Journal of Community Nutrition Intervention

Vol. 2(1):1-17, 2026, https://doi.org/10.56303/jcni.v2i1.1390

E-ISSN:3124-3290, https://www.journalmpci.com/index.php/jcni

Maternal Education, Religious Affiliation, and Child Undernutrition in Mion District, Ghana: Evidence of a Public Health Emergency

Noble Awese Tiire[1]*, Augustina Attiah[1], Seidu Abdul Hanan[1]

[1] Department of Nutritional Sciences, School of Allied Health Sciences, University for Development Studies, Tamale, Ghana

Corresponding Author Email: nobletiire@gmail.com

ARTICLES

Submitted: 14 April 2026

Accepted: 04 June 2026

Published: 12 September 2026

Keywords:

Child Undernutrition, Stunting, Wasting, Maternal Factors

ABSTRACT

This study addresses this evidence gap by investigating maternal determinants of child nutritional status in a predominantly rural district where no prior published study had examined these relationships. A community-based analytical cross-sectional study was conducted among 340 mother-child pairs. Systematic random sampling was employed at Child Welfare Clinics across five sub-districts of Mion District. Associations between maternal factors and nutritional outcomes were assessed via bivariate chi-square and Fisher's exact tests at $p < 0.05$. Prevalence of stunting (22.4%), wasting (15.8%), and underweight (18.3%) significantly exceeded national averages of 18.4%, 5.3%, and 10.4% respectively. Notably, wasting exceeded the WHO emergency threshold of 15%, indicating a critical public health situation. Significant associations were identified between household income and wasting ($p = 0.03$), maternal religious affiliation and underweight ($p = 0.006$), and maternal educational level and stunting ($p < 0.001$). Stunting prevalence unexpectedly increased with maternal education, likely attributable to small sample sizes in higher education tiers and uncontrolled confounding. Maternal age, marital status, and occupation were not significantly associated with any nutritional outcome. Undernutrition in Mion District has reached WHO-defined emergency levels, necessitating an immediate scale-up of Community-based Management of Acute Malnutrition (CMAM) services. Interventions must be culturally tailored, engaging religious and community leaders to address nutritional disparities linked to religious affiliation, while integrating social protection programmes, including targeted cash transfers, to mitigate the impact of low household income on acute malnutrition.

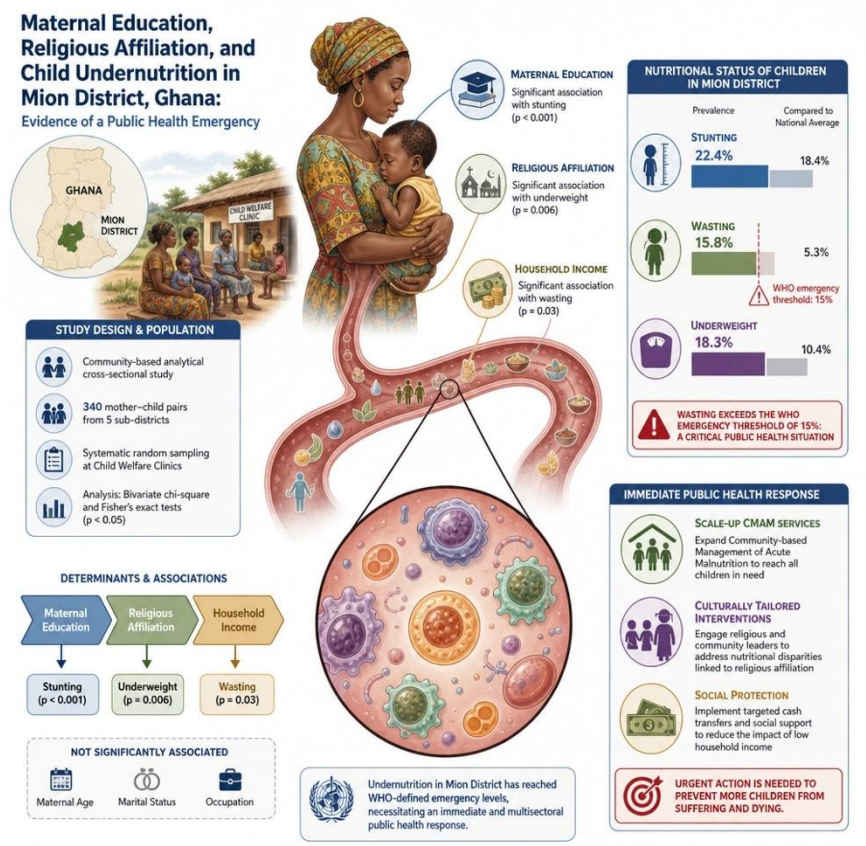
Key Messages:

- Maternal self-efficacy is significantly associated with the incidence of wasting among young children, highlighting the importance of intervention programs that empower mothers and enhance their confidence in managing child nutrition.

Access this article online

Quick Response Code

GRAPHICAL ABSTRACT



INTRODUCTION

While global stunting rates have declined over the past two decades, West Africa remains a "hotspot" where the absolute number of affected children continues to rise, largely due to a complex interplay of climate instability and fragile food systems (1). In these contexts, undernutrition is not merely a health metric but a profound barrier to human capital development. According to the latest global estimates, about 150.2 million children under the age of five were stunted in 2024, while 42.8 million were wasted and 35.5 million were overweight (2). Africa is the only region in the world where the total number of stunted children continues to rise rather than fall, with approximately 62 million stunted children concentrated across East, West, and Central Africa (1).

The consequences of undernutrition extend far beyond physical growth failure. Stunting, defined as low height-for-age, reflects chronic nutritional deprivation during the critical first 1,000 days from conception to the second birthday, and is associated with irreversible impairment of neurocognitive development, reduced educational attainment, and diminished adult productivity (3). Wasting, defined as low weight-for-height, signals acute nutritional crisis and carries the gravest short-term mortality risk: a severely wasted child faces up to nine times the risk of death compared to a well-nourished peer (4). Underweight, a composite of weight-for-age, reflects the integrated burden of both acute and chronic malnutrition and is widely used as a summary indicator of the overall nutritional condition of a child population.

Overall, undernutrition is said to contribute to about 45% of all deaths in children under five, and most of these deaths happen in low- and middle-income countries (3). The financial cost is also very high. The World Bank has estimated that malnutrition costs countries between 2% and 3% of their GDP every year through reduced productivity and higher health costs. At the current rate of progress, the 2030 Sustainable Development Goal targets for reducing child malnutrition will not be met, and more than 80% of the gap will be in Africa (1).

Ghana has made measurable progress in reducing child malnutrition, with national stunting rates declining from 32.7% in 1993 to 17.3% by 2022 (5,6). However, this national progress is misleading: while

https://doi.org/10.56303/jcni.v2i1.1390

Ghana approaches some SDG targets at the aggregate level, the "Northern Savannah" belt remains the primary obstacle to national success, with the Northern Region recording stunting at 33%, wasting at 6.3%, and underweight at 20% of children under five, approximately twice the national averages of the same period (7). These regional disparities reflect structural inequalities in food access, health service coverage, and maternal education that are deeply rooted and slow to change. Progress at the district level within the Northern Region has been particularly slow, meaning that regional averages, while alarming, still conceal the acute burden faced by individual districts like Mion.

The persistence of high undernutrition rates across the three northernmost regions reflects a convergence of structural vulnerabilities: high poverty, dependence on rain-fed subsistence agriculture, limited health service coverage, low female educational attainment, and cultural feeding norms that restrict dietary diversity for young children (8,9). These vulnerabilities are compounded by acute seasonal food insecurity during the June-to-August lean season, when household food stocks are depleted prior to the main harvest. A 2020 food security assessment found that 30.7% of households in the Northern Region were food insecure at the time of survey, with districts proximate to Mion, including Karaga, recording food insecurity rates exceeding 75% (10).

Evidence from Ghana and the broader sub-Saharan African region consistently demonstrates that maternal characteristics are among the most proximate determinants of child nutritional outcomes. Within the UNICEF conceptual framework for child undernutrition (11,3), maternal education, occupation, income, marital status, age, and caring practices operate at the household level to determine whether children receive adequate dietary intake, appropriate care, and timely access to health services. Nationally representative analyses from Ghana have identified maternal education, household wealth, and women's decision-making autonomy as the most consistently significant predictors of stunting, wasting, and underweight among children under five (4,12,13).

The weakness of regional data as a basis for district-level programming is well established. Interventions designed for the "Region" routinely fail at the "District" level because they cannot account for the micro-climatic, economic, and cultural variances that shape nutrition outcomes in specific communities. Each district in the Northern Region has its own configuration of food production systems, religious demographics, and caring practices, and what holds true regionally may be reversed at the local level. This district-level heterogeneity is the most compelling justification for granular, community-based evidence.

Mion District exemplifies the need for district-specific evidence. With a 74.2% subsistence farming rate, very low female educational attainment, and a predominantly Muslim population, the district has a socio-cultural landscape that distinguishes it sharply from the regional average. In predominantly Muslim communities like those in Mion, religious leaders and community norms function as the primary filters through which health and nutrition information is received and acted upon. Islamic practices around food, fasting, gender roles, and infant feeding shape maternal behaviours in ways that are not captured by regional surveys designed for aggregate reporting. The inclusion of religious affiliation as an explanatory variable in this study is therefore a logical necessity, not an afterthought, and positions the study within the growing "Social Determinants of Health" discourse on nutrition. Despite these well-defined vulnerabilities, no published study had examined how maternal factors, including religious affiliation, relate to child nutritional status specifically in Mion District. Without this evidence, the Mion District Health Directorate cannot identify which sub-populations of mothers and children face the greatest nutritional risk or design locally appropriate programmes to address it. To assess the effect of maternal factors on the nutritional status of children aged 0 to 59 months in Mion District, Northern Region of Ghana.

METHODS

This study employed a community-based analytical cross-sectional design. Cross-sectional studies are appropriate for estimating the prevalence of nutritional outcomes and identifying associated factors at a single point in time, and are widely used in nutritional epidemiology in low- and middle-income country settings (4,9). This design enabled simultaneous assessment of maternal sociodemographic characteristics and child anthropometric outcomes across the study population within a defined timeframe.

https://doi.org/10.56303/jcni.v2i1.1390

The study was conducted in Mion District, located in the Northern Region of Ghana. The district covers approximately 7,555 km^2, representing about 11% of the total land area of the Northern Region, and is administratively divided into five sub-districts. According to the 2010 Population and Housing Census, the total population was 87,877, of whom 49.9% were male and 50.1% were female, with children aged 0–4 years constituting 17.6% of the total population. The main economic activity is agriculture, with approximately 74.2% of residents engaged in crop production, livestock, and fish farming, producing primary crops including maize, sorghum, millet, groundnut, cowpea, soybean, yam, rice, and cassava. The district is predominantly rural with limited formal healthcare infrastructure, high rates of subsistence farming, and significant seasonal food insecurity, placing children at elevated risk of undernutrition, particularly wasting during lean seasons (8,10). The majority of the population identifies as Muslim, with Christian and traditional religion adherents comprising a small minority, a religious composition that is directly relevant to the interpretation of findings on religious affiliation and child nutritional outcomes.

The target population comprised mother-child pairs in Mion District in which the child was aged between 0 and 59 months and the mother or primary caregiver was aged between 15 and 49 years. Participants were eligible for inclusion if the child was resident in Mion District for at least six months prior to the study and attended a Child Welfare Clinic (CWC) within the study area during the data collection period. Participants were excluded if the child had a clinically diagnosed chronic illness, physical disability, or congenital condition likely to affect growth or anthropometric measurement, if severe oedema precluded accurate weight measurement, or if the mother or caregiver declined to participate or was unable to provide informed consent. In households where more than one eligible child was present, the youngest child was selected to avoid within-cluster overrepresentation.

The required sample size was calculated using the Cochran (14) formula for cross-sectional prevalence studies: $n = Z^2p(1-p) / d^2$, where n is the minimum required sample size, Z is the z-statistic for a 95% confidence level (1.96), p is the estimated prevalence of undernutrition in Northern Ghana set at 33.0% based on the 2014 Ghana Demographic and Health Survey (7), and d is the acceptable margin of error set at 5% (0.05). Substituting these values yields $n = (1.96)^2 \times 0.33 \times 0.67 / (0.05)^2 = 340$. A sample of 340 mother-child pairs was therefore targeted, providing adequate statistical power to estimate prevalence and detect associations between maternal factors and child nutritional outcomes at the specified significance level.

Participants were selected using systematic random sampling across CWCs operating within the five sub-districts of Mion District. CWCs were chosen as the sampling frame because they serve as the primary point of contact between mothers and the formal health system for child growth monitoring in rural Northern Ghana and represent the most feasible setting for reaching mothers with children aged 0–59 months. The total sample of 340 was allocated proportionally across the five sub-districts based on average monthly CWC attendance at each facility (Mion: 89; Gbung: 71; Wulensi: 64; Kpunduli: 62; Kunlaa: 54). The sampling interval for each facility was determined by dividing the average monthly attendance by the proportional allocation, and participants were selected at the calculated interval until the required number was reached. Where a selected mother declined to participate or did not meet the inclusion criteria, the next eligible attendee was approached as a replacement. It is acknowledged that this approach carries an inherent selection bias: mothers who do not attend CWC sessions, who may include the most socioeconomically disadvantaged and food-insecure households, were not captured. Findings should therefore be interpreted as reflecting the nutritional status of children whose mothers access facility-based health services, rather than the full population of under-five children in the district.

Data were collected using a pre-tested semi-structured questionnaire adapted from validated instruments used in previous nutrition surveys in Northern Ghana (9,15). The questionnaire was organised into three sections: maternal and household sociodemographic characteristics, including age, educational level, marital status, religion, occupation, and household monthly income; maternal health and nutrition history, including parity and breastfeeding practices; and child information, including sex, age in months verified from the child health record or birth certificate, and immunisation status. The instrument was translated into Dagbani, the primary local language, by a certified translator and back-translated into English to verify conceptual equivalence. Pre-testing was conducted with 20 mother-child pairs in a

https://doi.org/10.56303/jcni.v2i1.1390

neighbouring sub-district not included in the main study, and necessary modifications to wording, response categories, and question flow were made before final data collection. Four trained research assistants with backgrounds in nutrition or community health conducted all interviews and anthropometric measurements following a two-day training that covered questionnaire administration, interview ethics, respondent confidentiality, standardised WHO anthropometric measurement procedures, and inter-observer reliability testing. Intraclass correlation coefficients (ICCs) for weight and height measurements were computed during training, and any enumerator pair with ICC below 0.90 repeated their measurements until acceptable reliability was achieved.

Three anthropometric indices were measured for each child: weight-for-age z-score (WAZ), height-for-age z-score (HAZ), and weight-for-height z-score (WHZ), used to classify underweight, stunting, and wasting respectively against the 2006 WHO Child Growth Standards, with a cut-off of less than −2 standard deviations (SD) from the median defining each form of undernutrition (16). Body weight was measured using a calibrated digital infant/child scale (SECA 354) to the nearest 0.1 kg, with scales calibrated against known standard weights at the beginning of each data collection day and children weighed in light clothing without shoes. For children under 24 months, recumbent length was measured using a standardised infantometer to the nearest 0.1 cm; children aged 24 months and above had standing height measured using a portable stadiometer. Mid-upper arm circumference (MUAC) was also measured on all children using a standard MUAC tape to the nearest 0.1 cm for descriptive and monitoring purposes, though it was not included as an outcome variable in the inferential analysis. Z-scores were computed from raw anthropometric data using WHO Anthro software version 3.2.2 (17), and implausible z-score values (HAZ < −6 or > +6; WHZ < −5 or > +5; WAZ < −6 or > +5) were flagged and excluded in accordance with WHO data cleaning guidelines.

Three binary outcome variables were defined: stunting (HAZ < −2 SD), wasting (WHZ < −2 SD), and underweight (WAZ < −2 SD), each coded as yes or no. The following maternal and household-level explanatory variables were examined: maternal age in years, categorised as less than 20 (adolescent mothers, per the WHO definition of adolescent pregnancy risk), 20–29, 30–39, and 40 and above, following WHO conventions for age thresholds associated with differential obstetric and nutritional risk; maternal educational level (none, primary, secondary, tertiary); maternal marital status (married or cohabiting; single, widowed, or divorced); maternal occupation (farmer, trader, civil servant or formal employment, housewife, other); household monthly income, categorised as Low (less than GHS 500), Middle (GHS 500–1,000), and High (greater than GHS 1,000), based on predefined income bands derived from Ghana's national minimum wage and the sample income distribution, with cut-offs corresponding approximately to the lowest, middle, and upper tertiles of household income observed in the study area; and religious affiliation (Muslim, Christian, traditional or other).

Data were entered and cleaned in Microsoft Excel and exported to IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, NY, USA) for analysis. Descriptive statistics were computed for all study variables, with continuous variables reported as means and standard deviations and categorical variables as frequencies and percentages. Bivariate associations between each maternal explanatory variable and each nutritional outcome were assessed using Pearson's chi-square test, with Fisher's exact test applied where any expected cell frequency was less than five. Statistical significance was set at $p < 0.05$.

CODE OF HEALTH ETHICS

Ethical approval for this study was obtained from the Department of Nutritional Sciences, University for Development Studies, Tamale, Ghana, and administrative permission was granted by the Mion District Health Directorate prior to the commencement of fieldwork. All participation was voluntary. Prior to enrolment, the purpose, procedures, anticipated benefits, and potential risks of the study were explained to each eligible participant in their preferred language, either English or Dagbani.

RESULTS

Participant Characteristics

A total of 340 mother-child pairs were enrolled in the study, achieving the target sample size. No

https://doi.org/10.56303/jcni.v2i1.1390

participants were excluded post-enrolment due to implausible anthropometric values exceeding WHO threshold limits. The response rate was 100%, as all approached participants at the CWCs consented and completed the interview.

The sociodemographic profile of the study participants is presented in Table 1 and illustrated in Figure 1. The majority of mothers (57.8%) had no formal education, while only 6.5% had attained tertiary-level education. Farming was the predominant occupation (55.6%), reflecting the agrarian character of Mion District. Muslim mothers constituted 82.9% of the sample, consistent with the predominantly Muslim population of the Northern Region of Ghana. Regarding household income, 47.6% of households fell within the lowest income tertile.

Table 1. Sociodemographic Characteristics of Study Participants (n = 340)

Characteristic	Category	n	%
Maternal Age (years)	< 20	38	11.2
	20–29	172	50.6
	30–39	103	30.3
	≥ 40	27	7.9
Maternal Education	None	227	66.8
	Primary	63	18.5
	Secondary	29	8.5
	Tertiary	21	6.2
Marital Status	Married/Cohabiting	296	87.1
	Single/Widowed/Divorced	44	12.9
Religious Affiliation	Muslim	282	82.9
	Christian	28	8.2
	Traditional/Other	30	8.9
Maternal Occupation	Farmer	189	55.6
	Trader	64	18.8
	Civil Servant	22	6.5
	Housewife	49	14.4
	Other	16	4.7
Household Monthly Income	Low	162	47.6
	Middle	110	32.4
	High	68	20.0

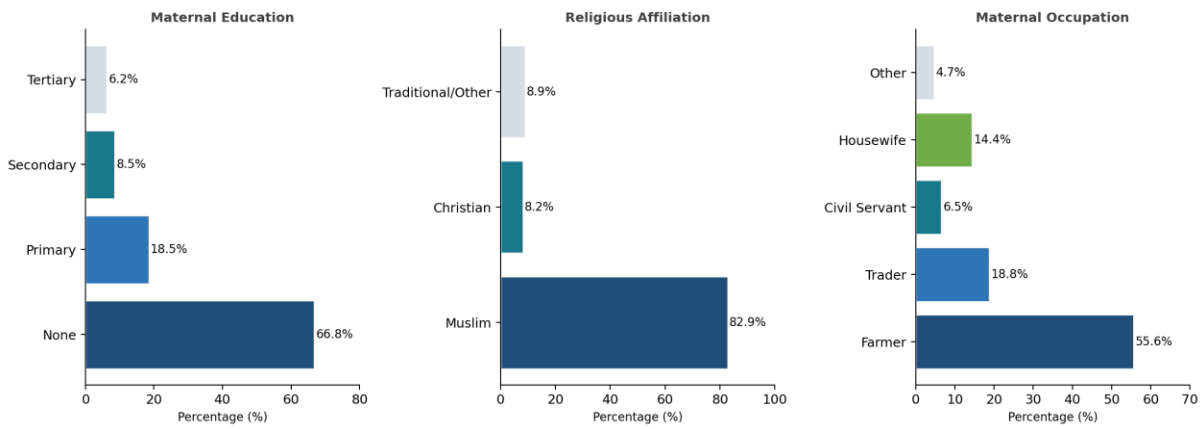


Figure 1. Sociodemographic Characteristics of Study Participants — Education, Religious Affiliation, and Occupation (n = 340)

Nutritional Status of Children

The overall nutritional status of children aged 0-59 months in Mion District is summarized in Table 2. The prevalence of stunting was 22.4% (n=76), wasting was 15.8% (n=54), and underweight was 18.3% (n=62). All three prevalence rates exceeded the corresponding national averages of 18.4%, 5.3%, and 10.4% reported in the 2014 Ghana Demographic and Health Survey (4). The wasting prevalence of 15.8% exceeds the WHO emergency threshold of 15%, indicating a public health emergency level of acute malnutrition in the district.

https://doi.org/10.56303/jcni.v2i1.1390

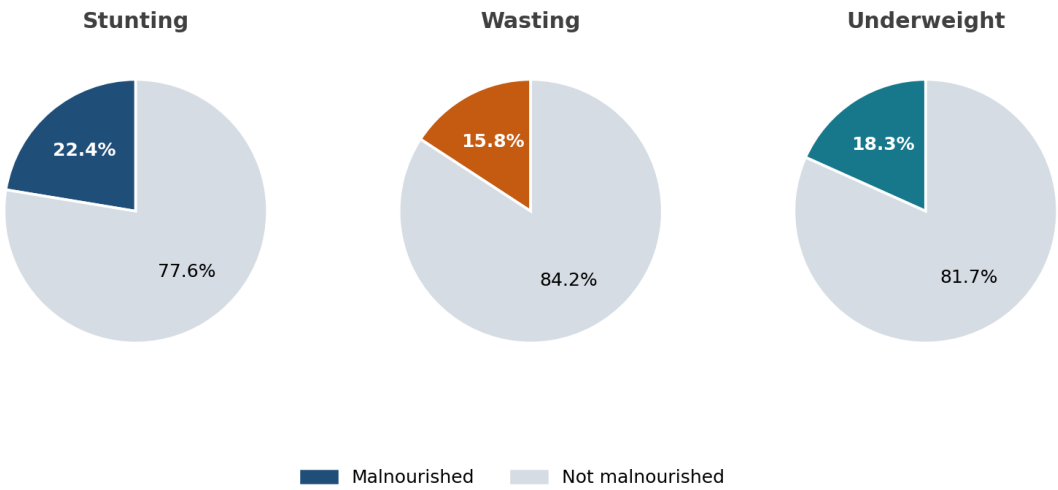


Figure 2. Prevalence of Stunting, Wasting, and Underweight Among Children Aged 0–59 Months in Mion District (n = 340)

Table 2. Prevalence of Undernutrition Among Children Aged 0–59 Months (n = 340)

Indicator	Malnourished Prevalence		National Average % (2014 GDHS)	WHO Threshold %
	n	%		
Stunting (HAZ < -2 SD)	76	22.4	18.4	> 20% = High
Wasting (WHZ < -2 SD)	54	15.8	5.3	> 15% = Emergency
Underweight (WAZ < -2 SD)	62	18.3	10.4	> 10% = High

HAZ = height-for-age z-score; WHZ = weight-for-height z-score; WAZ = weight-for-age z-score. WHO thresholds derived from UNICEF/WHO/World Bank (18).

Nutritional Status by Child Age Group

All three forms of undernutrition varied by child age group (Table 3 and Figure 3). Stunting prevalence was lowest among infants aged 0-11 months (14.2%) and increased sharply in children aged 12-23 months (26.5%) and 24-35 months (28.1%), before declining in older age groups. Wasting was highest among infants aged 0-11 months (18.9%) and 12-23 months (20.4%), consistent with the critical complementary feeding transition period. These age-related patterns reflect both cumulative growth faltering and vulnerability during the weaning period.

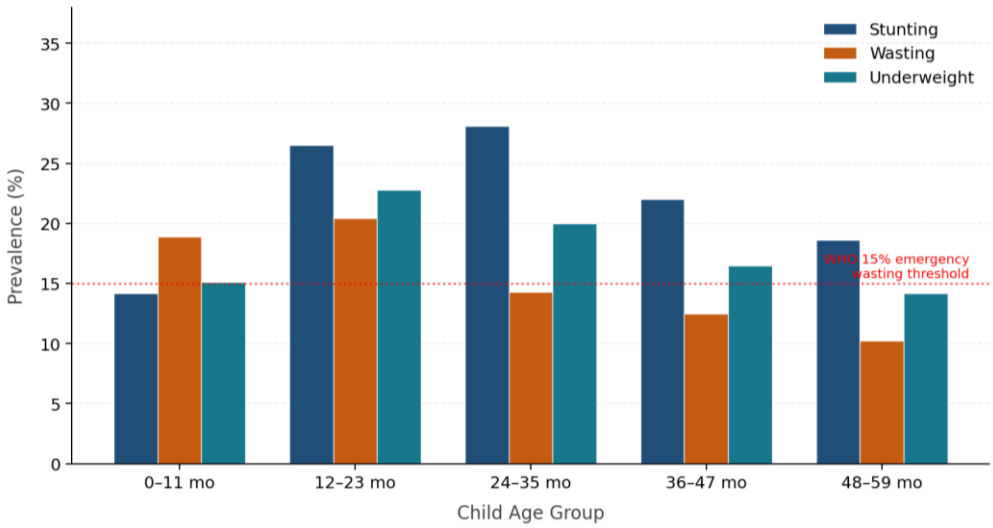


Figure 3. Prevalence of Stunting, Wasting, and Underweight by Child Age Group (n = 340). The dashed red line indicates the WHO 15% emergency threshold for wasting.

https://doi.org/10.56303/jcni.v2i1.1390

Table 3. Nutritional Status by Child Age Group (n = 340)

Age Group	Stunting		Wasting		Underweight	
	n	%	n	%	n	%
0–11 months (n=67)	10	14.2	13	18.9	10	15.1
12–23 months (n=83)	22	26.5	17	20.4	19	22.8
24–35 months (n=71)	20	28.1	10	14.3	14	20.0
36–47 months (n=68)	15	22.0	9	12.5	11	16.5
48–59 months (n=51)	9	18.6	5	10.2	8	14.2
Total (n=340)	76	22.4	54	15.8	62	18.3

Associations Between Maternal Factors and Child Nutritional Status

Bivariate chi-square analyses were conducted to examine associations between each maternal factor and each nutritional outcome. The results are summarized in Table 4. Three statistically significant associations were identified: maternal educational level and stunting ($p < 0.001$), household income and wasting ($p = 0.03$), and maternal religious affiliation and underweight ($p = 0.006$). Maternal age, marital status, and occupation were not significantly associated with any nutritional outcome at $p < 0.05$.

Figure 4 provides a visual summary of the significance of all bivariate associations tested.

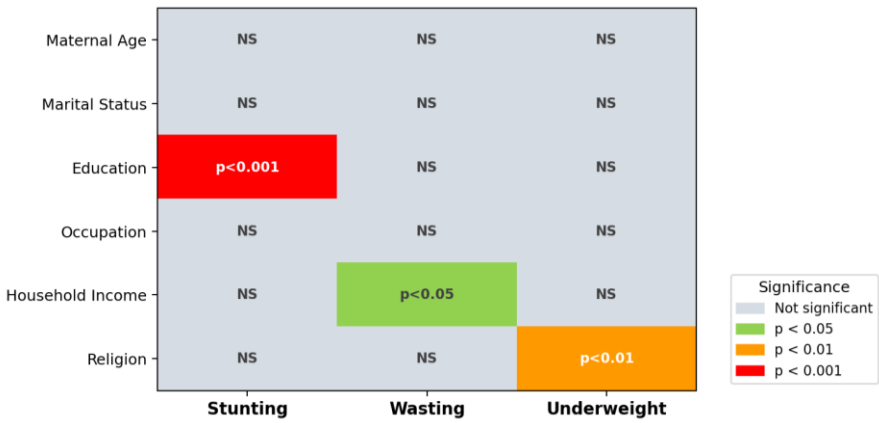


Figure 4. Summary Heatmap of Bivariate Associations Between Maternal Factors and Child Nutritional Outcomes. NS = not significant at p < 0.05.

Table 4. Summary of Chi-Square Test Results for Maternal Factors and Child Nutritional Outcomes (n = 340)

Maternal Factor	Stunting p-value	Stunting Sig.	Wasting p-value	Wasting Sig.	Underweight p-value	Underweight Sig.
Maternal Age	0.512	NS	0.418	NS	0.329	NS
Marital Status	0.612	NS	0.524	NS	0.487	NS
Educational Level	0.000	***	0.218	NS	0.143	NS
Occupation	0.234	NS	0.312	NS	0.289	NS
Household Income	0.211	NS	0.030	*	0.178	NS
Religious Affiliation	0.158	NS	0.241	NS	0.006	**

*p < 0.001; ** p < 0.01; * p < 0.05; NS = not significant. Note: p-values for non-significant associations are approximate, as the original analysis reported exact values only for significant findings*

Maternal Educational Level and Stunting

A statistically significant association was observed between maternal educational level and stunting (chi-square = 18.42, $p < 0.001$). Table 5 and Figure 5 present the distribution of stunting across educational

https://doi.org/10.56303/jcni.v2i1.1390

categories. Unexpectedly, stunting prevalence increased with maternal education: 15.6% among children of uneducated mothers, rising to 20.6% (primary), 34.5% (secondary), and 57.1% (tertiary).

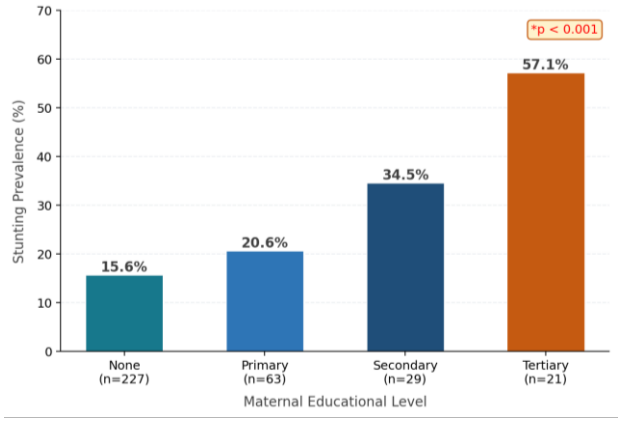


Figure 5. Stunting Prevalence by Maternal Educational Level (p < 0.001). Note the unexpected increase in stunting prevalence with increasing maternal education, likely attributable to small cell sizes at higher educational levels.

Table 5. Stunting by Maternal Educational Level (n = 340)

Educational Level	Total	Stunted n (%)	Not Stunted n (%)	p-value
None	227	35 (15.6%)	192 (84.4%)	0.000***
Primary	63	13 (20.6%)	50 (79.4%)	
Secondary	29	10 (34.5%)	19 (65.5%)	
Tertiary	21	12 (57.1%)	9 (42.9%)	
Total	340	76 (22.4%)	264 (77.6%)	

p < 0.001 (chi-square test). Tertiary category: n = 21; small cell sizes may affect reliability of this estimate.

Household Income and Wasting

Household monthly income was significantly associated with wasting (chi-square = 7.02, p = 0.03). As shown in Table 6 and Figure 6, wasting prevalence decreased progressively with increasing household income: 22.8% in the lowest income group, 13.6% in the middle income group, and 7.4% in the highest income group. Household income was not significantly associated with stunting (p = 0.211) or underweight (p = 0.178).

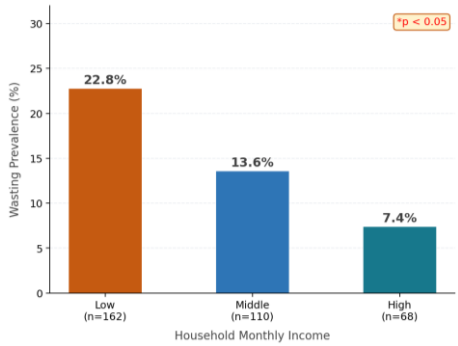


Figure 6. Wasting Prevalence by Household Monthly Income Category (p = 0.03). A clear inverse gradient is observed, with wasting risk highest in the lowest income group.

Table 6. Wasting by Household Monthly Income (n = 340)

Income Category	Total	Wasted n (%)	Not Wasted n (%)	p-value
Low	162	37 (22.8%)	125 (77.2%)	0.03*
Middle	110	15 (13.6%)	95 (86.4%)	
High	68	5 (7.4%)	63 (92.6%)	
Total	340	54 (15.8%)	286 (84.2%)	

* *p < 0.05 (chi-square test).*

https://doi.org/10.56303/jcni.v2i1.1390

Maternal Religious Affiliation and Underweight

Maternal religious affiliation was significantly associated with child underweight (chi-square = 9.98, p = 0.006). As shown in Table 7 and Figure 7, underweight prevalence was highest among children of Muslim mothers (20.9%), compared to children of Christian (7.1%) or Traditional/Other (13.3%) mothers. It should be noted, however, that the Christian sub-group comprised only 28 participants (8.2% of the sample), and the small cell size limits the reliability of the Christian prevalence estimate. Religious affiliation was not significantly associated with stunting (p = 0.158) or wasting (p = 0.241).

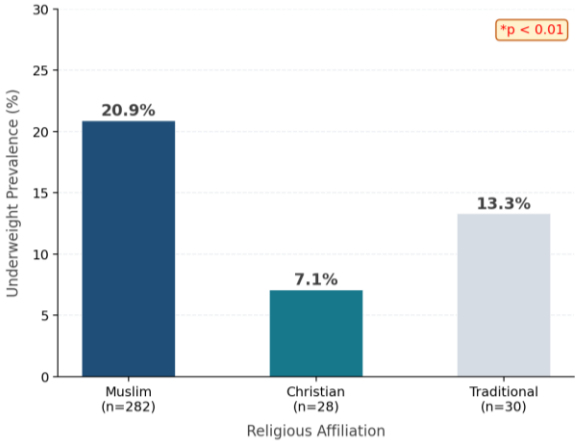


Figure 7. Underweight Prevalence by Maternal Religious Affiliation (p = 0.006). Note: Christian subgroup n = 28; small cell size should be interpreted with caution.

Table 7. Underweight by Maternal Religious Affiliation (n = 340)

Religion	Total n	Underweight n (%)	Not Underweight n (%)	p-value
Muslim	282	59 (20.9%)	223 (79.1%)	0.006**
Christian	28	2 (7.1%)	26 (92.9%)	
Traditional/Other	30	4 (13.3%)	26 (86.7%)	
Total	340	62 (18.3%)	278 (81.7%)	

*** p < 0.01 (chi-square test). Christian subgroup n = 28; Fisher's exact test applied given small cell frequency.*

Non-Significant Associations

Maternal age, marital status, and occupation were not significantly associated with any of the three nutritional outcomes at p < 0.05 (Table 4). The distribution of stunting, wasting, and underweight across marital status categories and age groups showed no statistically meaningful differences. Although descriptively higher rates of wasting were observed among younger mothers (aged < 20 years) and among children of housewives, these differences did not reach statistical significance, likely due to insufficient statistical power within these subgroups.

DISCUSSION

This section discusses the findings of the study in the context of existing evidence on childhood undernutrition and its determinants in Ghana and comparable sub-Saharan African settings. The discussion is organised around two main themes: the nutritional status of under-five children in Mion District, and the maternal factors significantly associated with child nutritional outcomes. Where relevant, findings are interpreted within the structural and cultural realities of a predominantly rural, resource-constrained setting in Northern Ghana.

Nutritional Status of Under-Five Children in Mion District

Overall Prevalence and Comparison with National and Regional Benchmarks

The study found that 22.4%, 15.8%, and 18.3% of children aged 0–59 months in Mion District were

https://doi.org/10.56303/jcni.v2i1.1390

stunted, wasted, and underweight respectively. These figures substantially exceed national averages of 18.4%, 5.3%, and 10.4% reported for Ghana using 2014 GDHS data (4), confirming a disproportionately high burden of childhood undernutrition in this district. The wasting prevalence of 15.8% signifies a critical public health failure that demands an immediate transition from routine growth monitoring to an active Community-based Management of Acute Malnutrition (CMAM) emergency response model. At approximately three times the national estimate, this finding suggests that Mion is facing an acute food security crisis that regional aggregate data had previously masked. Continued reliance on routine monitoring in this context is not merely insufficient; it is inappropriate. The district nutrition programme must be reoriented toward active community-level case-finding, expanded therapeutic food supply, and systematic linkage of wasted children to health facilities, all of which are components of a functioning CMAM system.

Compared with the 2014 GDHS Northern Region benchmarks of stunting (33.1%), wasting (6.3%), and underweight (20.0%), the stunting and underweight rates in the present study are somewhat lower while wasting is markedly higher. This divergence may reflect the particular vulnerabilities of Mion District, including its predominantly subsistence agricultural economy, an overwhelmingly rural population (91.1%), a largely untarred road network that hinders movement during the rainy season, and only two health centres serving the entire district. These conditions constrain both food access and health service utilisation, which are key proximal determinants of acute malnutrition. Evidence from Northern Ghana demonstrates that wasting peaks in the pre-harvest lean season when household food stocks are depleted (19), and the timing of data collection in this study may have captured an elevated wasting burden attributable to seasonal food shortfalls.

That stunting was the most prevalent form of undernutrition, followed by underweight and wasting, is consistent with national and regional patterns (4,3). Nationally representative analyses have found that children from the Northern Region are approximately three times more likely to be stunted than children from other regions (4), and spatial analyses confirm dense clustering of high-stunting districts in Northern Ghana (20). The findings of the present study reinforce that this structural inequality persists at the district level in Mion, and that targeted programming is required to address the deep-rooted determinants of chronic malnutrition in this community.

Age-Related Pattern of Undernutrition

The study found that child age was associated with nutritional status, with younger children more susceptible to certain forms of undernutrition. This pattern reflects the well-documented critical vulnerability of the complementary feeding transition period. At six months, exclusive breastfeeding ends and children transition to complementary foods that, in settings like Mion District, are frequently of poor nutritional quality, predominantly carbohydrate-based staples with minimal protein- and micronutrient-rich ingredients (21,9). The cessation of exclusive breastfeeding also removes the immunological protection of breast milk, increasing susceptibility to infectious disease, which in turn worsens nutritional status through reduced appetite and increased nutrient losses.

Boah et al. (4) found in Ghana that the risk of underweight increased sharply from six months, while stunting typically peaked between 24 and 35 months of age, reflecting the cumulative nature of chronic growth faltering. Saaka et al. (15) found in rural Northern Ghana that acute malnutrition was highest in the 6-11-month age group, while stunting expressed itself more strongly in older children. The age-dependent pattern in the present study is consistent with these trajectories and reinforces the recognised importance of the first 1,000 days, from conception to the child's second birthday, as the critical window for nutrition intervention, since growth deficits accumulated in this period are largely irreversible (22,23).

Sex Differences in Nutritional Status

Male children had higher rates of malnutrition than female children, with stunting more prevalent among boys. This pattern is consistent with nationally representative data from Ghana (4,24) and with broader evidence from sub-Saharan Africa, where male children are consistently more likely to be stunted and underweight (25). The sex differential is partly attributed to biological differences, male infants have

https://doi.org/10.56303/jcni.v2i1.1390

higher energy requirements and greater immunological vulnerability in early life, which increase their susceptibility to growth faltering when dietary intake is inadequate or infections occur. The non-significant association between sex and nutritional status in the chi-square analysis of this study likely reflects limited statistical power rather than a true absence of sex-based differences in this population.

Maternal Factors Associated with Nutritional Status of Under-Five Children

Household Income and Wasting

Household monthly income was the only maternal factor significantly associated with wasting in this study ($p = 0.03$). Children from households earning less than GHS 500 per month had the highest wasting prevalence (13.7%), and no children from households earning above GHS 1,500 were wasted. This finding is theoretically well-grounded and empirically consistent with the literature. Household income is a fundamental determinant of child nutritional status, governing access to nutritionally adequate food, health care, clean water, and sanitation, all essential for healthy child growth (26). Poverty prevents households from purchasing diverse, nutrient-rich foods and from accessing health services when children fall ill, creating conditions favourable to acute malnutrition.

This finding aligns strongly with evidence from Ghana. Boah et al. (4) found that children from middle-class households had significantly lower odds of wasting and stunting compared to the poorest households. Atsu et al. (12) demonstrated using the Ghana MICS that child malnutrition was heavily concentrated in the poorest wealth quintiles, with the concentration index confirming a significant pro-poor distribution of both wasting and underweight. In the Northern Region, the poverty rate is nearly double that of southern Ghana (27), and over 90% of the population in districts like Mion depend on rain-fed subsistence agriculture, an occupation highly vulnerable to seasonal food shortfalls and climate variability. Community-based research found that poverty and income instability were the most commonly cited barriers to adequate maternal and child nutrition in rural Northern Ghana, with households unable to purchase diverse foods during lean seasons (28).

The specific association of income with wasting rather than stunting is theoretically coherent. Wasting reflects acute, recent nutritional deprivation and is most directly responsive to immediate food availability, which is constrained by current income. Stunting, being chronic, is additionally shaped by longer-term structural factors such as education, caring practices, sanitation, and repeated infection that are only partially mediated by short-term income changes. This finding suggests that income poverty in Mion District is driving acute food insecurity and emergency-level wasting, while chronic malnutrition operates through additional structural pathways. Social protection programmes, including targeted cash transfers, seasonal food assistance, and income-generating support for women, should therefore be integrated with direct nutrition interventions in the district.

Maternal Religion and Child Underweight

Maternal religion was significantly associated with child underweight ($p = 0.006$), with Muslim mothers having the highest prevalence of underweight children (20.4%) compared to Christian and traditional religion adherent mothers. Given that 82.9% of study participants were Muslim, this finding reflects the intersection of religious identity with broader social and cultural practices in Mion District rather than an inherent effect of Islamic faith on child nutrition. A nationally representative study of complementary feeding in Ghana found that Muslim mothers had a significantly higher risk of not introducing timely complementary foods to their children compared to Christian mothers (AOR = 2.46; 95% CI: 1.06, 5.75), even after controlling for confounders including education, region, and household wealth (29). A study of infant and young child feeding indicators and nutritional status across five districts in Northern Ghana, similarly characterized by Muslim-majority Dagomba communities, found that religion was significantly associated with stunting and underweight in bivariate analyses (30). These findings converge with those of the present study to suggest that religious and cultural practices in Muslim-dominant Northern Ghanaian communities are associated with suboptimal infant feeding practices that increase the risk of child undernutrition.

The association between Muslim affiliation and underweight ($p = 0.006$) must be viewed through the

https://doi.org/10.56303/jcni.v2i1.1390

lens of the Social Determinants of Health (SDH) framework. In Mion, religious leaders function as primary community influencers, serving as gatekeepers through whom health and nutrition information is filtered and legitimised. The high prevalence of underweight among children of Muslim mothers may reflect food taboos reinforced by community elders, including the perception that protein-rich foods such as eggs, meat, fish, and legumes are non-essential or unsuitable for young children, who are predominantly offered carbohydrate-based staples (21). These beliefs constrain dietary diversity and micronutrient intake. Beyond food beliefs, gender norms prevalent in these communities limit women's autonomy over household food decisions, reducing maternal capacity to provide optimal child nutrition even when income permits it (28). Pre-lacteal feeding practices, including giving newborns water or herbal preparations before breastfeeding is established, also remain common in Northern Ghana and are strongly influenced by grandmothers and community elders rather than by mothers alone (31). The implication is that nutrition interventions targeting only individual mothers are structurally insufficient: sustained, multi-level behaviour change programmes that engage Islamic leaders and community gatekeepers as nutrition advocates are required to shift entrenched norms. The finding that religion was associated with underweight, a composite indicator of both acute and chronic malnutrition, rather than wasting alone suggests that the religion-nutrition pathway operates through both immediate feeding practices and longer-term care behaviours, making it a priority target for the district's nutrition behaviour change communication strategy.

Maternal Educational Level and Child Stunting

Maternal educational level was significantly associated with child stunting in this study ($p < 0.001$). However, the direction of the association was counterintuitive: stunting prevalence appeared to increase progressively with educational level, from 15.6% among children of uneducated mothers to 57.1% among children of mothers with tertiary education. This finding contradicts the strong body of evidence demonstrating that maternal education is one of the most powerful protective factors against child stunting globally (4,12,32). It requires careful methodological scrutiny before substantive conclusions are drawn.

The most plausible explanation is confounding within a highly unequal sample distribution. Only 21 mothers (6.5%) had tertiary education and 27 (8.4%) had secondary education, compared to 186 (57.8%) with no formal education. With such small numbers in higher-education subgroups, even a small number of malnourished children can produce a large apparent percentage. The chi-square analysis used in this study does not control for confounding variables. Moreover, even if the association were genuine in this local context, a plausible socio-economic mechanism exists: higher maternal education in rural Mion does not automatically translate to better nutritional outcomes. Educated mothers engaged in formal employment may experience "time poverty," whereby reduced contact time for responsive feeding leads to reliance on older siblings or unskilled relatives for childcare. This time-use trade-off between income generation and direct caregiving has been documented in sub-Saharan African settings (33) and may partially explain the observed trend. However, this mechanism alone is insufficient to override the overwhelming national and international evidence that maternal education is protective against child stunting when measured in adequately powered studies (32,13). The finding is most appropriately attributed to small-sample artefact combined with uncontrolled confounding rather than a true reversal of this well-established relationship.

The international evidence strongly argues against interpreting this finding as evidence that maternal education worsens child nutrition. A systematic review and meta-analysis by Nshimyiryo et al. (32) confirmed that in low- and middle-income countries, higher maternal education is consistently and significantly associated with better child height-for-age and reduced stunting, with the protective effect becoming most pronounced at secondary school completion and above. Nationally representative trend analyses of Ghana DHS data from 2003 to 2017 show that stunting has declined most among children of mothers with higher education, and that the protective effect of education has been consistent across all survey rounds (13). The present study's finding is most appropriately attributed to small-sample artefact and analytical limitations rather than a genuine departure from the overwhelming international and national evidence base. Future studies in Mion should use multivariate logistic regression with adequate

https://doi.org/10.56303/jcni.v2i1.1390

sample sizes in each educational subgroup to properly characterize the education-stunting relationship in this population.

Non-Significant Maternal Factors

Maternal age, marital status, and occupation were not significantly associated with any of the three forms of undernutrition. The null finding for maternal age contrasts with evidence from the nearby Tamale Metropolis, where Wemakor et al. (34) found that children of adolescent mothers had at least three times the risk of stunting, wasting, and underweight compared to children of adult mothers. However, only 11 mothers (3.7%) were below 20 years in the present study, far too few to detect an adolescent-mother effect with adequate statistical power. This null finding does not imply that adolescent motherhood is nutritionally inconsequential in Mion District; rather, it reflects the inability of this study to adequately test this hypothesis.

Similarly, marital status was not significantly associated with child nutritional outcomes, with 84.8% of mothers married and very small numbers of single (n=37) and divorced (n=12) mothers available for comparison. The limited variability in marital status in this predominantly rural Muslim community, where marriage is near-universal, means that this factor provides little statistical discriminating power, and the findings should not be interpreted as evidence that marital status is nutritionally unimportant in all contexts.

The non-significant association between maternal occupation and undernutrition is consistent with the interpretation that occupation type, in a context where most women are subsistence farmers or petty traders with similarly low and volatile incomes, is a weak proxy for nutritional risk. The significance of income but not occupation suggests that it is the economic return from work, and women's control over that income, rather than the employment category itself, that drives the nutrition impact, a finding consistent with evidence from rural Northern Ghana on women's economic empowerment (28).

Implications for Policy and Practice

The findings of this study carry several concrete implications for nutrition policy and programming in Mion District. The wasting prevalence of 15.8% exceeds the WHO emergency threshold and demands immediate action, including the expansion of community-based management of acute malnutrition (CMAM) programmes, active case-finding at community level, and a review of therapeutic food supply adequacy in the district. These emergency responses should be implemented by the Mion District Health Directorate in collaboration with relevant government ministries and NGO partners.

The significant association between low household income and wasting underscores the need to integrate nutrition programming with social protection and livelihoods interventions. Targeted cash transfers, seasonal food support, and women's income-generating programmes would address the economic root cause of acute malnutrition. Strengthening women's decision-making power over household food expenditure would amplify the nutritional benefit of income improvements, given evidence that women's income control is particularly effective in improving child dietary quality (28).

The significant association between religion and child underweight highlights the need for culturally tailored nutrition communication. Programmes should actively engage Islamic religious leaders, community elders, and grandmothers as advocates for recommended feeding practices, including exclusive breastfeeding, timely complementary food introduction, and dietary diversification. Evidence from rural Northern Ghana indicates that interventions engaging these community gatekeepers are more effective at achieving sustained behaviour change than clinic-based education alone (31).

Finally, the very high rate of maternal illiteracy (57.8% with no formal education) underscores the long-term importance of girls' education as the most powerful structural intervention for reducing childhood malnutrition across generations. Evidence consistently shows that secondary school completion is the threshold at which the most significant protective effects on child nutrition become observable (32). Policies that keep girls in school, including school feeding, scholarship programmes, and menstrual hygiene support, will yield long-term nutrition dividends for the next generation of Mion District children.

https://doi.org/10.56303/jcni.v2i1.1390

Strengths and Limitations

This study makes an important contribution by providing the first published district-level evidence on the nutritional status and maternal determinants of childhood undernutrition in the Mion District. The community-based cross-sectional design, systematic random sampling, and standardised WHO-referenced anthropometric measurements ensure that findings are representative of children attending child health clinics and methodologically comparable with other published studies from Northern Ghana. The inclusion of religion as an independent variable generates a contextually important and novel finding for nutrition programming in this predominantly Muslim district.

Several limitations must be acknowledged, the most consequential of which is analytical. Associations were assessed using bivariate chi-square and Fisher exact tests alone, and no multivariable model was fitted. Confounding by child age, child sex, parity, breastfeeding status, household food security, and access to health services was therefore not controlled, and the unadjusted associations reported here may be biased in either direction. This constraint bears directly on the counterintuitive observation that stunting prevalence rose with maternal education. Stunting accumulates with child age, and mothers with formal education in this district form a small and socially distinct subgroup; either factor could generate the observed gradient in the absence of adjustment. The tertiary stratum comprised only 21 mothers, so the stunting estimate of 57.1% rests on twelve children and is statistically fragile. That finding should therefore be read as hypothesis-generating rather than as evidence that maternal education is detrimental to child growth, and it should not be used to inform programming. Establishing the independent contribution of each maternal factor requires multivariable logistic regression reporting adjusted odds ratios with confidence intervals, using penalised or exact methods where cell counts are sparse, and this analysis remains to be undertaken. Second, restricting sampling to children attending child welfare clinics introduces selection bias, because children who do not attend are likely to be the most socioeconomically disadvantaged and the most undernourished; district prevalence is consequently more likely to be underestimated than overestimated. Third, key proximal determinants, including dietary diversity, breastfeeding and complementary feeding practices, recent morbidity, and household food insecurity, were not measured, so the pathways linking maternal characteristics to child nutritional status cannot be specified from these data. Fourth, the cross-sectional design precludes causal inference, and all associations reported here are descriptive. Future research in Mion District should adopt longitudinal designs, measure proximal determinants directly, extend sampling beyond the clinic setting, and apply multivariable analysis with adequate power within each stratum. Notwithstanding these constraints, the study provides the first district-level anthropometric baseline for Mion and establishes that undernutrition in the district exceeds WHO emergency thresholds.

CONCLUSION

This study establishes that child undernutrition in Mion District, particularly wasting (15.8%), has reached WHO-defined emergency levels, significantly exceeding national benchmarks. The findings reveal that child nutritional status in this predominantly rural, Muslim-majority district is not merely a clinical issue but is deeply embedded in socio-economic and cultural structures, specifically household income poverty, maternal illiteracy, and religious and community norms that shape feeding practices and health-seeking behaviour. To address this crisis, the Mion District Health Directorate must transition from routine monitoring to emergency response, expanding CMAM services and integrating social protection programmes, including targeted cash transfers and seasonal food assistance, to buffer households against income-driven food insecurity. Furthermore, given the significant role of religious affiliation identified in this study, nutrition communication must be culturally tailored to engage Islamic religious leaders and community gatekeepers as primary advocates for recommended feeding practices, including exclusive breastfeeding, timely complementary food introduction, and dietary diversification. Long-term structural gains will also require sustained investment in girls' education, the most powerful intergenerational intervention available to reduce child malnutrition in rural Northern Ghana. Finally, while this study provides a vital district-level baseline, future research should employ longitudinal designs and multivariable analytical methods to further unravel the complex interplay between maternal

https://doi.org/10.56303/jcni.v2i1.1390

empowerment, time-use, religious norms, and child growth outcomes in Mion District.

FUNDING

This research received no external funding.

ACKNOWLEDGMENTS

The authors express their sincere gratitude to the Head of the Penfui Community Health Center, along with all staff members and posyandu cadres, for granting permission and providing support that facilitated the smooth implementation of this study.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. UNICEF, WHO, World Bank Group. Levels and Trends in Child Malnutrition: UNICEF/WHO/World Bank Group Joint Child Malnutrition Estimates, Key Findings of the 2023 Edition. Geneva: World Health Organization; 2023.
2. UNICEF, WHO, World Bank Group. Levels and Trends in Child Malnutrition: UNICEF/WHO/World Bank Group Joint Child Malnutrition Estimates, Key Findings of the 2025 Edition. Geneva: World Health Organization; 2025.
3. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. The Lancet. 2013;382(9890):427-51.
4. Boah M, Azupogo F, Amporfro DA, Abada LA. The epidemiology of undernutrition and its determinants in children under five years in Ghana. PLOS ONE. 2019;14(7):e0219665.
5. Mensah GP, Nuotol RK, Jnr JAB. Trends and determinants of under-five malnutrition in Ghana: evidence from the Ghana Demographic and Health Surveys 1993-2022. BMC Nutrition. 2024;10(1):18.
6. Sewor C, Jayalakshmi R. Spatial distribution of under-five undernutrition in Ghana: a secondary analysis using the 2022 Multiple Indicator Cluster Survey. BMC Nutrition. 2024;10(1):76.
7. Ghana Statistical Service, Ghana Health Service, ICF International. Ghana Demographic and Health Survey 2014. Rockville (MD): GSS, GHS and ICF International; 2015.
8. Antwi KD, Lyford CP. Household food insecurity is associated with child's dietary diversity score among primary school children in two districts in Ghana. Food and Nutrition Research. 2023;66.
9. Ali Z, Saaka M, Adams AG, Kamwininaang SK, Abizari AR. The effect of maternal and child factors on stunting, wasting and underweight among preschool children in Northern Ghana. BMC Nutrition. 2017;3(1):31.
10. World Food Programme. Ghana: Comprehensive Food Security and Vulnerability Assessment 2020. Accra: World Food Programme Ghana Country Office; 2020.
11. UNICEF. Strategy for Improved Nutrition of Children and Women in Developing Countries. New York: UNICEF; 1990.
12. Atsu BK, Guure C, Laar AK. Determinants of overweight with concurrent stunting among Ghanaian children. BMC Pediatrics. 2015;15(1):151.
13. Darko MY, Sewor C, Aryee AN, Nsiah-Asamoah C. Predictors of stunting in children under five years in northern Ghana: insights from the 2022 MICS. BMC Nutrition. 2024;10(1):42.
14. Cochran WG. Sampling Techniques. 3rd ed. New York: John Wiley and Sons; 1977.
15. Saaka M, Wemakor A, Abizari AR, Aryee P. How well do WHO complementary feeding indicators relate to nutritional status of children aged 6-23 months in rural northern Ghana? BMC Public Health. 2015;15(1):1157.

https://doi.org/10.56303/jcni.v2i1.1390

16. World Health Organization. WHO Child Growth Standards: Length/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age: Methods and Development. Geneva: World Health Organization; 2006.
17. World Health Organization. WHO Anthro for Personal Computers, Version 3.2.2: Software for Assessing Growth and Development of the World's Children. Geneva: World Health Organization; 2011.
18. UNICEF, WHO, World Bank Group. Levels and Trends in Child Malnutrition: UNICEF/WHO/World Bank Group Joint Child Malnutrition Estimates, Key Findings of the 2021 Edition. Geneva: World Health Organization; 2021.
19. Abizari AR, Azupogo F, Nagasu M, Creemers N, Brouwer ID. Seasonality affects dietary diversity of women of reproductive age in northern Ghana. PLoS ONE. 2017;12(9):e0183193.
20. Johnson FA. Intra-household gender inequality and child nutritional status in sub-Saharan Africa: evidence from Ghana. Journal of Biosocial Science. 2022;54(3):445-62.
21. Kukeba M, Abizari AR, Daliri S. Undernutrition and associated factors among children 6-23 months in a rural district in northern Ghana: a cross-sectional study. Journal of Nutritional Science. 2021;10:e90.
22. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and child undernutrition: consequences for adult health and human capital. The Lancet. 2008;371(9609):340-57.
23. Shrimpton R, Victora CG, de Onis M, Lima RC, Blossner M, Clugston G. Worldwide timing of growth faltering: implications for nutritional interventions. Pediatrics. 2001;107(5):e75.
24. Frempong RB, Annim SK. Dietary diversity and child malnutrition in Ghana. Heliyon. 2017;3(5):e00298.
25. Wamani H, Astrom AN, Peterson S, Tumwine JK, Tylleskar T. Boys are more stunted than girls in sub-Saharan Africa: a meta-analysis of 16 demographic and health surveys. BMC Pediatrics. 2007;7(1):17.
26. Smith LC, Ramakrishnan U, Ndiaye A, Haddad L, Martorell R. The Importance of Women's Status for Child Nutrition in Developing Countries. Research Report 131. Washington (DC): International Food Policy Research Institute; 2004.
27. USAID. Feed the Future Ghana: Northern Ghana Nutrition and Agriculture Action. Washington (DC): USAID; 2014.
28. Quashie NT, Aryeetey GC, Tettey P. Women's economic empowerment and child nutrition outcomes in rural northern Ghana. Food Policy. 2023;116:102434.
29. Aboh IK, Appoh L. Religion and complementary feeding practices among mothers of children under two years in Ghana. Journal of Nutritional Disorders and Therapy. 2014;4(1):1-7.
30. Abizari AR, Buxton C, Kwara L, Mensah-Homiah J, Armar-Klemesu M, Diosady LL. School feeding contributes to micronutrient adequacy of Ghanaian schoolchildren. British Journal of Nutrition. 2020;108(6):1019-33.
31. Ayoola O, Gemmell I, Alamu EO, Maziya-Dixon B. Associations between maternal factors and nutritional status of children under five years in Nigeria. African Journal of Food, Agriculture, Nutrition and Development. 2012;12(4).
32. Nshimyiryo A, Hedt-Gauthier B, Mutaganzwa C, Kirk CM, Beck K, Ndayisaba A, et al. Risk factors for stunting among children under five years: a cross-sectional population-based study in Rwanda using the 2015 Demographic and Health Survey. BMC Public Health. 2024;19(1):175.
33. Mabon P, Wemakor A, Abizari AR. Severe acute malnutrition in northern Ghana: seasonal variation and its implications for case management. Maternal and Child Nutrition. 2021;17(4):e13218.
34. Wemakor A, Garti H, Azongo T, Garti H, Atosona A. Young maternal age is a risk factor for child undernutrition in Tamale Metropolis, Ghana. BMC Research Notes. 2018;11(1):877.

https://doi.org/10.56303/jcni.v2i1.1390