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Original Research Article

Associations of Dietary Diversity and Socioeconomic Factors with Anthropometric Failure among Children (6 To 23 Months Old) in Sagnarigu Municipality

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Abstract: ***Background:*** The role of adequate nutrition in population health is widely acknowledged. The objective of the study was to determine associations of dietary diversity and socioeconomic factors with anthropometric failure among children (6 to 23 months old) in Sagnarigu Constituency. ***Methods:*** This was a cross-sectional study, which involved 231 children randomly selected from child welfare clinics within Sagnarigu Municipality. Dietary diversity of children was computed from 8 food groups based on mothers recall of foods child ate in the past 24-hour period (previous day and night) preceding the survey. Child anthropometric data were assessed based on World Health Organization's (WHO) standard protocols. ***Results:*** From a multiple binary logistics regression analysis, children who failed to meet the minimum dietary diversity (MDDS) (1-4 food groups) compared with those who met the MDDS (5-8 food groups) had higher odds for underweight [3.54(1.18-10.60); P = 0.024), stunting [2.97(1.39-6.33); P = 0.005], and a coexistence of multiple growth faltering indicators [2.68(1.38-5.22); P = 0.004]. Also, the odds of stunting in children were higher among those whose mothers lacked formal education compared with those whose mothers had formal education [2.70(1.15-6.32); P = 0.022]. ***Conclusions:*** In the study, low MDDS was a significant predictor of stunting, underweight, and the coexistence of multiple indicators of anthropometric failure. The health management team in the Sagnarigu Constituency has to intensify education on the importance of children meeting the MDDS.

Keywords: Undernutrition, stunting, wasting, underweight, Sagnarigu.

Introduction

Population health is hugely influenced by food and nutrition security. Therefore, nutritional well-being is a fundamental requirement if governments across the world are to achieve global targets in population health [1]. To achieve this, effective nutrition assessment in communities is a valuable tool [1-7]. Children are the future workforce in every nation and their nutritional wellness is instructive for the maintenance of developmental goals [1, 5–7]. Nutritional inadequacies during early years in the child's life are associated with a myriad of developmental problems such as mental retardation, poor academic performance, and low economic productivity later in adulthood [8]. Globally, malnutrition is responsible for about 45% of crude mortality in children under five years old [9].

Recently, global estimates of malnutrition in children revealed that 5.7%, 6.7% and 22.0 % of children under-five years are overweight, wasted and stunted and most of these children live in Africa and Asia [12]. In Ghana, stunting (14.2%), overweight (2.9%), and wasting (6.8%) are hugely prevalent [12], which have consequences for public health [13]. The conventional parameters used in assessing malnutrition (stunting, underweight and wasting) in children as they standalone usually fail to identify multiple indicators of undernutrition [7]. Therefore, the composite index of anthropometric failure (CIAF) was introduced in the early 2000s, which encompasses an estimation of children with multiple indicators of undernutrition and has been shown to be a better predictor of disease risk [7]. Yet, its prevalence and determinants in developing countries including Ghana is scarcely assessed [14]. However, a few studies show a high prevalence of CIAF in India (47.8%) [7, 15], Ethiopia (48.4%) [16], Bangladesh (48.3%) [17], China (21.7%) [14] and Ghana (35.6 %) [7]. Children with CIAF have up to twelve times greater risk of early mortality compared with those with only a single form of malnutrition (stunting, underweight and wasting) [18].

The determinants of child malnutrition are complex and intertwined. However, parental poor socioeconomic status [19–24], being an older child [23] and a male child [25] have been shown to associate with an increased risk of undernutrition in children. Additionally, children who fail to meet the MDDS may suffer nutrient inadequacies [26], growth problems [27], increased risk of both morbidity [28] and mortality [9]. Unfortunately, inappropriate complementary feeding is still widespread in developing countries, including Ghana [29]. Data show that the prevalence of MDDS in Ghana is only 28 %, which is much lower (17.2%) in the Northern Region [30]. Also, in Ethiopia, it was reported that only 23.3% met the MDDS [31]. These inappropriate complementary feeding practices especially low MDDS is a major cause of growth problems in children [32].

Although relationships between dietary diversity intake and anthropometric indicators of nutritional status have been widely studied among children aged 6-23 months, the findings lack consensus. Thus, nutritionist and pediatricians may become confuse regarding nutrition education messages they ought to pass onto mothers and child care givers. For example, numerous studies including those from Ghana found that the risk of undernutrition was negatively associated with dietary diversity [27, 29, 33–39]. In contrast, other studies have reported null associations between dietary diversity and growth failure in children [23, 40, 41]. It is evident from the above that the association between dietary diversity and growth deficits in children has not been clearly established on the basis of the several conflicting results as outlined. Hence, more studies may be required to clarify such relationships. Therefore, study evaluated associations of dietary diversity and socioeconomic factors with CIAF, stunting, and underweight in the Sagnarigu Municipality.

METHODOLOGY

Study design

The study is cross-sectional in design. Child welfare clinics (CWCs) were used as data participant recruitment and data collection sites. In the study, 231 mother-child pairs were randomly selected from these CWC centers. A formal ethical clearance was sought from the Ethical Review Committee of Kwame Nkrumah University of Science and Technology (KNUST). Also, at every CWC, permission was sought from the leadership before participant recruitment. Moreover, all mothers or caregivers were required to consent to the participation of the study based on their own will and on behalf of their children. As part of the inclusion criteria, children were free from major medical complications-based mother's verbal report or health records for the child. On the other hand, mothers who refused to wear nose mask to avoid a possible coronavirus (COVID-19) infection were excluded from the study.

DATA COLLECTION TOOLS

Semi-structured questionnaires

Semi-structured questionnaires were used to collect information on demographic variables of mother-child pairs: age, ethnicity, marital status ethnicity, parity, household size, educational level, occupation, religion, household dietary diversity.

Dietary intake assessment and calculation of infant and young child dietary diversity (MDDS)

By using quantitative 24- hour dietary recalls, detailed data on foods which were either consumed [thus, during the day or night] by the child were collected based on mother's recall.

The foods child ate were grouped into 8 subclasses. The 8 subclasses are: 1. Breast milk, 2. Grains, roots and tubers, 3. Legumes and nuts, 4. Dairy products, 5. Flesh foods, 6. Eggs ,7. Vitamin-A rich fruits and vegetables, and 8. Other fruits and vegetables. The criterion for MDDS was 5 of 8 groups [low means 0-4 food groups, and high means child ate from 5-8 food groups]. This criterion is superior to the previously recommended MDDS calculation which originally has 7 food groups with 0-3 considered low and 4-7 as high [42, 43].

Anthropometric assessment

Weight of children was measured with an electronic (digital reading) scale and recorded to the nearest 0.1 kg (100g). Child's mother was weighed alone then the scale was tarred then the mother and child were weighed together. Both mother and child were on light clothing and without wearing sandals. Recumbent length was assessed in all children and reported to the nearest centimeter (0.1 cm) [44]. The WHO anthro software version 3.2 was used to calculate the z-scores of children based on their age, sex and date of birth. Nutritional status of children was classified as normal or malnourished using WHO 2017 updates for child z-score classification [45]. Thus, for the weight-for-length/height, moderate acute malnutrition was defined as: weight-for-length/height ≤–2 standard deviations (SD) and ≥–3 SD; normal was defined as weight-for-length/height > –2 to ≤ +2; overweight was defined as weight-for-length/height >2 SD and ≤3 SD. For the height-for-age classification, severely stunted (severe chronic malnutrition) was defined as: length/height-for-age <–3 SD; moderately stunted (moderate chronic malnutrition) was defined as: length/height-for-age ≤–2 SD and ≥–3 SD, normal was defined as: height/length-for-age > –2 to < +2 SD. For the weight-for-age classification, severely underweight was defined as: weight-for-age <–3 SD, moderately underweight was defined as: weight-for-age <–2 SD and ≥–3, normal: weight-for-age > –2 to ≤ +2 SD [45]. Also, CIAF was defined based on seven distinct groups of children (Table 1) [7, 18, 46].

Table-1: Groups of anthropometric failure among children

Group	Description	Wasting	Stunting	Underweight
	No failure	No	No	No
	Wasting only	Yes	No	No
	Wasting and underweight	Yes	No	Yes
	Wasting, stunting and underweight	Yes	Yes	Yes
	Stunting and underweight	No	Yes	Yes
	Stunting only	No	Yes	No
	Underweight only	No	No	Yes

** From the table, one other possible theoretical combination is "wasting and stunting" but not underweight. However, this combination is not physically plausible since a child cannot wasted and stunted yet, that child is not underweight [7].*

Study variables

Explanatory variables. The explanatory variables were mother-child pair democratic characteristics: educational level, occupation, monthly income, maternal age, ethnicity marital status, ethnicity, parity, religion, household size, sex and age of child, and child MDDS.

Outcome variables

The outcome variables were child undernutrition indicators [stunting, wasting, and underweight, CIAF], and overweight and/obesity.

Sample size determination

The main objective of the study was to assess the odds of undernutrition indicators among children in relations to whether the child has met the MDDS or not using binary logistic regressions model. In calculating the required sample size, from literature, an advice was offered based on the number of predictors (p). The sample size, N > 50 + 8 * p [47, 48]. In the present study, p = 20 as there are 20 predictors which include complementary feeding parameters and mother-child pair socio-demographic variables. Hence, in replacing p into the formula, it will yield 210 study subjects. Since N must be greater than 210, adding an extra 10% of 210 to the initial calculation (210 subjects) will finally yield a total sample size of 231 which satisfies the equation.

DATA ANALYSIS

WHO anthro software version 3.2 was used to compute child anthropometric z-scores using the 2006 WHO child growth standards as reference population. Also, Statistical Product and Service Solutions (SPSS) version 24.0 software was used for data analysis. First, univariate analyses were conducted for sociodemographic variables of mother-child pairs and, child MDDS, including indices of child anthropometric data. The strength of associations of socio-economic variables and MDDS status (0-4 food groups, and 5-8 food groups) with odds of malnutrition indicators among the children was assessed using binary logistic regressions models. In the unadjusted model, odds of malnutrition indicators were computed across the independent variables (socioeconomic variables and MDDS status). In the full model thus, multiple binary logistics regressions analysis was conducted, in which multiple independent variables (exclusive breastfeeding status; maternal age, maternal education, parity, child's age and sex) were entered into the covariate box and one nutritional status indicator was entered into the dependent variable box. In both the unadjusted and the adjusted models, the reference categories were set to ''first'' using the contrast function. In these two models, the odds ratio (OR) and 95% confidence interval (95%CI) were calculated to determine the strength of association between the independent variables and the outcomes (malnutrition indicators). All statistical tests of associations were considered statistically significant when P-value < 0.05.

RESULTS

Table 2 below is an illustration of the sociodemographic characteristics for mother/care giver and children enrolled in the study. In a whole, the vast majority (86.6%) of the mothers were within 18-34 years of age. Also, a little over 90.0% of the mothers were married. The mothers were predominantly Muslims (83.5%). Also, a little over 40.0% of them either had some form of primary education or no any form of formal education. Regarding ethnicity, the Dagombas were the majority (63.2%). In the study, all the mothers were multiparous, and living in the same household with child's father (91.3%). Closed to 53.0% of the children were 6 to 11 months old. Regarding the sex distribution of the children, the proportion of males was slightly higher (53.2%) than their female counterparts.

Table-2: Sociodemographic characteristics for mother/care giver and children

Variable	Response Categories	Frequency	Percentage (%)
Maternal age	18-24	52	22.5
	25-34	148	64.1
	35-44	31	13.4
Marital status	Married	209	90.5
	Not married	22	9.5
Religion	Christian	35	15.2
	Muslim	193	83.5
	Traditionalist	3	1.3
Maternal education	No formal Educational	48	20.8
	Primary	24	10.4
	Junior High School	33	14.3
	Senior High School	71	30.7
	Tertiary	55	23.8
Maternal occupation status	Salaried worker	123	53.2
	Unemployed	39	16.9
	Farming	2	0.9
	Trader	67	29.0
Ethnicity	Dagomba	146	63.2
	Mamprusi	27	11.7
	Gonja	22	9.5
	Mossi	4	1.7
	Others	32	13.9
Number of births	1 Birth	52	22.5
	2 Births	72	31.2
	3 Births	46	19.9
	4 Births	36	15.6
	Grand multipara	25	10.8
Biological father living in the household	Yes	211	91.3
	No	20	8.7

Ethnic groups classified under others: (Bimoba, Ashanti, Frafra). A grand multipara: woman five or more deliveries who have achieved a gestational age of 24 weeks or more.

Table-2: Continued: Sociodemographic characteristics for mother/care giver and children

Variable	Response Categories	Frequency	%
Sex of household head	Male	219	94.8
	Female	12	5.2
Caretaker of child in the absence of mother	Older Children	19	8.2
	Other Relatives	81	35.0
	Neighbour/Friend	1	0.4
	Maid	2	0.9
	Nursery School	1	0.4
Age of child in months	6-11 months	122	52.8
	12-17 months	83	35.9

Variable	Response Categories	Frequency	%
	18-23 months	26	11.3
Child's sex	Male	123	53.2
	Female	108	46.8
Place of delivery	Health Facility	221	95.7
	Home	10	4.3
Number of antenatal visits	Less than 8 visits	156	67.5
	8 or more visits	75	32.5

In the study, 18.2% of the children were offered drinking water at an age less than 6 months. Further, closed to 68% of the children were fed 3-4 times with liquid, semi-solid or solid foods during the previous day and night before the study. Also, closed to 40.0% of the children met the MDDS of at the least five food groups from eight food groups (Table 3).

Table-3: Table for complementary feeding practices

Variables	Response Categories	Frequency	%
Age at which child was introduced to complementary feeding	Below 6 months	42	18.2
	At 6 months	164	71.0
Child minimum meal frequency per day	1-2	69	29.9
	3-4	156	67.5
	Above 4	5	2.2
	Don't know	1	0.4
Child dietary diversity	Low (1-4 groups)	83	35.9
	High (5-8 groups)	148	64.1

Table 4 below outlines the nutritional status of children according to anthropometric indicators. The prevalence of wasting, stunting, and underweight was 6.5%, 16.5%, and 7.8%, respectively. Surprisingly, the prevalence of overweight was very low (0.4%).

Table-4: Nutritional status of children

College	Response categories	Frequency	%
	Severely wasted [WHZ<– 3 SD	6	2.6
Weight for height (WHZ)	Moderately wasted [WHZ≤–2 SD and ≥–3 SD]	9	3.9
	Normal [WHZ> -2 to ≤ 2	215	93.1
	Overweight [WHZ>2 SD and ≤3 SD	1	0.4
	Severely stunted [HAZ<–3 SD	17	7.4
Height/length-for-age (HAZ)	Moderately stunted [HAZ ≤–2 SD and ≥–3 SD	21	9.1
	Normal [HAZ> -2 to ≤ 2	193	83.5
	Severely Underweight [WAZ< –3 SD	2	0.9
Weight-for-age (WAZ)	Moderately Underweight [WAZ< –2 SD and ≥ –3 SD]	16	6.9
	Normal [WAZ≥ -2 ≤ 2	213	92.2

In the study, the prevalence of children experiencing concurrent indicators of undernutrition revealed that 4.8, 1.7, and 0.9%, of them had stunting and underweight only, wasting and underweight only, and CIAF (stunting, underweight, and wasting combined), respectively (Table 5).

Table-5: Composite index of anthropometric failure (CIAF)

CIAF		Frequency	%
Normal Growth	No growth failure	179	77.5
Proportion with single or multiple forms of malnutrition (n=52)	Stunting alone	25	10.8
	Underweight alone	1	0.4
	Wasting alone	9	3.9
	Sunting and underweight alone	11	4.8
	Wasting and underweight alone	4	1.7
	Stunting, underweight, and wasting	2	0.9

Table 6 below is an illustration of the odds of underweight [using weight-for-age z-score classification] according to child dietary diversity status and sociodemographic variables of mother-child pairs. Without the control for the effects of covariates, unexpectedly the odds of underweight were significantly lower among children classified under a low dietary (1-4) diversity compared with those grouped under a high (5-8) dietary diversity [0.33(0.12 -0.87); P = 0.026]. However, upon adjustment for the effects of covariates (exclusive breastfeeding status; maternal age, parity, maternal education, child's age and sex), the odds of underweight among the children became significantly higher among children classified under the low dietary diversity compared with their colleagues who failed to meet the minimum dietary diversity [3.54(1.18-10.60); P = 0.024].Children of mothers with a parity of 3 or more births were less likely to be underweight compared with their colleagues whose mothers' had only 1-2 birth births [0.31(0.20-0.96); P = 0.042]. However, in the multiple binary logistic regressions model, there was no a significant association between maternal parity the underweight of the children.

Table-6: Odds of underweight [using weight-for-age z-score classification] according to child dietary diversity status and sociodemographic variables of mother-child pairs

	Unadjusted		**Adjusted**	
Variable	OR (CI at 95%)	P-value	OR (CI at 95%)	P-value
Child dietary diversity				
High (5-8) [0] (**ref.**)				
Low (1-4) [1]	0.33(0.12 -0.87)	0.026	3.54(1.18-10.60)	0.024
mother's age				
18-24 months (0) (**Ref.)**				
Below 6 months (1)	0.42(0.15-1.15)	0.091	0.69(0.23-2.09)	0.509
Education of mother				
Formal education (0) (**Ref.)**				
No formal education (1)	1.52(0.51-4.50)	0.449	2.76(0.78-9.81)	0.117
Parity				
1-2 births (0) (**Ref.)**				
3 or more births (1)	0.31(0.20-0.96)	0.042	0.24(0.06-0.91)	0.035
Occupation of mother				
Yes (0) (Ref.)				
No (1)	2.94(1.03- 8.40)	0.045	2.29(0.75-6.97)	0.145
Age of child				
6-12 months (0) (Ref.)				
13 and above (1)	1.47(0.56-3.89)	0.435	2.12(0.70-6.41)	0.181
Child's sex				
Male (0) (Ref.)				
Female (1)	0.54(0.20-1.50)	0.240	0.61(0.21-1.83)	0.380

OR: Odds ratio; CI: Confidence interval at 95%; Ref.: Reference category; Partial model: Includes only one covariate and the dependent variable (low weight-for-age z-score indicator [<-2]: underweight (yes=1; No=0). Full model: includes seven covariates thus, exclusive breastfeeding status; maternal age, parity, maternal education, child's age and sex, and the dependent variable (low weight-for-age z-score indicator [< -2]: underweight (yes=1; No=0); p-value: statistical significance level.

From the Table 7 below, in the unadjusted model, the odds of stunting were significantly higher among children classified under a low MDDS compared with those grouped under a a high MDDS [2.96(1.46-6.06); P = 0.003]. Similarly, upon adjustment for the effects of covariates, the odds of stunting were still significantly higher among children classified under a low MDDS compared with their colleagues who failed to meet the MDDS [2.97(1.39-6.33) 0.005); P = 0.005].

In the unadjusted model, the odds of stunting were higher among children whose mothers had no formal education compared with those whose mothers had formal education [2.73(1.28-5.81); P = 0.009]. Further, in upon the adjustment for the effects of the covariates, the odds of stunting were still higher among those whose mother s had no formal education compared with whose mothers had formal education [2.70(1.15-6.32); P = 0.022].

Table-7: Odds of chronic malnutrition [using height-for-age z-score indicator] according to child dietary diversity status and sociodemographic variables of mother-child pairs.

	Unadjusted		**Adjusted**	
Variable	OR (CI at 95%)	P-value	OR (CI at 95%)	P-value
Child dietary diversity				
High (5-8) [0] (**ref.**)				
Low (1-4) [1]	2.96(1.46-6.06)	0.003	2.97(1.39-6.33)	0.005
mother's age				
18-24 months (0) (**Ref.**)				
Below 6 months (1)	0.78(0.35-1.73)	0.540	0.80(0.33-1.97)	0.628
Education of mother				
Formal education (0) (**Ref.**)				
No formal education (1)	2.73(1.28-5.81)	0.009	2.70(1.15-6.32)	0.022
Parity				
1-2 births (0) (**Ref.**)				
3 or more births (1)	1.19(0.60-2.40)	0.619	0.94(0.40-2.21)	0.883
Occupation of mother				
Yes (0) (Ref.)				
No (1)	1.83(0.78-4.27)	0.163	1.73(0.70-4.23)	0.233
Child's sex				
6-12 months (0) (Ref.)				
13 and above (1)	1.05(0.51-2.16)	0.898	1.32(0.60-2.90)	0.485
Sex of child				
Male (0) (Ref.)				
Female (1)	0.91(0.45-1.83)	0.785	0.93(0.44-1.96)	0.851

OR: Odds ratio; CI: Confidence interval at 95%; Ref.: Reference category; Partial model: Includes only one covariate and the dependent variable (low height-for-age z-score indicator [≤-2]: chronic malnutrition (yes=1; No=0). Full model: includes seven covariates thus, exclusive breastfeeding status; maternal age, parity, maternal education, child's age and sex, and the dependent variable (low height-for-age z-score indicator [≤-2]: chronic malnutrition (yes=1; No=0); p-value: statistical significance level.

Children with a low MDDS compared with those who met the MMDDS were more likely either only one form of undernutrition or multiple indicators of undernutrition [2.63(1.40-4.94); P = 0.003). Similarly, in the adjusted model, the odds of a child having either only one indicator of undernutrition or multiple indicators were higher 2.68(1.38-5.22); P = 0.004) among those who failed to meet the MDDS compared with those who met the MDDS [(Table 8)].

Table-8: Odds of a child with one or more multiple indicators of malnutrition [acute and chronic] according to child dietary diversity status and sociodemographic variables of mother-child pairs

	Unadjusted		**Adjusted**	
Variable	OR (CI at 95%)	P-value	OR (CI at 95%)	P-value
Child dietary diversity				
High (5-8) [0] (**ref.**)				
Low (1-4) [1]	2.63(1.40-4.94)	0.003	2.68(1.38-5.22)	0.004
mother's age				
18-24 months (0) (**Ref.**)				
Below 6 months (1)	0.73(0.36-1.49)	0.388	0.81(0.37-1.79)	0.606
Education of mother				
Formal education (0) (**Ref.**)				
No formal education (1)	1.79(0.88-3.64)	0.106	1.81(0.82-3.98)	0.143
Parity				
1-2 births (0) (**Ref.**)				
3 or more births (1)	0.99(0.53-1.84)	0.978	0.88(0.42-1.85)	0.729
Occupation of mother				
Yes (0) (Ref.)				
No (1)	1.85(0.86-4.00)	0.119	1.70(0.76-3.81)	0.196
Age of child				
6-12 months (0) (Ref.)				
13 and above (1)	1.15(0.61-2.18)	0.666	1.41(0.71-2.80)	0.327
Child's sex				
Male (0) (Ref.)				
Female (1)	0.79(0.43-1.48)	0.466	0.84(0.44-1.63)	0.614

OR: Odds ratio; CI: Confidence interval at 95%; Ref.: Reference category; Partial model: Includes only one covariate and the dependent variable (composite index of anthropometric growth failure (either stunted or underweight or wasted or a combination of different forms of malnutrition): Growth failure present (yes=1; No=0). Full model: includes seven covariates thus, exclusive breastfeeding status; maternal age, parity, maternal education, child's age and sex, and the dependent variable (composite index of anthropometric growth failure (either stunted or underweight or wasted or a combination of different forms of malnutrition): Growth failure present (yes=1; No=0); p-value: statistical significance level.

In the Table 9 below, the results showed that neither MDDS nor exclusive breastfeeding status; maternal age, parity, maternal education, child's age and sex was significantly associated with the odds of underweight in children. However, children who failed to meet the MDDS had higher odds for wasting compared with those who met the MDDS [1.13(0.32-3.26); P = 0.96).

Table-9: Odds of acute malnutrition based on weight-for-height z-score indicator according to child dietary diversity status and sociodemographic variables of mother-child pairs.

	Unadjusted		**Adjusted**	
Variable	OR (CI at 95%)	P-value	OR (CI at 95%)	P-value
Child dietary diversity				
High (5-8) [0] (**ref.**)				
Low (1-4) [1]	0.86(0.29-2.68)	0.828	1.13(0.32-3.26)	0.963
mother's age				
18-24 months (0) (**Ref.)**				
Below 6 months (1)	0.79(0.24-2.58)	0.691	0.98(0.27-3.49)	0.970
Education of mother				
Formal education (0) (**Ref.**)				
No formal education (1)	0.57(0.12-2.61)	0.468	0.66(0.13-3.29)	0.607
Parity				
1-2 births (0) (**Ref.)**				
3 or more births (1)	0.56(0.19-1.69)	0.303	0.61(0.17-3.29)	0.430
Occupation of mother				
Yes (0) (Ref.)				
No (1)	1.34(0.36-4.99)	0.665	1.25(0.33-4.80)	0.747
Age of child				
6-12 months (0) (Ref.)				
13 and above (1)	1.61(0.56-4.62)	0.374	1.76(0.58-5.31)	0.315
Child's sex				
Male (0) (Ref.)				
Female (1)	0.99(0.35-2.84)	0.994	1.12(0.38-3.32)	0.834

OR: Odds ratio; CI: Confidence interval at 95%; Ref.: Reference category; Partial model: Includes only one covariate and the dependent variable (Weight-for-height z-score indicator [≤2]: acute malnutrition (yes=1; No=0). Full model: includes seven covariates thus, exclusive breastfeeding status; maternal age, parity, maternal education, child's age and sex, and the dependent variable (Weight-for-height z-score indicator [≤2]: acute malnutrition (yes=1; No=0); p-value: statistical significance level.

DISCUSSION

Poor nutritional status is widely recognised as an important risk for both morbidity and deaths along with a poor mental development in children [49]. In this present study, the prevalence of wasting, stunting, and underweight was 6.5%, 16.5%, and 7.8%, respectively. Surprisingly, the prevalence of overweight was very low (0.4%). However, stunting and wasting compare fairly well with previous results. For example, in the year 2020, results from global reports show that the prevalence of wasting and stunting were 6.7 and 22.0 %, respectively among children under-five years old. Also, in Ghana, 14.2 % and 6.8 % of children under five years were found to be stunted and wasted, respectively. Further, the prevalence of overweight was found to be 2.9 % [12]. The differences observed in these reports and the present study may be due to variations in the study designs and characteristics of children included in the studies. For instance, in the present study, only children within 6-23 months were recruited whereas, in the previous study, it included 6-59 years old children. Moreover, the present sample size was too small compared with the previous study [12].

For the prevalence of CIAF, 4.8%, 1.7%, and 0.9% of the children were stunting and underweight only, wasting and underweight only, and stunting, underweight, and wasting all combined, respectively. These values as outlined in the above are far lower than what have found in other studies. For instance, the prevalence of CIAF was found to be 47.8% in India [7, 15]; 48.4% in Ethiopia [16], 48.3% in Bangladesh [17], 21.7% in China [14] and 35.6 % in Ghana [7]. The consequences of a child experiencing CIAF are enormous; hence every government ought to implement effective nutrition and health programmes to minimize the emergence of CIAF in children. For example, children with CIAF have up to twelve times greater risk of early mortality compared with those with only a single form of malnutrition [18]. The results show that closed to 40.0% of the children met the MDDS of at least five food groups from eight food groups. In Ghana for example, according to national reports, only 28 % of children are fed the received the MDDS, with a much more lower prevalence (17.2%) in Northern Region [30], and only 23.3% in Ethiopia [31].

Further, upon the adjustment for the effects of the covariates (exclusive breastfeeding status; maternal age, parity, maternal education, child's age and sex), the odds of stunting were higher among children whose mothers had no formal education compared with those whose mothers had formal education. Socioeconomic status of a household is an embodiment of a host of factors and its proximate assessment ranges from educational status, occupational status and list of household asset enumeration. The present corroborate earlier findings that a poor socioeconomic status and a lack of formal education among mothers are linked malnutrition in their children [17, 19–24, 50–55]. However, in the present study, age and sex of child were not associated with undernutrition indicators. In contrast, previous observational studies found that older children [23], and being a male child [25] were significantly associated with an increased risk of undernutrition.

Upon adjustment for the effects of the covariates, the odds of stunting and underweight were significantly higher among children classified under the low MDDS compared with their colleagues who failed to meet the MDDS. However, our findings did not support a significant association between MDDS and odds of wasting. These relationships corroborate results from previous studies. For example, In Ethiopia, findings from a previous cross-sectional study showed a low dietary diversity was significantly associated with stunting but not wasting [37]. Also, in another cross-sectional study, a low dietary diversity was associated with stunting and underweight but not wasting [33]. The present study revealed that children with a low MDDS compared with those who met the MDDS were more likely to experience multiple indicators of undernutrition. In similar fashion, results from a previous cross-sectional study showed that low MDDS was associated with CIAF [56].

CONCLUSIONS

The prevalence of wasting, stunting, and underweight was 6.5%, 16.5%, and 7.8%, respectively. In the study, 64.1% of the children met the minimum dietary diversity of at least five (5) food groups out eight (8). Further, a low MDDS was a significant predictor of stunting, underweight, and the coexistence of multiple indicators of anthropometric failure. The health management team in the Sagnarigu Constituency has to intensify education on the importance of children meeting the MDDS.

LIMITATION AND STRENGTHS

The study has both strengths and some weaknesses. The findings of the study may be useful to nutrition and health policy makers in the Sagnarigu Constituency. However, the study was not without limitations especially, this is a cross-sectional study with its inherent weaknesses. It will not claim a causal relation between socio-economic factors or MDDS and odds of malnutrition in children. Therefore, conclusions that would be drawn from this study would be restricted to observed associations. Also, a 24-hour recall approach was used in collecting the dietary data. With this approach, mothers or caregivers may not be able to report accurately all foods fed to the child due to cognitive challenges such as lack of knowledge, forgetfulness and interview situations which may cause underreporting of dietary intakes [57–59]. However, the recommended multiple pass system was followed to enhance quality of dietary data reported by mothers [57, 60–62]. Also, to minimize the extent of underreporting, highly trained interviewers would be used.

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REFERENCES

1. Munoz, N., & Bernstein, M. (2018). *Nutrition Assessment: Clinical and Research Applications: Clinical and Research Applications*. Jones & Bartlett Learning.
2. Hughes, R. (2008). Workforce development: challenges for practice, professionalization and progress. *Public health nutrition*, *11*(8), 765-767.
3. Hughes, R. (2003). Definitions for public health nutrition: a developing consensus. *Public Health Nutr, 6;* 615–20.

doi:10.1079/PHN2003487.
4. Prescott, S. L. (2016). Early Nutrition as a Major Determinant of 'Immune Health': Implications for Allergy, Obesity and Other Noncommunicable Diseases. *Preventive Aspects of Early Nutrition*, *85*, 1-17.
5. Nandy, S., Irving, M., Gordon, D., Subramanian, S. V., & Smith, G. D. (2005). Poverty, child undernutrition and morbidity: new evidence from India. *Bulletin of the World Health Organization*, *83*, 210-216.
6. Nandy, S., Irving, M., Gordon, D., Subramanian, S. V., & Smith, G. D. (2005). Poverty, child undernutrition and morbidity: new evidence from India. *Bulletin of the World Health Organization*, *83*, 210-216.
7. Nandy, S., & Svedberg, P. (2012). The Composite Index of Anthropometric Failure (CIAF): An alternative indicator for malnutrition in young children. In *Handbook of anthropometry* (pp. 127-137). Springer, New York, NY.
8. Katona, P., & Katona-Apte, J. (2008). The interaction between nutrition and infection. *Clinical Infectious Diseases*, *46*(10), 1582-1588.
9. Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., De Onis, M., ... & Maternal and Child Nutrition Study Group. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *The lancet*, *382*(9890), 427-451.
10. SUN. (2015). Nutrition and the Sustainable Development Goals. Scaling Up Nutrition. https://scalingupnutrition.org/nutrition/nutrition-and-the-sustain able-development-goals/.
11. Ruel, M.T., Alderman, H. (2013). Nutrition-sensitive interventions and programmes: How can they help to accelerate progress in improving maternal and child nutrition? The Lancet.
12. UNICEF / WHO / World Bank. (2021). Levels and trends in child malnutrition. UNICEF /WHO / World Bank Group Joint Child Malnutrition Estimates. Key findings of the edition. 2021.
13. De Onis, M., Borghi, E., Arimond, M., Webb, P., Croft, T., Saha, K., ... & Flores-Ayala, R. (2019). Prevalence thresholds for wasting, overweight and stunting in children under 5 years. *Public health nutrition*, *22*(1), 175-179.
14. Pei, L., Ren, L., & Yan, H. (2014). A survey of undernutrition in children under three years of age in rural Western China. *BMC public health*, *14*(1), 1-10.
15. Savanur, M. S., & Ghugre, P. S. (2015). Magnitude of undernutrition in children aged 2 to 4 years using CIAF and conventional indices in the slums of Mumbai city. *Journal of Health, Population and Nutrition*, *33*(1), 1-7.
16. Endris, N., Asefa, H., & Dube, L. (2017). Prevalence of malnutrition and associated factors among children in rural Ethiopia. *BioMed research international*, *2017*.
17. Islam, M. S., & Biswas, T. (2020). Prevalence and correlates of the composite index of anthropometric failure among children under 5 years old in Bangladesh. *Maternal & child nutrition*, *16*(2), e12930.
18. Svedberg, P. (2000). Poverty and Undernutrition. Oxford University Press. doi:10.1093/0198292686.001.0001.
19. Svedberg, P. (2007). Can indicators of child malnutrition be improved–and for what purposes. *Taking action for the world's poor and hungry people. Beijing, China*.
20. Galgamuwa, L. S., Iddawela, D., Dharmaratne, S. D., & Galgamuwa, G. L. S. (2017). Nutritional status and correlated socio-economic factors among preschool and school children in plantation communities, Sri Lanka. *BMC public health*, *17*(1), 1-11.
21. Owoaje, E., Onifade, O., & Desmennu, A. (2014). Family and socioeconomic risk factors for undernutrition among children aged 6 to 23 Months in Ibadan, Nigeria. *The Pan African medical journal*, *17*.
22. Jude, C. K., Chukwunedum, A. U., & Egbuna, K. O. (2019). Under-five malnutrition in a South-Eastern Nigeria metropolitan city. *African health sciences*, *19*(4), 3078-3084.
23. Khamis, A. G., Mwanri, A. W., Kreppel, K., & Kwesigabo, G. (2020). The burden and correlates of childhood undernutrition in Tanzania according to composite index of anthropometric failure. *BMC Nutrition*, *6*(1), 1-13.
24. Wemakor, A., & Laari, J. (2018). Association between household dietary diversity and nutritional status of children (6–36 months) in Wenchi Municipality, Brong Ahafo Region, Ghana. *Nutrire*, *43*(1), 1-10.
25. Wamani, H., Åstrøm, A. N., Peterson, S., Tumwine, J. K., & Tylleskär, T. (2007). Boys are more stunted than girls in sub-Saharan Africa: a meta-analysis of 16 demographic and health surveys. *BMC pediatrics*, *7*(1), 1-10.
26. Moursi, M. M., Arimond, M., Dewey, K. G., Treche, S., Ruel, M. T., & Delpeuch, F. (2008). Dietary diversity is a good predictor of the micronutrient density of the diet of 6-to 23-month-old children in Madagascar. *The Journal of nutrition*, *138*(12), 2448-2453.
27. Arimond, M., & Ruel, M. T. (2004). Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. *The Journal of nutrition*, *134*(10), 2579-2585.
28. Caulfield, L. E., de Onis, M., Blössner, M., & Black, R. E. (2004). Undernutrition as an underlying cause of child deaths associated with diarrhea, pneumonia, malaria, and measles. *The American journal of clinical nutrition*, *80*(1), 193-198.
29. Suara, S. B., & Aryee, P. A. (2018). Growth faltering and inadequate dietary intake among children (6-23 months old) in sissala east district, ghana. *UDS International Journal of Development*, *5*(1), 75-87.
30. GSS, G. (2014). ICF International. *Ghana demographic and health survey*, *2015*.
31. Temesgen, H., Negesse, A., Woyraw, W., & Mekonnen, N. (2018). Dietary diversity feeding practice and its associated factors among children age 6–23 months in Ethiopia from 2011 up to 2018: a systematic review and meta-analysis. *Italian journal of pediatrics*, *44*(1), 1-10.

32. Unicef. (2013). Improving child nutrition: the achievable imperative for global progress. *New York: UNICEF*, 1-14.
33. Darapheak, C., Takano, T., Kizuki, M., Nakamura, K., & Seino, K. (2013). Consumption of animal source foods and dietary diversity reduce stunting in children in Cambodia. *International archives of medicine*, *6*(1), 1-11.
34. Sawadogo, P. S., Martin-Prevel, Y., Savy, M., Kameli, Y., Traissac, P., Traoré, A. S., & Delpeuch, F. (2006). An infant and child feeding index is associated with the nutritional status of 6-to 23-month-old children in rural Burkina Faso. *The Journal of nutrition*, *136*(3), 656-663.
35. Rah, J. H., Akhter, N., Semba, R. D., De Pee, S., Bloem, M. W., Campbell, A. A., ... & Kraemer, K. (2010). Low dietary diversity is a predictor of child stunting in rural Bangladesh. *European journal of clinical nutrition*, *64*(12), 1393-1398.
36. Ahmad, I., Khalique, N., & Khalil, S. (2018). Dietary diversity and stunting among infants and young children: a cross-sectional study in Aligarh. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine*, *43*(1), 34.
37. Motbainor, A., Worku, A., & Kumie, A. (2015). Stunting is associated with food diversity while wasting with food insecurity among underfive children in East and West Gojjam Zones of Amhara Region, Ethiopia. *PloS one*, *10*(8), e0133542.
38. Amugsi, D. A., Mittelmark, M. B., & Lartey, A. (2014). Dietary diversity is a predictor of acute malnutrition in rural but not in urban settings: evidence from Ghana. *Child Care Practices, Resources for Care, and Nutritional Outcomes in Ghana: Findings from Demographic and Health Surveys*.
39. Frempong, R. B., & Annim, S. K. (2017). Dietary diversity and child malnutrition in Ghana. *Heliyon*, *3*(5), e00298.
40. Khamis, A. G., Mwanri, A. W., Ntwenya, J. E., & Kreppel, K. (2019). The influence of dietary diversity on the nutritional status of children between 6 and 23 months of age in Tanzania. *BMC pediatrics*, *19*(1), 1-9.
41. Sié, A., Tapsoba, C., Dah, C., Ouermi, L., Zabre, P., Bärnighausen, T., ... & Oldenburg, C. E. (2018). Dietary diversity and nutritional status among children in rural Burkina Faso. *International health*, *10*(3), 157-162.
42. WHO. (2008). Indicators for assessing infant and young child feeding practices: Part 1 Definitions. Conclusions of a consensus meeting held 6–8 November 2007 in Washington D.C., USA. Geneva: World Health Organization. Washington D.C.
43. Organization, W.H. (2017). Global Nutrition Monitoring Framework: operational guidance for tracking progress in meeting targets for 2025. Geneva: World Health Organization; 2017. Licence: CC BY-NC-SA 3.0 IGO. 2017.
44. WHO. (2008). Training Course on Child Growth Assessment. WHO Child Growth Standards. Geneva; 2008. https://www.who.int/childgrowth/training/module_b_measuring_growth.pdf.
45. World Health Organization. (2017). Guideline: assessing and managing children at primary health-care facilities to prevent overweight and obesity in the context of the double burden of malnutrition.
46. Nandy, S., & Miranda, J. J. (2008). Overlooking undernutrition? Using a composite index of anthropometric failure to assess how underweight misses and misleads the assessment of undernutrition in young children. *Social science & medicine*, *66*(9), 1963-1966.
47. Green, S. B. (1991). How many subjects does it take to do a regression analysis. *Multivariate behavioral research*, *26*(3), 499-510.
48. Jenkins, D. G., & Quintana-Ascencio, P. F. (2020). A solution to minimum sample size for regressions. *PloS one*, *15*(2), e0229345.
49. Boah, M., Azupogo, F., Amporfro, D. A., & Abada, L. A. (2019). The epidemiology of undernutrition and its determinants in children under five years in Ghana. *Plos one*, *14*(7), e0219665.
50. Washington, D.C.: FHI 360/FANTA. (2006).
51. Suara, S. B., Siassi, F., Saaka, M., Foroshani, A. R., & Sotoudeh, G. (2019). Association between Carbohydrate Quality Index and general and abdominal obesity in women: a cross-sectional study from Ghana. *BMJ open*, *9*(12), e033038.
52. Suara, S. B., Siassi, F., Saaka, M., Foroshani, A. R., Asadi, S., & Sotoudeh, G. (2020). Dietary fat quantity and quality in relation to general and abdominal obesity in women: a cross-sectional study from Ghana. *Lipids in health and disease*, *19*(1), 1-13.
53. Asif, M. A., Akbar, M., Noor, F., Sherwani, R. A. K., & Farooq, M. (2019). The Interrelationships of Child Under-Nutrition, Ecological and Maternal Factors: A Case Study of Pakistan by using Composite Index of Anthropometric Failure. *Applied Ecology and Environmental Research*, *17*(6), 13035-13055.
54. Ali, M. K., Bhaskarapillai, B., Shivashankar, R., Mohan, D., Fatmi, Z. A., Pradeepa, R., & CARRS investigators. (2016). Socioeconomic status and cardiovascular risk in urban South Asia: The CARRS Study. *European journal of preventive cardiology*, *23*(4), 408-419.
55. Mutisya, M., Kandala, N. B., Ngware, M. W., & Kabiru, C. W. (2015). Household food (in) security and nutritional status of urban poor children aged 6 to 23 months in Kenya. *BMC public health*, *15*(1), 1-10.
56. Femelia, W., Rusti, S., & Abidin, Z. (2019). Diversity in Main Dishes Prevents Children From Composite Index Of Anthropometric Failure (CIAF). *J Human Care*, *3*, 19-25.
57. Briefel, R. R., Sempos, C. T., Mcdowell, M. A., Chien, S., & Alaimo, K. (1997). Dietary methods research in the third National Health and Nutrition Examination Survey: underreporting of energy intake. *The American journal of*

clinical nutrition, *65*(4), 1203S-1209S.
58. Bathalon, G. P., Tucker, K. L., Hays, N. P., Vinken, A. G., Greenberg, A. S., McCrory, M. A., & Roberts, S. B. (2000). Psychological measures of eating behavior and the accuracy of 3 common dietary assessment methods in healthy postmenopausal women. *The American journal of clinical nutrition*, *71*(3), 739-745.
59. Johansson, G., Wikman, Å., Åhrén, A. M., Hallmans, G., & Johansson, I. (2001). Underreporting of energy intake in repeated 24-hour recalls related to gender, age, weight status, day of interview, educational level, reported food intake, smoking habits and area of living. *Public health nutrition*, *4*(4), 919-927.
60. Slimani, N., Deharveng, G., Charrondière, R.U., Van Kappel, A.L., Ocké, M.C., Welch A. (1999). Structure of the standardized computerized 24-h diet recall interview used as reference method in the 22 centers participating in the EPIC project. Comput Methods Programs Biomed.
61. Conway, J.M., Ingwersen, L.A., Vinyard, B.T., Moshfegh, A.J. (2003). Effectiveness of the US Department of Agriculture 5-step multiple-pass method in assessing food intake in obese and nonobese women. *Am J Clin Nutr*.
62. Conway, J.M., Ingwersen, L.A., Moshfegh, A.J. (2004). Accuracy of dietary recall using the USDA five-step multiple-pass method in men: An observational validation study. J Am Diet Assoc.

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