., 2020). The magnitude of the sanitation crisis is alarming, with no certified open defecation-free local government in sight and a lack of behaviour change communication (BCC) strategy targeting preschool children (Ministry of Health, 2023; Okaali et al., 2022).

The limited understanding of how these sanitation practices, including inadequate access to sanitation facilities, improper disposal of diapers, and harmful sociocultural norms, affect child health in the rural Gulu district. Additionally, factors such as age, climate, and access to safe water, people poorly understand how they moderate the influence on these relationships. This knowledge gap significantly hinders effective intervention development, contributing to elevated morbidity and mortality rates among children.

Theoretical Review

The well-being of children is strongly linked to their environmental context, particularly concerning proper disposal practices for human excreta and diapers (Bronfenbrenner, 1979). Employing the Social Ecological Model (SEM), we can effectively analyse the interrelationships between sanitation facilities, diaper disposal, and the incidence of diarrhoea in children under five years old. While the SEM has proven instrumental in tackling health issues ranging from menstrual hygiene to the promotion of beneficial health behaviours (Sommer et al., 2021), it has encountered critique for its tendency to oversimplify intricate relationships and for neglecting power dynamics and cultural nuances (Freitas & Santana, 2022). Notably, a theoretical lacuna exists within the SEM framework, as it inadequately accounts for the complex interplay of power dynamics, cultural factors, and environmental influences on child health outcomes (Freitas & Santana, 2022). Researchers must bridge this gap to fortify the SEM framework and cultivate a more nuanced comprehension of the intricate relationships spanning individual, community, and societal factors. Furthermore, the mechanisms through which ideas and behaviours disseminate across SEM levels

remain poorly delineated, highlighting the pressing need for systematic investigations into these dissemination pathways (Eriksson et al., 2025).

Implementing policies informed by the SEM can catalyse health-enhancing transformations by organising efforts to instigate structural changes, promote equitable resource distribution, and empower individuals to control their health and well-being within their environments (Eriksson et al., 2025; Golden et al., 2015). However, significant literature gaps persist. Firstly, there is an evident scarcity of comprehensive research evaluating the long-term sustainability and scalability of SEM-led policy interventions (Eriksson et al., 2025). Secondly, empirical studies are requisite to assess the genuine impact of SEM-informed policies on enabling individuals to control their health outcomes and behaviours, including quantifying changes in health metrics and behavioural patterns (Golden et al., 2015). Lastly, critical analyses must scrutinise the unintended consequences, potential discrepancies, and cultural factors associated with SEM-centric policy implementation to ensure that health-augmenting measures are inclusive and effective across varied populations and contexts.

Review of Sanitation Facilities, Diaper Disposal, and Prevalence of Diarrhoea Disease

The global sanitation crisis poses a formidable threat to child health outcomes and exacerbates environmental degradation (WHO & UNICEF, 2023). Extensive research consistently demonstrates that inadequate sanitation facilities significantly contribute to the prevalence of diarrheal diseases, especially among children under five (Van Meyel et al., 2022; Baker et al., 2016). For example, a study conducted in Uganda revealed that children residing in households with insufficient sanitation facilities exhibit a heightened likelihood of experiencing diarrheal diseases (UBOS, 2023). Additionally, qualitative research emphasises the pivotal role of cultural beliefs and social norms in shaping local sanitation practices (Driessnack, 2023; Palinkas et al., 2025).

In a complementary study, Prüss-Ustün et al. (2019) asserted that providing improved sanitation facilities could lead to marked reductions in the incidence of diarrheal diseases among young children. Similarly, a systematic review by Kabir et al.(2021) found that enhanced sanitation facilities could diminish the risk of diarrheal diseases by as much as 36% (Penakalapati et al., 2017). Nevertheless, there remains an urgent need for further research to identify and address the specific barriers impeding access to sanitation facilities across diverse regions (Golden et al., 2015). Moreover, the effectiveness of Community-Led Total Sanitation (CLTS) initiatives in ameliorating sanitation facilities is well-documented (Bauza et al., 2019; Biran et al., 2022). Thomas (2016) established that CLTS initiatives could significantly enhance sanitation facilities while concurrently alleviating diarrheal disease incidence among children under five. Despite these findings, further context-specific studies are essential to devise sustainable sanitation strategies that align with the intrinsic values of local communities(Belay et al., 2022).

Studies by Seidu et al. (2020) and Tefera et al. (2024) identify age and gender as pivotal factors in excreta disposal practices, suggesting that tailored interventions are needed. However, challenges persist in effectively addressing the sanitation needs of infants and pre-schoolers, as noted by Anand et al.(2022). Similarly, Wani et al. (2022) and Contreras et al. (2022) underscore the positive impact of improved sanitation facilities on child health outcomes, emphasising the importance of accessible handwashing stations and hygienic latrines. Research gaps include exploring how age and gender interact with socioeconomic status and cultural contexts to influence sanitation behaviours and developing age-specific sanitation strategies tailored to these interactions.

The environmental ramifications of diaper disposal have emerged as a pressing concern, particularly in low-income contexts (White et al., 2023). Empirical studies illuminate that inadequate diaper disposal

methods can exacerbate health risks, including the prevalence of diarrheal diseases (Omona et al., 2020). Moreover, the ongoing debate regarding reusable versus disposable diapers accentuates the necessity for sustainable waste management practices (Alsatari et al., 2023)

While educational campaigns show promise in promoting better hygiene practices (Ejemot-Nwadiaro et al., 2021), their effectiveness varies across different age groups and cultural contexts. This highlights the importance of culturally sensitive educational initiatives tailored to local beliefs and practices (Rahat et al., 2014). Research gaps include evaluating the effectiveness of culturally sensitive approaches in promoting sustained behaviour change and understanding how educational messages can be tailored to effectively reach diverse age groups, including infants and preschool children. Achieving sustained behaviour change is crucial for long-term health outcomes, making this research imperative.

Critically, the effectiveness of Community-Led Total Sanitation (CLTS) initiatives relies on overcoming deeply ingrained cultural norms and social obstacles to latrine utilisation (Novotný et al., 2017; Bausa et al., 2020). Therefore, context-specific studies are essential for developing enduring sanitation strategies that align with the community's values (Belay et al., 2022). Research deficiencies exist in understanding the elements that support the enduring success of CLTS projects and in incorporating child-specific sanitation requirements into community-led initiatives in a meaningful and effective manner.

The relationship between sanitation infrastructure and disease prevention has been widely studied, yet findings remain contested regarding the extent to which quantitative improvements translate into health benefits. Bauza et al.(2020) demonstrated a clear correlation between increased sanitation facility availability and reduced disease incidence, particularly in low-resource settings. Their large-scale study argued that expanding access to basic sanitation, even without advanced technology, significantly lowers children's diarrheal and waterborne disease rates. However, this perspective is nuanced by WHO (2023), which states that merely increasing the *number* of sanitation facilities does not uniformly improve childhood diarrhoea. The research emphasised that poorly maintained, culturally inappropriate, or unsafely managed sanitation systems can perpetuate contamination risks. For instance, shared latrines in densely populated urban areas often become transmission hotspots if inadequate cleaning protocols are not followed (O'Reilly et al., 2023). This aligns with Yamauchi et al. (2022), who found that "safely managed" sanitation (as defined by SDG 6.2) reduced child stunting by 10% compared to basic facilities, underscoring the role of quality.

Further complicating this debate, MacLeod et al.(2025) introduced behavioural factors, showing that hygiene education and community ownership of sanitation programs are critical mediators of health impacts. Their systematic review noted that interventions combining infrastructure upgrades with community-led total sanitation (CLTS) campaigns had 2–3 times greater disease reduction than infrastructure-only projects.

II. MATERIALS AND METHODS

Design Description

This study employed a convergent parallel design, cross-sectional in nature, with an implicit lens and equal priority for quantitative and qualitative data collection and analysis methods to investigate the relationships between sanitation facilities, diaper disposal, and diarrhoea prevalence among children under five in Gulu District (Crewell & Clark, 2017). A pragmatic mixed-methods research paradigm guided the study, acknowledging the research phenomenon's complexity and emphasising knowledge acquisition through quantitative and qualitative methods (Morgan, 2007; Creswell, 2013). The study's conceptual

framework was informed by the Social Ecological Model (SEM) (Bronfenbrenner, 1979), which recognises the interplay between individual, family, community, and societal factors influencing health outcomes.

The Study context

This study was conducted in the Awach and Owoo sub-counties, Gulu District, Uganda, chosen for their diverse geographical and demographic characteristics. The district's tropical climate- dry and wet season with varied terrain, and population of 26,508 people with 4,414 households (UBOS, 2024) offered an ideal setting for examining the connections between sanitation facilities, diaper disposal, and childhood diarrhoea outcomes. The study focused on households with children under five years old, caregivers, healthcare professionals, and village community leaders in the Awach and Owoo sub-counties. Awach sub-county has a population of 6,371 males and 6,631 females with a total of 2,167 households, while Owoo sub-county has a population of 6,618 males and 6,888 females with a total of 2,251 households. A total of 4,418 households and 3,399 caregivers were purposively selected, along with 10 healthcare practitioners and 42 community leaders. Eligibility criteria included participants aged 18 or older, residing in the sub-counties, and capable of providing informed consent. The study employed a multilevel unit of analysis, quantitatively used individual household caregivers, and qualitatively used FGD and KI methods to provide a holistic understanding of sanitation practices and diarrhoea prevalence in Awach and Owoo sub-counties.

Recruitment and participant selection

The study employed a multi-stage sampling strategy, integrating both probability and non-probability sampling methods. The quantitative sample size was calculated using Fisher's formula, $n=z^2p(1-p)/d^2$ (n=317). Data saturation principles for qualitative data (n=43), where n represents the sample size, z represents the standard normal deviation at 1.96 for a 95% confidence level, p represents the proportion in the target population with diarrhea disease prevalence (29.1% based on a study by Omona et al. (2020), q represents 1–p. The d represents the margin of error set at 0.05 (5%) for households and 0.1 (10%) for villages in this study, as the formula was chosen as a reference point.

To ensure participant heterogeneity, we employed maximum variation sampling. The sub-county was stratified into rural and urban areas, focusing on those with low sanitation coverage. Villages and households were selected using simple random sampling, proportionate to size within the strata. Participants for the Focus Group Discussion (FGD) were purposively selected from each stratum and comprised community household child caregivers and sanitation committee members, both male and female. Expert sampling was used to select key informants for in-depth interviews. A total of 360 participants were recruited, comprising 317 households' caregivers with children under five years, 33 community members participating in four FGDs including the sanitation committee, and 10 key informants involving health assistants, health inspectors, health educators, public health nurses, the District health officer, and sanitation and hygiene coordinators from civil society organisations and the ministry of health.

Data Collection

The mixed method of data collection was used to provide a comprehensive understanding of the research problem (Creswell & Clark, 2017). Quantitative data were collected through a structured questionnaire method; the structured questionnaire was designed to collect data on demographics, sanitation facilities, diaper disposal practices, and childhood diarrhoea outcomes. A random sample of 317 households was selected from a sampling frame of households with children under five years in the two sub-counties.

Trained data collectors to administer the structured questionnaires and observed the sanitation status of each household. Local Council 1 was a guide during the survey and helped provide the household list and map for the village households to ease sampling. The survey took about 60 minutes per household, which was confirmed by pre-testing conducted outside the study areas in the same setting.

Qualitative data were collected through focus group discussions (FGDs) and in-depth key informant interviews (KIIs). FGDs were conducted with caregivers, sanitation committee members, and community leaders, while KIIs were conducted with healthcare professionals, sanitation officers, and community leaders. All FGDs and KIIs were audio recorded and transcribed verbatim. Each FGD had 8-10 participants invited through the area's health inspector in a venue agreed upon at health facilities and subcounty headquarters. A round table-shaped seating was used during the discussion to ensure maximum participation. Overarching questions were used to improve narration in each interview on promoting sanitation and hygiene practices to reduce child diarrhoea and to explain how the caregivers access children's sanitation facilities, including diapers, potty latrines, and handwashing facilities. All interviews were conducted by the lead author in the local language (Acholi) using a translator, recorded, and saved as audio files, transcribed directly in English by research assistants and online transcription for comparison purposes.

Data collection procedures involved identifying households, conducting structured interviews, facilitating focus group discussions, and observing sanitation status. Ethical considerations were paramount, and approval was obtained from relevant authorities such as the Nkumba University vetting committee(NUVC), Lacor Hospital Institutional Review Board(LHIRB), reference number LACOR-2014-347, Uganda National Council of Science and Technology(UNCST), reference number HS4991ES, and District authorities.

Informed consent was obtained from all study participants before data collection, with assurance of confidentiality, anonymous questionnaires, pseudonyms for qualitative data, and adherence to the World Medical Association Declaration of Helsinki guidelines. Data collection prioritised participants' comfort and convenience, with secure storage and access controls upholding ethical standards (Landrigan et al., 2021). Participants were also assured their right to withdraw from the study without penalty. Data collection took place in private settings to ensure privacy, and only authorised research personnel had access to the data.

To ensure homogeneity, separate research assistants were assigned to each sub-county. FGDs with caregivers and sanitation committee members were conducted separately. Quantitative and qualitative data were collected concurrently, and the integration decision involved merging data at the interpretation stage. Quantitative data validity and reliability were ensured through face validity assessment, content validity determination using the Content Validity Index (CVI > 0.79), construct validity confirmation through exploratory factor analysis (EFA), which revealed a three-factor solution explaining 72% of the variance in child excreta disposal practices. Additionally, confirmatory factor analysis (CFA) supported this model, demonstrating a good fit to the data. Structural equation modelling (SEM) indicated significant relationships between child excreta disposal practices and childhood diarrhoea outcomes influenced by socioeconomic status and access to sanitation facilities. Reliability was established through Cronbach's alpha coefficient (0.85), indicating high internal consistency. Qualitative data validity and reliability were ensured through member checking, peer debriefing, prolonged engagement, data triangulation, and inter-rater and intra-rater reliability checks.

Data Analysis Procedure

The data collected from Awach and Owoo sub-counties in Gulu district, Uganda, was analysed using a mixed-methods approach, integrating quantitative and qualitative data analysis techniques to understand the research problem comprehensively. The quantitative data were analysed using SPSS and Jamovi software, while the qualitative data were analysed using thematic analysis in QDA Miner Lite software.

Quantitative Data Analysis

A quantitative data analysis was conducted using SPSS and Jamovi software, starting with data cleaning and reduction through exploratory factor analysis (EFA), which revealed a three-factor solution accounting for 72% of the variance in sanitation facilities and diaper disposal practices. Confirmatory factor analysis (CFA) validated the three-factor model, demonstrating a good fit to the data. Structural equation modelling (SEM) was used to examine the relationships between variables, identify causal relationships, and test hypotheses. Additionally, logistic regression analysis was performed to model the relationships between sanitation facilities, diaper disposal, and diarrheal outcomes, with the Hosmer-Lemeshow test and Variance Inflation Factors (VIF) used to assess the model's goodness of fit and multicollinearity, respectively. Odds ratios (OR) and 95% confidence intervals (CI) were used to determine the components related to outcome variables, with statistical significance set at $P<0.05$.

Qualitative Data Analysis

Qualitative data analysis was conducted using deductive thematic analysis with QDA Miner Lite software, involving data coding, codebook development, and thematic analysis. A coding framework was developed based on research objectives and literature review, and coding reliability was ensured through independent coding by two researcher assistants. Thematic analysis identified and categorised themes and patterns, which were interpreted in alignment with research objectives. This deductive analysis facilitated re-testing of the data in a new context, and abductive data integration and triangulation enriched data interpretation and theoretical re-testing.

III. RESULTS

This study utilised quantitative and qualitative data from Awach and Owoo sub-counties in Gulu District, Uganda, achieving a remarkable 100% response rate from participants. Three hundred seventeen household caregivers, 10 Key Informants, and four Focus Group Discussions contributed to the research. The results are presented in descriptive, factor reduction, and inferential statistics.

Descriptive Results

The descriptive results in Table 1 delve into demographic characteristics, access to sanitation facilities, and diaper disposal practices among caregivers before examining the relationships between sanitation facilities, diaper disposal, and the prevalence of diarrhoea among children under five. According to Table 1, the demographic data collected reveals that 94% (298/317) of caregivers were female, with 94.5% residing in rural areas and 93.5% in urban settings. This highlights the significant role of women in making decisions about child health, a factor that significantly influences the effectiveness of health interventions targeting caregivers. The higher prevalence of younger caregivers (ages 18-24) in rural areas (40.9%) compared to urban areas (30.1%) reflects the varied cultural norms surrounding parenting. This age disparity underscores the need for targeted health education programs addressing the challenges of younger caregivers in each setting.

Concerning religious affiliation, 54.6% identified as Catholic, 25.6% as Pentecostal, and 19.9% as Protestant. Regarding education level, 71.6% (227/317) of caregivers had only completed primary

education, with a higher rate in rural areas (75.6%) compared to urban areas (67.3%). Lower educational attainment may affect caregivers' understanding of essential health practices, highlighting the importance of implementing educational programs to improve health literacy among rural and urban populations.

Consequently, 77% (244/317) of caregivers were peasant farmers, with 79.9% residing in rural areas and 20.1% in urban areas, indicating a link between their economic status and access to child health resources. The data also revealed a wide range of socioeconomic statuses, with 56.8% (180/317) of caregivers falling into the low socioeconomic status category, showing significant disparity. Specifically, 80.5% of rural caregivers were classified as having a low socioeconomic status, compared to 31.4% of urban caregivers. This disparity underscores the need for targeted interventions to address rural communities' unique challenges. Additionally, household sizes typically ranged from 4 to 6 members (50.8%), impacting resource distribution and caregiving dynamics.

Child demographics reveal that the children's ages ranged from 0 to 59 months. More than half, 50.8% (161/317), were between 24 and 59 months old. The gender distribution was relatively balanced, with 160 males (50.5%) and 157 females (49.5%). Regarding birth order, most children were firstborn or secondborn, accounting for 52.7% (167/317). Approximately 87.7% (278/317) of children were not enrolled in school, and 9.1% were disabled.

The study found that 87.7% of caregivers are mothers, emphasising the importance of maternal health programs. The balanced gender distribution among children (49.5% female and 50.5% male) indicates that health interventions should be inclusive and cater to both genders equally. The child age distribution reveals that 56.7% of children are between 24 and 59 months old, underscoring the need for early childhood interventions. Additionally, the higher prevalence of later-born children suggests that resource distribution may vary within families, which should be considered when planning health programs.

The alarming statistic that 87.7% of children are not enrolled in early child development (ECD) school raises significant concerns about educational access and its impact on child health. The higher prevalence of disabilities in rural areas (12.8%) compared to urban areas (5.2%) indicates a critical need for targeted interventions for affected children. These interventions could encompass specialised healthcare services, educational support, and community awareness programs. The disparity in disability prevalence between rural and urban areas underscores the necessity for tailored interventions that address the distinct challenges faced by rural communities.

Table 1: Demographic Characteristics of the Respondents per Subcounty

Variables	Categories	Owoo S/C (Rural) n (%)	Awach S/C (Urban) n (%)	Gulu District n (%)
Gender caregiver	Female	155(94.5%)	143 (93.5%)	298(94.0%)
	Male	9(5.5%)	10(6.5%)	19(6.0%)
Age caregiver	18-24 years	67(40.9%)	46(30.1%)	113(35.6%)
	25-34 years	58(35.4%)	56(36.6%)	114(36.0%)
	35-44 years	25(15.2%)	44 (28.8%)	69(21.8%)
	45 years+	7(4.3%)	7(4.6%)	10(3.2%)
Education level	No education	14(8.5%)	8 (5.2%)	22(6.9%)
	Primary	124(75.6%)	103(67.3%)	227(71.6%)
	Secondary	22(13.4%)	25(16.3%)	47(14.8%)
	Tertiary	4(2.4%)	17(11.1%)	21(6.6%)
Occupation	Employed	4(2.4%)	5(3.3%)	9(2.8%)
	Self-employed	14(8.5%)	33(21.6%)	47(14.8%)
	Unemployed	1(0.6%)	16(10.5%)	17(5.4%)
	Peasant farmer	131(79.9%)	94(61.4%)	225(71.0%)
	Homemaker	14(8.5%)	5(3.3%)	19(6.0%)
Religious affiliations	Catholic	90(54.9%)	83 (54.2%)	173(54.6%)
	Protestant	22(13.4%)	41 (26.8%)	63(19.9%)
	Pentecostals	52(31.7%)	29 (19.0%)	81(25.6%)
Relationship with the child	Mother	139(84.8%)	139(90.8%)	278(87.7%)
	Father	6(3.7%)	10(6.5%)	16(5.0%)
	Grandparents	16(9.8%)	4(2.6%)	20(6.3%)
	Maid	3(1.8%)	0(0.0%)	3(0.9%)
Child's age in months	Less than 12 months	38(23.2%)	39(25.5%)	77(24.3%)
	13-23 months	33(20.1%)	46(30.1%)	79(24.9%)
	24-59 months	93(56.7%)	68(44.4%)	161(50.8%)
Child gender	Female	83(50.6%)	74(48.4%)	157(49.5%)
	Male	81(49.4%)	79(51.6%)	160(50.5%)
Birth order	First bone	51(31.1%)	36(23.5%)	87(27.4%)
	Second bone	35(21.3%)	45(29.4%)	80(25.2%)
	Third bone	19(11.6%)	37(24.2%)	56(17.7%)
	Forth bone	59(36.0%)	35(22.9%)	94(29.7%)
School enrolment	Not enrolled	145(88.4%)	133(86.9%)	278(87.7%)
	Preschool	4(2.4%)	6(3.9%)	10(3.2%)
	Nursery	15(9.1%)	14(9.2%)	29(9.1%)
Disability	Yes	21(12.8%)	8(5.2%)	29(9.1%)
	No	143(87.2%)	145(94.8%)	288(90.9%)
Socio-economic status	Low	132(80.5%)	48(31.4%)	180(56.8%)
	medium	3118.9%)	103(67.3%)	134(42.3%)
	High	1(0.6%)	2(1.3%)	3(0.9%)

Key: S/C= Subcounty, n=sample size, % =percentage

Table 2: Diarrhoea and Sanitation Status in Gulu District

Variables	Categories	Owoo S/C (Rural) n (%)	Awach S/C (Urban) n (%)	Gulu District n (%)
Diarrhoea in the last 6 months	Yes	98(59.8%)	100(65.4%)	198(62.5%)
	No	66(40.2%)	53(34.6%)	119(37.5%)
Vaccination-rota virus	Yes	99(60.4%)	139(90.8%)	238(75.1%)
	No	65(39.6%)	14(9.2%)	79(24.9%)
Access to sanitation facilities	Yes	123(75%)	115(75.2%)	238(75.1%)
	No	41(25%)	38(24.8%)	79(24.9%)
Methods of human waste disposal	Improved	41(25%)	32(20.9%)	73(23.0%)
	Unimproved	123(75.0%)	121(79.1%)	244(77.0%)
Hand-washing facility	Yes	26(15.9%)	39(25.5%)	65(20.5%)
	No	138(84.1%)	114(74.5%)	252(79.5%)
Annual cleansing	Unimproved	108(65.9%)	108(70.6%)	216(68.1%)
	Improved	56(34.1%)	45(29.4%)	101(31.9%)
Access to the child excreta facility	Yes	66(40.2%)	97(63.4%)	163(51.4%)
	No	98(59.8%)	56(36.6%)	154(48.6%)
Type of diapers	Cloth diaper	113(68.9%)	85(55.6%)	198(62.5%)
	Disposable diapers	27(16.5%)	31(20.3%)	58(18.3%)
	Both	24(14.6%)	37(24.2%)	61(19.2%)
Diaper disposal method	Wrapped and dumped	16(9.8%)	7(4.6%)	23(7.3%)
	Put in the latrine	59(36.0%)	55(35.9%)	114(36.0%)
	Buried	2(1.2%)	8(5.2%)	10(3.2%)
	Emptied and washed	87(53.0%)	83(54.2%)	170(53.6%)
Hygiene education	Yes	114(69.5%)	104(68.0%)	218(68.8%)
	No	50(30.5%)	49(32.0%)	99(31.2%)
Wash your hands with soap.	Never	13(7.9%)	6(3.9%)	19(6.0%)
	Sometimes	56(34.1%)	82(53.6%)	138(43.5%)
	Always	95(57.9%)	65(42.5%)	160(50.5%)
Clean the latrines with disinfectants.	Never	94(57.3%)	14(9.2%)	108(34.1%)
	Sometimes	48(29.3%)	130(85.0%)	178(56.2%)
	Always	22(13.4%)	9(5.9%)	31(9.8%)

Key: S/C= Subcounty, n=sample size, % =percentage

From Table 2, the assessment of children aged 0-59 months revealed a significant prevalence of diarrhoea. The findings indicate that 62.5% (198/317) of the participants experienced diarrhoea in the past six months, with rates of 59.8% in Owoo S/C (Rural) and 65.4% in Awach S/C (Urban). This high prevalence of diarrhoea highlights the vulnerability of children to gastrointestinal illnesses, which can lead to malnutrition, dehydration, and other serious health issues. A further inductive analysis revealed that 75.1%

of the children in Gulu District received vaccination against Rotavirus, 60.4% in rural areas, and 90.8% in urban areas, the primary causes of childhood diarrhoea. However, 24.9% (79/317) of children missed vaccination opportunities, indicating a need for improved vaccination outreach. An inductive analysis of medical treatment-seeking behaviour revealed a disparity between caregivers who sought medical assistance for diarrhoea in their children, 55.2% (175/317), and those who did not, 44.8% (142/317). This highlights a potential gap in health-seeking behaviour that could be addressed through education and awareness campaigns.

Observations of sanitation practices revealed that 75% (238/317) of the population in the Gulu District has access to sanitation facilities. Specifically, 75% of Owoo Subcounty (Rural) and 75.2% of Awach Subcounty (Urban) have access to these facilities. However, a sizable proportion (24.9%) practised open defecation with no access to a latrine. Improved latrines, categorised as basic sanitation facilities, were found in 23% (73/317) households. In comparison, handwashing facilities were observed in 20.5% of the Gulu District, 15.9% in rural areas, and 25.5% in urban areas. Unimproved annual cleansing was observed in 68.1% of the Gulu District, 65.9% in rural areas, and 70.6% in urban areas. Furthermore, 68.8% of individuals in the Gulu District received hygiene education, with rates of 69.5% in rural areas and 68% in urban areas.

Regarding diaper disposal practices, 62.5% (198/317) of households opted for cloth diapers, while only 19.2% (61/317) used a combination of disposable and cloth diapers. The predominant method of diaper disposal involved emptying, washing, and reusing, which was reported by 52.6% (166/317) of caregivers, while 36% (114/317) favoured pit latrine disposal. In terms of child excreta disposal, open defecation was the most prevalent practice, occurring in 40.7% (129/317) of cases, followed by disposal in latrines without slabs at 32.2% (102/317) and in latrines with slabs at 20.8% (66/317). Furthermore, sharing latrines was a common strategy to mitigate open defecation, driven by economic considerations.

Data Reduction using Factor Analysis and Structural Equation Modelling

Before delving into the quantitative data analysis using inferential statistics such as regression analysis, correlation, hypothesis tests, confidence intervals, and ANOVA, data reduction analysis was conducted through Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modelling (SEM), the EFA aimed to unveil underlying factors in the data using the maximum likelihood method with Promax rotation. Table 3 indicates that the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.73, indicating the suitability of the data for factor analysis. Moreover, Bartlett's test of sphericity yielded a significant outcome ($\chi^2 = 245.6$, $p < 0.001$), indicating the appropriateness of the data for factor analysis and ruling out the possibility of identity matrices. The EFA identified two key factors: hygiene promotion (Factor 1) and child sanitation facilities (Factor 2), accounting for 40% of the total variance. More specifically, Factor 1 elucidated 21.5% of the variance with an eigenvalue of 3.25, while Factor 2 represented 18.5% with an eigenvalue of 2.78. The commonality range for the variables spanned from 0.42 to 0.83, denoting moderate to high shared variance.

Figure 1 illustrates the application of Confirmatory Factor Analysis (CFA) to validate the two-factor model. The results indicated a good fit with the following values: $\chi^2/df = 2.56$, Comparative Fit Index (CFI) = 0.92, Tucker-Lewis Index (TLI) = 0.90, and Root Mean Square Error of Approximation (RMSEA) = 0.06. These results supported the validity of the two-factor model, with Factor loadings ranging from 0.51 to 0.85 for Factor 1 and 0.48 to 0.82 for Factor 2, demonstrating good convergent validity and adequate representation of variables.

In Figure 2, Structural Equation Modelling (SEM) was utilised to examine the relationships between child sanitation, hygiene promotion, and climate as exogenous variables. The results revealed a negative influence of climate change on child sanitation ($\beta = -0.320$, $p < 0.001$), subsequently impacting hygiene promotion ($\beta = 0.412$, $p < 0.001$). The SEM model demonstrated a satisfactory fit: χ^2 (11) = 13.1, p = 0.284, RMSEA = 0.025.

The study's validity and reliability were also assessed using the Content Validity Index (CVI) and Cronbach's alpha coefficients. The results showed a strong consensus among experts on the relevance of items (CVI = 0.88). Additionally, there was a high level of internal consistency, with Cronbach's alpha coefficients of 0.73 and 0.79 for Factors 1 and 2, respectively.

Table 3: Exploratory Factor Analysis Results (n=317)

Item code	Item description	Factor 1	Factor 2	Uniqueness	KMO-M
HP47	Is a potty/toilet training seat available	0.789		0.309	0.702
HP48	How often is the potty/toilet cleaned	-0.705		0.381	0.754
HP49	Household guidance on diaper disposal	0.551		0.694	0.768
CS41	How do you dispose of a soiled diaper	0.427		0.820	0.790
CS43	Political commitment to child sanitation	0.422		0.820	0.807
CS36	Accessibility to the child's excreta facility		0.690	0.503	0.785
CS37	How accessible are caregivers to children?		0.656	0.524	0.746
CS38	Type of child excreta facilities available		0.587	0.652	0.843
SF32	Access to sanitation facilities		0.504	0.698	0.753

Key: The 'maximum likelihood extraction method was used with 'ProMax.' Note 2: Factor 1 represents Hygiene promotion, while Factor 2 signifies Child sanitation facilities. The KMO-MSA, a measure of overall sample adequacy, was calculated to be 0.767.

Confirmatory factor analysis using a path diagram

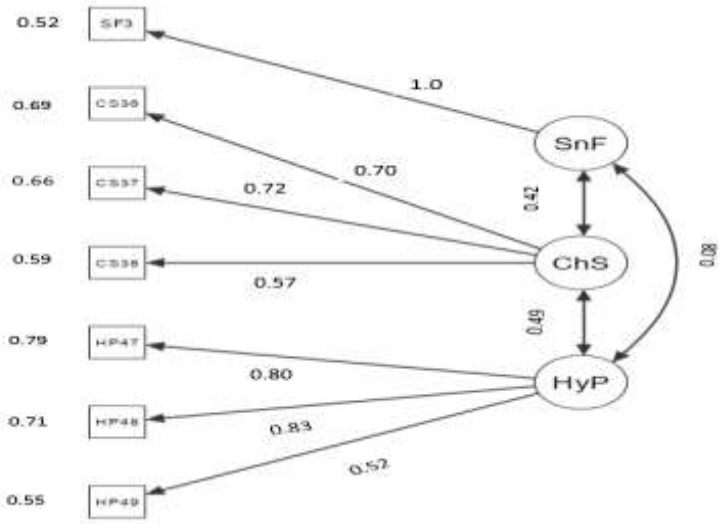

Figure 1: Path diagram for Confirmatory factor analysis

Key: SnF = Sanitation facility, ChS = Child sanitation, and HyP = Hygiene promotion

Structural Equation Model

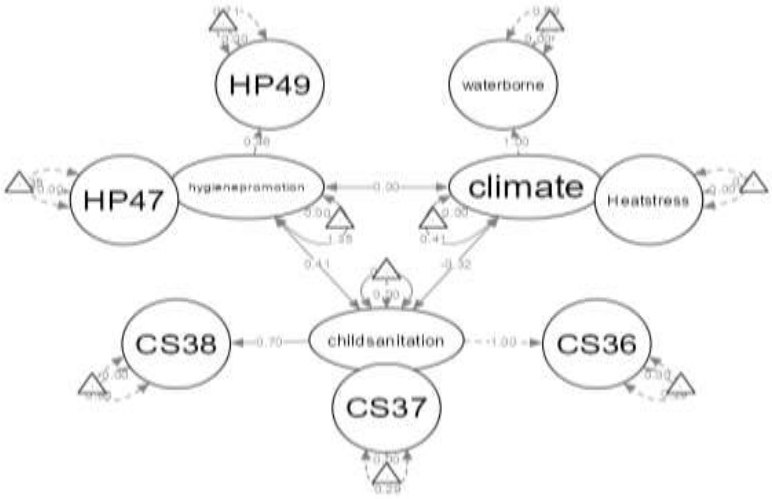

Figure 2: Structural Equation Model

Key: CS=child sanitation facilities, HP= Hygiene promotion indicators

The research objectives and a comprehensive literature review guided the justification for variable selection. The variables were selected based on their relevance to the research questions and their ability to elucidate the connections between sanitation, hygiene, and child health. EFA, CFA, and SEM* employment ensured the chosen variables were robust and dependable indicators of the underlying constructs. An additional crucial variable was included to strengthen the initial findings.

The content validity of the data collection tools was evaluated using the Content Validity Index (CVI), which yielded a score of 0.84. This score exceeds the 0.80 threshold, indicating strong expert consensus on item relevance and representation. The results confirm the appropriateness of the items for assessing the targeted constructs. The reliability of the data collection tools was evaluated using Cronbach's alpha coefficients. The results demonstrated high internal consistency, with Factor 1 achieving an α coefficient of 0.73 and Factor 2 achieving an α coefficient of 0.79. Both scores surpassed the 0.70 threshold, validating the reliability of the scales. The findings of this study have significant implications for understanding the relationships between sanitation, hygiene, and child health. The results suggest that hygiene promotion and child sanitation facilities influence child health outcomes. Therefore, public health initiatives should prioritise these factors to improve program effectiveness and cater to community-specific needs.

In summary, this study employed exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and structural equation modelling (SEM) to examine the relationships between sanitation, hygiene, and child health. The EFA identified two significant factors: hygiene promotion and child sanitation facilities. The CFA validated the two-factor model, and the SEM revealed that climate change negatively impacts child sanitation, subsequently affecting hygiene promotion. Based on this study's findings, suggested recommendations include prioritising hygiene promotion and child sanitation facilities in public health initiatives to enhance program effectiveness and address community-specific needs. Policymakers and practitioners should focus on developing targeted interventions that address hygiene promotion, child sanitation facilities, and climate change to reduce the risk of diarrhoea and create healthier environments

for children. Future research should explore the influence of climate change on child sanitation and hygiene promotion in various settings to guide policy and practice.

Inferential Statistical Findings

The analysis of sociodemographic factors, as presented in Table 4, provides significant insights into the prevalence of diarrhoea. An inductive examination of the data reveals key patterns. Initially, the findings suggest that female-headed households show a trend towards lower odds of diarrhoea, with a crude odds ratio (COR) of 0.52 (95% CI: 0.205-1.315, p = 0.174). However, this association is not statistically significant in the multivariate analysis, as indicated by an adjusted odds ratio (AOR) of 0.52 (95% CI: 0.205-1.322, p = 0.175).

A notable correlation exists between the age of the household head and the prevalence of diarrhoea. Younger household heads (ages 18-24) demonstrate the highest prevalence at 62%. As age increases, the prevalence of diarrhoea decreases. Specifically, household heads aged 25-34 years have an AOR of 0.24 (95% CI: 0.06-0.678, p = 0.008), those aged 35-44 years have an AOR of 0.26 (95% CI: 0.066-1.041, p = 0.056), and those aged 45-54 years have an AOR of 0.11 (95% CI: 0.027-0.483, p = 0.002). This trend highlights the significance of age-related factors, which may reflect maturity, experience, and resource availability, contributing to improved health management among older individuals.

An inductive data analysis further reveals that younger children are particularly vulnerable to diarrhoea. Children under 12 months exhibit a high prevalence of 71%, while those aged 13-23 months show an even higher prevalence at 82%. As children grow older, the odds of experiencing diarrhoea decrease significantly. Specifically, children aged 13-23 months have an AOR of 0.37 (95% CI: 0.198-0.678, p = 0.001), and those aged 24-59 months have an AOR of 0.18 (95% CI: 0.089-0.357, p < 0.001). The analysis also reveals that gender does not significantly impact diarrhoea prevalence, with an OR of 0.81 (95% CI: 0.513-1.276, p = 0.358).

In summary, the age of both household heads and children critically influences diarrhoea prevalence. Younger households and children under two years old are at the highest risk, while older household heads and children exhibit protective effects. Gender does not play a significant role in this context. Therefore, targeted interventions focusing on younger households and children are essential for reducing diarrhoea incidence and improving public health outcomes.

Table 4: Demographic Characteristics Associated with the Prevalence of Diarrhoea

Associated factors/IV	Response	Diarrhoea Yes	Diarrhoea No	Bivariate Analysis COR (95%CI)	Multivariate Analysis AOR (95%CI)
Gender household	Female	189(63%)	109(37%)	0.52(0.205-1.315)	0.52(0.205-1.322)
	Male	9(47%)	10(53%)	1	1
Age household	18-24 years	70(62%)	43(38%)	1**	1**
	25-34 years	67(59%)	47(41%)	0.23(0.058-0.916) **	0.24(0.06-0.678) **
	35-44 years	53(77%)	16(23%)	0.26(0.066-1.044) **	0.26(0.066-1.041) **
	45-54 Years	5(50%)	5(50%)	0.11(0.026-0.478) **	0.11(0.027-0.483) **
	55 +years	1(33%)	2(67%)	0.375(0.061-2.305)	0.35(0.056-2.172)
Child age	<12 months	55(71%)	22(29%)	1**	1**
	13-23 months	65(82%)	14(18%)	0.38(0.210-0.673) **	0.37(0.198-0.678) **
	24-59 months	78(48%)	83(52%)	0.20(0.105-0.390) **	0.18(0.089-0.357) **
Child gender	Female	102(65%)	55(35%)	0.81(513-1.276)	0.81(0.513-1.280)
	Male	96(60%)	64(40%)	1**	1**

Key: The variables considered in step 1 were Gender, Age of household caregiver, child age, and gender. Only p-values less than 0.25 were selected for multivariate analysis. The significance level was set at ** p<0.05. COR represents the crude odds ratio, while AOR signifies the adjusted odds ratio.

Relationships between Sanitation Facilities, Diaper Disposal, and Diarrhoea Prevalence

This study reveals significant correlations between sanitation facilities, diaper disposal, and the prevalence of diarrhoea. It delves into factors such as access to sanitation facilities, their types, cleanliness, education programs, and guidelines, as outlined in Table 5.

Table 5: Relation between Sanitation Facilities, Diaper Disposal, and Diarrhoea Prevalence

Variables	Response	Diarrhea Outcomes		Bivariate analysis	Multivariate analysis
		Yes	No	COR (95%CI)	AOR (95%CI)
Access to sanitation facilities	Yes	133(56%)	105 (44%)	3.67(1.949,6.893) **	3.00(1.439, 6.260) **
	No	65(82%)	14(18%)	1	1
How accessible are the facilities to caregivers and children	Highly accessible	28 (48%)	31(52%)	1**	1**
	Moderately accessible	121(65%)	65(35%)	2.36(1.158, 4.806) **	2.50(1.024, 6.085) **
	Not accessible	49(68%)	22(32%)	1.14(0.641, 2.044)	1.00(0.499, 2.014)
Access to child excreta facilities	Yes	92(56%)	71(44%)	1.70(1.075, 2.701) **	2.05(1.226, 3.413) **
	No	105(69%)	48(31%)	1	1
Types of child excreta facilities available	Slab latrines	36(55%)	30(45%)	1**	1**
	Non-Slab Latrine	53(52%)	49(48%)	2.15(1.160, 3.997) **	2.02(0.892, 4.167) **
	Diapers	5(63%)	3(37%)	2.39(1.383, 4.126) **	1.86(1.002, 3.445) **
	Potty	9(90%)	1(10%)	1.55(0.352, 6.8244)	2.28(0.481, 10.816)
	Bucket latrine	2(100%)	0(0%)	0.29(0.035, 2.348)	0.26(0.020, 3,376)
	Open defecation	93(72%)	36(28%)	0.00(0.000, ------)	0.00(-----, --------)
Is Potty or latrine training available for learners?	No	112(59%)	78(41%)	1**	
	Sometimes	69(65%)	38(35%)	1.53(0.828, 2.831)	
	Always	45(68%)	21(32%)	1.18(0.615, 2.265)	
Received guide on diaper disposal	Yes	96(70%)	42(30%)	0.58(0.363, 0.925) **	0.45(0.265, 0.775) **
	No	102(57%)	77(43%)	1	1
Clean latrine surface with disinfectants	Never			1**	1**
	Sometimes			0.26(0.114, 0.610) **	0.20(0.077, 0.520) **
	Always			0.31(0.139, 0.685) **	0.30(0.124, 0.724) **

Key: COR= crude odds ratio, AOR= adjusted odds ratio, 95%CI= 95% confidence interval, ** p<0.05

The results presented in Table 5 reveal a significant positive relationship between sanitation facilities, diaper disposal, and diarrhoea prevalence among children aged 0-59 months. An inductive analysis of the data yields several key insights.

Firstly, the findings demonstrate that children with access to sanitation facilities have a lower prevalence of diarrhoea (56%) than those without access (82%). The crude odds ratio (COR) of 3.67 (95% CI: 1.949-6.893, $p < 0.001$) and the adjusted odds ratio (AOR) of 3.00 (95% CI: 1.439-6.260, $p = 0.002$) confirm this association.

Furthermore, the accessibility of excreta facilities plays a significant role in reducing the risk of diarrhoea. Moderate access is associated with an increased risk (COR: 2.36, 95% CI: 1.158-4.806, $p = 0.018$; AOR: 2.50, 95% CI: 1.024-6.085, $p = 0.043$), while no access does not show a significant difference.

Access to child-specific sanitation facilities reduces the prevalence of diarrhoea by 2.05 times (56% vs. 69%). The adjusted odds ratio of 2.05 (95% CI: 1.22-3.41, $p = 0.006$) underscores the importance of child-friendly sanitation solutions. The qualitative findings in Table 6, Theme 1, regarding sanitation facilities and practices, reveal that the community faces significant challenges in accessing child-friendly sanitation options. The lack of child-specific toilets and potties (Subtheme 1.1) may contribute to the high rates of diarrhoea and other sanitation-related illnesses. This highlights the vital role of child-friendly sanitation facilities in reducing the likelihood of diarrhoea.

Latrines without slabs are 2.15 times linked to an increased risk of diarrhoea (COR: 2.15, 95% CI: 1.160-3.997, $p = 0.014$; AOR: 2.02, 95% CI: 0.892-4.167, $p = 0.092$). Observation findings revealed that 80% of households lacked latrines with slabs, and 85% of households in rural areas had a low socio-economic status.

Conversely, diaper use correlates with improved outcomes by 2.39 times (COR: 2.39, 95% CI: 1.383-4.126, $p = 0.002$; AOR: 1.86, 95% CI: 1.002-3.445, $p = 0.049$). Thematically, the improper disposal of diapers (Subtheme 1.2) and inadequate upkeep of hygiene and sanitation practices (Subtheme 1.3) worsen the situation. Insufficient diaper disposal methods and suboptimal hygiene practices are notable contributing factors to diarrhoea.

Guidelines for proper diaper disposal significantly reduce the risk of diarrhoea by 0.45 times (AOR: 0.45, 95% CI: 0.265-0.775, $p = 0.004$). Table 6, theme 2, findings related to diaper disposal and the prevalence of diarrhoea emphasise the critical role of disposal practices in preventing this condition. The lack of guidance on proper diaper disposal (Subtheme 2.1) and the prevalence of open defecation (Subtheme 2.2) contribute to the spread of pathogens that cause diarrhoea. This highlights the importance of proper diaper disposal and sanitation practices in preventing the transmission of diarrhoea-causing pathogens.

Regular cleaning practices significantly reduce the odds of diarrhoea by 0.20 times (AORs: 0.20, 95% CI: 0.093-0.433, $p < 0.001$ for "sometimes"; and 0.30 times (AOR: 0.30, 95% CI: 0.141-0.643, $p = 0.002$ for "always"). Quantitative findings highlight the crucial role of access to proper sanitation facilities, effective excreta disposal methods, clear guidelines for diaper disposal, and regular cleaning practices in reducing the prevalence of diarrhoea among children. Interventions targeting these factors can significantly improve child health outcomes in affected communities.

The qualitative findings in Table 6 indicate that the community faces significant sanitation-related challenges, including limited access to child-friendly sanitation facilities, improper diaper disposal, and inadequate maintenance and hygiene practices (KI,3). These challenges contribute to the prevalence of diarrhoea and other sanitation-related illnesses.

Based on both findings, it can be inferred that enhancing access to child-friendly sanitation facilities, promoting proper diaper disposal practices, and improving maintenance and hygiene practices are crucial in reducing the prevalence of diarrhoea. This underscores the significance of sanitation and hygiene practices in preventing diarrhoea. The researcher rejects the null hypothesis and accepts the alternative

hypothesis, stating that a relationship exists between sanitation facilities, diaper disposal practices, and the prevalence of diarrhoea in children under five years.

Table 6: Thematic analysis of Sanitation Practices and Diarrhoea Prevalence Among Children under Five Years

Themes	Descriptions	Codes	Sub-themes	Quotes
Sanitation facilities and practices	This theme explores the challenges related to sanitation facilities and practices in the community, including limited access to child-friendly sanitation facilities, poor diaper disposal practices, and lack of maintenance and hygiene.	Limited access to sanitation facilities	1.1. Limited access to child-friendly sanitation facilities	*For children 0-2 years, caregiver use their legs to support children defecating, and 3-5 years do open defecation. As quoted by FGD participant: "We do not have potty; we do not have those toilets that are designed specifically for children (KI/FGD participant)*
		Improper diaper disposal	1.2. Poor diaper disposal practices	*Diaper use and disposal are still suboptimal due to economic status. Quote: "Some of them throw them in rubbish pits... others leave them in the compound." (KI participant)*
		Poor maintenance and hygiene	1.3. Lack of maintenance and hygiene	*Quote: "We see many households that have no slabs; they clean using broom, and those with slabs wash using brushes and clean water." (KI participants)*
Diaper disposal and Prevalence of diarrhea	The theme examines the relationship between diaper disposal practices and the prevalence of diarrhea in the community.	Diaper disposal and diarrhea	2.1. Diaper disposal and diarrhea	Quote: "*Diaper disposal, we have not provided so much of guidance... we recommend that they are disposed of in pit latrines.*" (KI participant)
		Open defecation and diarrhea	2.2. Open defecation and diarrhea	Quote: "*Open defecation is still a common practice for both children and adults.*" (KI participant)

IV. DISCUSSION AND FINAL INTERPRETATION

Demographics, sanitation, and diaper disposal situation

The demographic data reveal that caregivers in the Gulu District are predominantly female (94%), aligning with the literature by Seidu et al. (2020), which indicates that women play a crucial role in child health decision-making. The high prevalence of younger caregivers (40.9% aged 18-24 in rural areas) suggests a need for targeted health education programmes that address their unique challenges, including a lack of experience, limited access to resources, and potential health risks associated with their age. These findings are consistent with the Social Ecological Model (SEM), which emphasises the importance of understanding individual and community-level factors affecting health outcomes, as Freitas & Santana (2022) outlined. Furthermore, low educational attainment (71.6% with only primary education) may hinder caregivers' understanding of essential health practices. This underscores the need for educational initiatives to enhance health literacy, particularly in rural settings, as Golden et al. (2015) have outlined.

The study's sanitation facilities and diaper disposal practices indicate that 75% of the population has access to sanitation facilities; however, 24.9% still practice open defecation, a known risk factor for diarrhoea, as noted by Van Meyel et al. (2022). The presence of inadequate sanitation and insufficient handwashing facilities (15.9% in rural areas) highlights significant gaps in hygiene interventions that must be addressed to improve child health outcomes. These findings align with the literature from Baker et al.(2016) and Wagari et al. (2022), which demonstrate that inadequate sanitation facilities are associated with increased rates of diarrhoeal diseases among children under five. The study's findings support this notion, suggesting that improved sanitation practices are crucial for reducing diarrhoea prevalence in vulnerable populations.

The diaper disposal practices observed indicate that 62.5% of households use cloth diapers, and 52.6% prefer to wash and reuse them, raising concerns about hygiene and disease transmission. This aligns with Alsatari et al.(2023), whose findings show that inadequate diaper disposal can exacerbate health risks, including diarrhoeal diseases. The prevailing practices reflect a need for community-based health education initiatives to promote proper diaper disposal and enhance hygiene practices among caregivers, as noted in a study by Yamauchi et al.(2022).

Health-seeking behaviour and vaccination rates indicate that only 55.2% of caregivers sought medical assistance for diarrhoea, highlighting a gap in awareness regarding the importance of timely intervention. This finding is supported by Ssemata et al.(2024), who state that barriers to accessing healthcare often correlate with poor health outcomes. Additionally, the 24.9% of children who missed vaccination opportunities against rotavirus, a significant cause of diarrhoea, underscores the need for enhanced outreach and education, as emphasised in the research by Golden et al. (2015).

Association between demographics and diarrhoea prevalence

The study's findings reveal significant associations between caregiver demographics and the prevalence of diarrhoea among children. Older caregivers exhibit lower prevalence rates, while younger children, particularly those under two years old, show higher rates of diarrhoea. Moreover, female-headed households report lower diarrhoea prevalence, underscoring the importance of gender-sensitive health interventions. The 9.1% of children with disabilities translates to more inclusiveness in sanitation interventions. The health and well-being of children with disability are shaped by sanitation practices, diaper disposal methods, and caregivers' knowledge. Access to healthcare and sanitation facilities at the community level is crucial for reducing the prevalence of diarrhoea. Societal factors, including poverty and education, significantly influence these health outcomes. The implications of these results indicate a need for targeted public health interventions to enhance health literacy among caregivers, empower female

household heads, improve community healthcare infrastructure, and address socioeconomic disparities. This aligns with the Social Ecological Model (SEM*), which suggests that health outcomes are influenced by multiple factors, including individual, interpersonal, community, and societal levels, as outlined by Golden et al. (2015).

At the individual level, the results indicate that older caregivers (ages 45-54) show significantly lower rates of diarrhoea among children, likely due to improved health literacy and better resource management skills. In contrast, younger children, especially those under 24 months, demonstrate high rates of diarrhoea, highlighting the need for targeted interventions for this vulnerable age group. This finding aligns with the literature by Heidari et al. (2022), which suggests that caregiver age positively correlates with health management practices. However, some studies suggest that younger caregivers with higher education levels can also effectively manage child health, indicating that age alone may not be the sole factor influencing health outcomes.

At the relationship level, the analysis highlights the influence of caregiver gender on the prevalence of diarrhoea. Female-headed households reported lower rates of diarrhoea, supporting findings from other studies, such as Sahiledengle (2020), that underscore the critical role women play in household health management. However, the literature also diverges, indicating that male higher-education caregivers may demonstrate more effective health practices, as Sahiledengle (2019) outlined. This suggests that gender and educational background must be considered when evaluating caregiver effectiveness in preventing child diarrhoea.

Community-level factors, particularly access to healthcare and sanitation facilities, are crucial in addressing diarrhoea prevalence. The study reveals a significant correlation between the age of the household head and diarrhoea rates, indicating that older heads may have better access to resources. This finding is consistent with research by Bausa et al. (2019), which underscores the importance of community health infrastructure in promoting child health. However, other studies suggest inadequate health-seeking behaviour can result in high diarrhoea rates, even in well-resourced communities. This highlights the importance of community engagement, education, and access to resources in combating the prevalence of diarrhoea.

At the societal level, the findings reveal that poverty, limited educational opportunities, and inadequate healthcare infrastructure are significant contributors to the prevalence of diarrhoea. This is consistent with the existing literature by Penakalapati et al. (2017), which identifies socioeconomic factors as critical determinants of child health. However, some studies suggest that cultural beliefs and practices can also significantly influence health outcomes, indicating a divergence in how societal factors are understood and addressed. Therefore, public health strategies must consider these complexities to reduce diarrhoea prevalence effectively.

The study emphasises the multifaceted nature of diarrhoea prevalence among children, framed within the Social-Ecological Model. Individual, relationship, community, and societal levels are critical in shaping health outcomes. The literature review reveals consistency and divergence in findings, underscoring the complex factors influencing child diarrhoea prevalence. By addressing these relationships and considering consistent trends and divergences, public health strategies can be tailored to meet the specific needs of diverse populations, ultimately reducing diarrhoea rates and improving child health outcomes.

Relationships between sanitation facilities, diaper disposal, and diarrhoea

This discussion integrates the quantitative and qualitative findings to elucidate the complex relationships between sanitation facilities, diaper disposal practices, and diarrheal prevalence among children under

five. Notably, the quantitative analysis reveals a statistically significant positive correlation, wherein access to sanitation facilities is associated with a 3.67 times higher reduction in diarrheal prevalence. This finding converges with the qualitative thematic analysis, underscoring the importance of improved sanitation facilities and hygiene practices in mitigating diarrheal risk. These results corroborate existing literature, including studies by Bausa et al. (2020) and White et al. (2023), highlighting the critical role of sanitation infrastructure in preventing diarrheal diseases in diverse contexts. The implications of these findings are profound, underscoring the imperative of enhancing sanitation facilities and diaper disposal practices to reduce diarrheal prevalence and promote child health.

While the quantitative findings underscore the correlation between sanitation and diarrhoea, qualitative insights reveal that caregivers' knowledge and attitudes influence their sanitation practices. Caregivers expressed concerns about unsuitable sanitation facilities for young children, indicating a barrier to proper hygiene practices. This divergence highlights that improvements in infrastructure alone are insufficient; caregivers must also be equipped with knowledge and resources to utilise sanitation facilities effectively.

Integrating quantitative and qualitative findings reinforces the need for practical solutions, such as enhancing sanitation facilities and promoting proper diaper disposal. The quantitative data provide robust evidence for the efficacy of these interventions, while qualitative insights reveal contextual factors that influence their implementation. Caregivers emphasised the need for clear guidelines and resources, suggesting that practical solutions can empower them to adopt healthier behaviours. This aligns with educational interventions suggested by Van Meyel et al.(2022), illustrating the importance of knowledge dissemination in promoting hygienic practices.

The comprehensive understanding that arises from this integrated approach suggests that regular cleaning routines, proper hand washing, and clear guidelines on diaper disposal are essential in mitigating the risk of diarrhoea. The findings suggest that public health strategies should enhance sanitation facilities and promote hygiene practices among caregivers. The implications for policymakers are significant; investments in high-quality sanitation infrastructure, education, and support for caregivers can effectively reduce the prevalence of diarrhoea among children.

From a pragmatic perspective, the Social-Ecological Model (SEM*) highlights the influence of various factors on health outcomes at different levels. The significant decrease in diarrhoea prevalence among children with access to sanitation facilities (56% vs. 82%) underscores the importance of practical interventions that enhance sanitation access, especially in marginalised regions. This finding highlights the urgent need for policymakers to prioritise access to sanitation as a vital component of public health initiatives.

The study revealed that simply increasing sanitation facilities is insufficient to effectively reduce diarrhoea risks, as it was highlighted that having moderate access to these facilities does not lead to significant health improvements. This reinforces the argument made by Lawrence et al. (2016), who conducted their study in urban areas of low—and middle-income countries. They argue for prioritising the quality of sanitation infrastructure over quantity, suggesting that better-maintained facilities can substantially impact public health. At the same time, Seng et al. (2024) indicated that increasing the number of sanitation facilities can lead to lower incidence rates of diseases. Hutton and Haller's findings diverge from this perspective by stressing that not all sanitation improvements yield the same health benefits (Hutton & Haller, 2007). This emphasises the need for public health policies to consider both the availability and the quality of sanitation services to protect child health and reduce disease transmission effectively.

The study findings highlight the necessity of child-specific sanitation solutions, as evidenced by a lower prevalence of diarrhoea among children with access to these tailored facilities (56% vs. 69%), particularly among disabled children. This aligns with the studies by Seidu et al. (2020) in Bangladesh and Baker et al. (2016) in the United States, emphasising the importance of robust sanitation infrastructure in preventing disease transmission. Their research supports the notion that well-designed sanitation facilities contribute to better health outcomes, reinforcing that quality is as important as quantity in sanitation provision. However, these findings contrast the Anand et al. (2022) study in Indonesia and Bausa et al. (2019) in Latin America, suggesting that broader community-level sanitation improvements may yield more significant benefits for child health overall. Their research suggests improving access to community sanitation can enhance collective health, benefiting all age groups rather than focusing solely on children. Proper diaper use and disposal practices are essential for minimising faecal contact and reducing the risk of diarrhoea. These findings align with the study by White et al. (2023) in Kenya, who emphasise the hygiene benefits of proper diaper use. Ejemot-Nwadiaro et al. (2021) in Ethiopia highlighted the vital role of educational interventions in promoting these practices. The results underscore the need for knowledge and skills at both individual and community levels, suggesting that educational programs on proper diaper disposal are essential in strategies to reduce diarrhoea prevalence among young children. This aligns with practices seen in other regions (Rahat et al., 2014); however, it contrasts with the views of some scholars in other countries who question the effectiveness of these interventions in specific contexts.

Following practical guidelines for diaper disposal is crucial for reducing the risk of diarrhoea, as effective waste management practices can significantly improve public health outcomes. This finding aligns with the study by Rahat et al. (2014) in Bangladesh, underscoring the significance of educational interventions in promoting better hygiene practices. This finding is consistent with other research indicating that prioritising proper sanitation and hygiene can lead to significant health benefits. However, this contrasts with studies by Ejemot-Nwadiaro et al. (2021), which suggest that the effectiveness of educational programs may vary depending on community engagement and the availability of resources for their implementation.

Regular cleaning practices proved significant for individuals who consistently maintained sanitation facilities effectively, with 0.3 times more likelihood of reducing the prevalence of diarrhoea. This highlights the importance of public health campaigns promoting regular cleaning habits among caregivers, as emphasised by previous studies. The triangulated data from both quantitative and qualitative analyses illustrate the critical relationship between sanitation practices and child health outcomes. The qualitative findings indicate that caregivers frequently lack knowledge about effective cleaning methods and the significance of hygiene in preventing diarrhoeal diseases, revealing a substantial gap that educational interventions need to address. Public health strategies can better serve vulnerable populations by concentrating on child-specific sanitation solutions and educating caregivers, ultimately enhancing health outcomes.

The findings underscore the importance of a multifaceted approach that effectively combines infrastructural improvements, educational interventions, and community engagement to reduce the prevalence of diarrhoea among children. Public health initiatives can significantly enhance child health and prevent diarrhoeal diseases by prioritising access to quality sanitation, promoting proper hygiene practices, and ensuring regular maintenance of sanitation facilities. These findings have profound implications for public health policy and practice. Emphasising the need for integrated strategies that

address both the infrastructural and educational aspects of sanitation and hygiene to protect the health of young children.

Interpretation

This comprehensive study elucidates the intricate relationship between sanitation facilities, diaper disposal practices, and the prevalence of diarrhoea among children aged 0 to 59 months. The quantitative analysis reveals a strong positive correlation, with a crude odds ratio (COR) of 3.67 and an adjusted odds ratio (AOR) of 3.00, indicating that enhanced sanitation and hygiene are crucial in preventing diarrhoea in young children, particularly those with disabilities.

The qualitative data offer a nuanced understanding of caregivers' knowledge, attitudes, and perceptions regarding sanitation, underscoring the importance of empowering caregivers through targeted education to promote healthier behaviours. The convergence of quantitative and qualitative insights emphasises the necessity of multifaceted public health interventions that address infrastructural improvements and educational initiatives.

Utilising the Social-Ecological Model (SEM) provides a comprehensive understanding of how individual, community, and societal factors intersect to influence health outcomes. The reduced prevalence of diarrhoea among children with access to quality sanitation facilities highlights the importance of prioritising policies that ensure sanitation infrastructure availability and quality. The findings underscore the importance of tailoring interventions to meet children's needs and developing child-friendly sanitation solutions to enhance health outcomes. The analysis also emphasises the importance of proper diaper use and disposal practices in mitigating faecal contamination.

Abductive reasoning reveals that the relationship between sanitation facilities, diaper disposal practices, and diarrhoea prevalence is not solely causal but is somewhat influenced by various factors, including caregiver knowledge, attitudes, and perceptions. This study's findings suggest that public health interventions should adopt a holistic approach, addressing the unique needs of children and engaging caregivers through education and community involvement. This study advocates for comprehensive, integrated public health strategies to prioritise access to quality sanitation, promote proper hygiene practices, and ensure consistent facility maintenance. Public health initiatives can significantly reduce the prevalence of diarrhoea and its associated morbidity and mortality by addressing the unique needs of children and engaging caregivers through education and community involvement.

Summary

This study comprehensively examines critical issues and observations concerning preventing diarrhoea in young children. The key findings highlight the crucial relationship between sanitation facilities, diaper disposal practices, and diarrhoea prevalence, underscoring the need for enhanced sanitation and hygiene practices. The study's results underscore the necessity for multifaceted public health interventions that empower caregivers through education, prioritise quality sanitation infrastructure, and tailor interventions to meet children's specific needs. The convergence of quantitative and qualitative insights highlights the importance of enhancing sanitation and hygiene practices in reducing diarrhoea prevalence.

Notably, the study's observations reveal a significant reduction in the prevalence of diarrhoea among children with access to quality sanitation facilities. Moreover, proper diaper use and disposal practices are emphasised as critical in minimising the risk of diarrhoea. Regular maintenance and cleaning of sanitation facilities are also crucial in reducing the prevalence of diarrhoea, especially in children with disabilities. This study underscores the importance of comprehensive, integrated public health strategies prioritising access to quality sanitation, promoting proper hygiene practices, and ensuring consistent facility

maintenance. Public health initiatives can significantly reduce diarrhoea prevalence and promote overall community well-being by addressing the unique needs of children and engaging caregivers through education and community involvement.

Limitations of the Study

This study, examining the relationship between sanitation facilities, hygiene practices, and diarrhoea prevalence among children under 59 months, presents several limitations warrant consideration. Firstly, the reliance on cross-sectional data restricts causal inferences between identified factors and diarrhoea prevalence, limiting targeted interventions.

The absence of longitudinal data obscures temporal relationships between sociodemographic characteristics and health outcomes, potentially hindering intervention effectiveness (Cohen, 2018). Furthermore, the sample size may not be sufficiently large to detect smaller effect sizes or generalise findings to broader populations.

Using the Social-Ecological Model (SEM) presents limitations, as its complexity can challenge translation into practice and effective intervention implementation (Bronfenbrenner, 1979; Richard et al., 2011). Future research should simplify SEM application in practical contexts, ensuring key interactions among individual, community, and systemic factors are effectively addressed in health interventions.

V. CONCLUSION AND RECOMMENDATION

Diarrhoea remains a significant global public health challenge among children aged 0 to 59 months. This study emphasises the crucial influence of sociodemographic factors, sanitation facilities, and hygiene practices on determining diarrhoea prevalence.

Key findings from the study reveal that caregivers aged 45-54 exhibited lower diarrhoea rates (AOR 0.11, suggesting enhanced health literacy. Children under 24 months demonstrated high prevalence rates, emphasising the need for targeted interventions. Furthermore, female-headed households exhibited higher diarrhoea prevalence (63% vs. 47%), underscoring the importance of gender-sensitive health strategies.

Access to adequate sanitation facilities was identified as a crucial factor in reducing the risk of diarrhoea. Children with access to such facilities reported 3 times lower prevalence rates (56% vs. 82%). Furthermore, child-friendly excreta facilities and proper diaper disposal practices were also found to mitigate the risk of diarrhoea.

An integrated approach combining improved sanitation access, gender-sensitive interventions, and adequate hygiene education is essential for reducing diarrhoea prevalence. The Social-Ecological Model (SEM) offers a comprehensive framework for understanding individual, relational, community, and societal interactions impacting health outcomes.

The study's findings contribute to improving child health outcomes and reducing health inequities, aligning with the United Nations' Sustainable Development Goals (SDGs). Policymakers, practitioners, and researchers should prioritise access to quality sanitation, promote proper hygiene practices, and empower caregivers through education. The following recommendations are extended to policymakers, health practitioners, households, community leaders and researchers:

- **Policymaker Recommendations**
- Allocate funds to prioritise investments in constructing and maintaining adequate sanitation facilities, especially in high-risk areas (WHO & UNICEF, 2023).
- Design child-friendly facilities, ensuring sanitation facilities cater to the unique needs of young children and provide safe and hygienic environments.

- Develop public health campaigns targeting families with children under two years old, promoting hygiene practices, adequate nutrition, and timely medical care.
- Establish monitoring frameworks to assess the impact of implemented policies and interventions on diarrhoea prevalence.
- **Health Practitioner Recommendations**
- Conduct awareness campaigns to educate caregivers about proper diaper disposal practices and the health risks of inadequate disposal.
- Provide community workshops to educate caregivers about child health, nutrition, and sanitation practices.
- Promote hygiene practices, encouraging households to practice proper hygiene, including regularly cleaning and maintaining sanitation facilities (Taylor et al., 2022).
- **Community Leader Recommendations**
- Implement community-led initiatives to regularly clean and maintain sanitation facilities, mitigating the risk of diarrheal diseases.
- Conduct regular assessments to identify gaps and areas for improvement in sanitation access and usage (WHO & UNICEF, 2023).
- Engage local communities, ensuring interventions are culturally appropriate and effectively address unique challenges faced by vulnerable populations.
- **Household Recommendations**
- Practice proper diaper disposal and educate caregivers about its importance and link to reduced diarrhoea prevalence.
- Maintain good hygiene practices, ensuring the regular cleaning and maintenance of sanitation facilities (Taylor et al., 2022).
- Prioritise health education, involving community workshops and education programs to enhance health literacy and resource management.
- **Researcher Recommendations**
- Conduct longitudinal studies to explore the impact of caregiver age and health literacy on child health outcomes.
- Investigate gender roles, understanding how men and women manage health resources differently and their implications for child health (Greene & Barker, 2022).
- Research child-specific sanitation facilities, identifying best practices for reducing the risk of diarrhoea.

Abbreviations

EFA: Exploratory Factor Analysis; CFA: Confirmatory Factor Analysis; SEM: Structural Equation Model; KI: Key Informants; FGD: Focus Group Discussion; COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; QDA: Qualitative Data Analysis; CLTS: Community-Led Total Sanitation; ODF: Open Defecation Free.

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