ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 7
September 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2022; 22(7): 20829-20848 https://doi.org/10.18697/ajfand.112.22135

THE ASSOCIATION BETWEEN DIETARY DIVERSITY AND ANTHROPOMETRIC INDICES OF CHILDREN AGED 24-59 MONTHS: A CROSS-SECTIONAL STUDY IN NORTHERN GHANA

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Volume 22 No. 7
September 2022
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ABSTRACT

The quality of diet has been shown to influence the nutritional status of children and women in some developing contexts. However, studies on the association between diet quality and the nutritional status of children aged 24-59 months are scanty in sub-Saharan Africa. More so, the conclusions from the few studies that are available are inconsistent. The objective of this study was to determine the association between the dietary diversity score (DDS) and the nutritional status of children aged 24-59 months in the Tolon District of Ghana. The study population included 200 child-mother pairs, randomly selected from 2 large rural communities in the Tolon district of Ghana. A single qualitative 24-hour recall (24HR) and semi-structured questionnaires were used to collect children's data through face-to-face interviews with their mothers/caregivers. Anthropometry measures were used to define wasting (WHZ < -2SD), underweight (WAZ < -2SD) and stunting (HAZ < -2SD). A summated DDS was based on the Food and Agriculture Organization's 13 food groupings. Multiple linear regression models, adjusting for potential confounding variables (including the child's age, sex, birth order, sickness, mother's age, literacy and occupation, paternal age, occupation and household size, wealth and food security) were fitted to analyse the association between DDS and nutritional status (WHZ, WAZ and HAZ). The prevalence rates of stunting, underweight and wasting among the sampled children were 58.3%, 20.3% and 4.2%, respectively. The mean DDS was 6.3 ± 1.2 out of a possible maximum score of 13, with the dietary pattern mostly plant foods with little consumption of animal source foods. There was a significant positive association between DDS and WHZ (β=0.16, *P*=0.03) and adjusting for potential confounding variables did not change the observed association. The association between DDS and WAZ was significantly positive only after adjusting for confounding variables (β=0.17, *P*=0.01). Although positive, the association between DDS and HAZ was not statistically significant in both crude (β=0.03, *P*=0.73) and adjusted (β=0.10, *P*=0.29) models. The high prevalence of stunting and underweight among the children requires urgent attention from the ministry of health and its development stakeholders. The findings of the present study suggest improvement in dietary diversity may be an effective approach to improving wasting and underweight during the life phase when young children are completely reliant on family meals. Sensitization programmes on dietary diversification need to be strengthened in child-welfare clinics. Intervention programmes such as backyard gardening, small ruminant rearing and income-generation activities may improve access to a diverse diet.

Keywords: Dietary diversity, wasting, stunting, underweight, weight-for-height, weight-for-age, height-for-age

https://doi.org/10.18697/ajfand.112.22135

INTRODUCTION

Globally, about one-fifth of children under five suffer from stunting with about 7% wasted [1]. According to Black *et al.* [2], stunting, wasting and deficiencies of vitamin A and zinc, among others, cause 45% of child deaths which result in 3·1 million deaths annually; similarly, about 45% of under-five mortality in Ghana is attributable to malnutrition [3]. The 2014 Ghana Demographic and Health Survey (GDHS) indicates that 19% of children younger than five years are stunted, 5% wasted and 11% are underweight [4]. According to the GDHS, the Northern region compared to other regions in Ghana is worse off in malnutrition with the prevalence of stunting (33%) being the highest in Ghana; the 2017 Ghana micronutrient survey report also affirms this [5]. Stunting rates reported in the 2014 GDHS are also highest among children after the age of 24 months as children are fully integrated into family meals after 24 months; this makes the quality of diet after this age critical in determining their nutritional status. One study in India found a positive correlation between the diet of children aged 24-59 months and that of the mothers' diet, besides household dietary diversity [6].

A key determinant of the nutritional status of infants and young children is the quality of their diet [2]. Dietary diversity has widely been identified as a critical element of high-quality diets and a proxy indicator of micronutrient adequacy [7]. A dietary diversity score (DDS) is usually assessed as the number of food groups consumed over a reference period, commonly 1 day [7, 8]. There is substantial evidence from both developed [9, 10] and developing countries [11, 12] that dietary diversity is strongly associated with nutrient adequacy and is thus an essential element of diet quality.

In a Demographic and Health survey data analysis of children younger than 24 months, Arimond and Ruel [13] found a significant positive association between DDS and stunting in 10 out of 11 countries analysed. In Mali, children younger than 5 years with a low DDS were about twice more likely to be stunted and underweight compared to those with a high DDS but the association remained statistically significant for only children from urban areas but not rural areas in a stratified analysis [14]. In their study among children aged 24-59 months, Ekesa *et al.* [15] found a significant positive association between DDS and stunting as well as being underweight in Burundi but not in the Democratic Republic of Congo. However, a recent study from India among children aged 24-59 months found no association between DDS and the nutritional status of the children [6]. The above suggests inconsistency in the association between DDS and the nutritional status of children in some settings.

Although two previous studies from Ghana [16, 17] illustrate that DDS is significantly associated with child nutritional status, neither of these studies considered the life stage of children when they are completely dependent on family meals. The study of Frempong *et al.* [16] though nationally representative included children aged 0-59 months without stratified results by age group and the study of Nti [17] was limited to children under 24 months years of age in the Eastern Region of Ghana. Considering this data gap, the present study aims to examine the association between dietary diversity and nutritional status, during the life stage when pre-school children are fully dependent on family meals. It was hypothesized that children aged 24-59 months with a higher dietary diversity score would have higher nutritional status indices and consequently lower malnutrition rates.

MATERIALS AND METHODS

Study design: An analytical cross-sectional study design was used. In brief, anthropometry was conducted and dietary intake using a qualitative 24-hour dietary recall (24HR), and socio-economic and demographic data were collected through face-to-face interviews between April and May 2016. The data collection period coincided with the lean season, during which time food insecurity is prevalent.

Study Area: The study was carried out in the Tolon District in the Northern Region of Ghana. The district has a single rainy and dry season from April to October and November to March, respectively. Almost ninety per cent (88.4%) of the population is rural and crop farming (97.5%) is the primary economic activity [18]. Crops commonly cultivated in the district include maize, yam, groundnut and rice and about 74.1% of the residents engage in livestock and poultry rearing [18]. The main food sources of vitamin A and iron in the district are green leafy vegetables such as amaranth (*Amaranthus spp*.), okra leaves and fruit (*Abelmoschus esculentus*), jute mallow (*Corchorus olitorius*) and kenaf/roselle (*Hibiscus sabdariffa*). Although seasonal, mangoes are also a good dietary source of vitamin A and iron in the district.

Study population, sample size and sampling: The study included 200 children from the ages of 24-59 months with their mothers. A child-mother/caregiver pair was randomly sampled through a modified random transect walk from two large communities (Nyankpala and Woribogu), conveniently selected from the Tolon District due to their proximity to the Nyankpala Campus of the University for Development Studies. Eligibility included age 24-59 months and the willingness of the mother/caregiver to participate. The required sample size was estimated using Cochran's single random sample formula; a minimum sample of 185 children was estimated based on the ability to determine with a margin of error of 5% at 95% confidence interval and an average underweight prevalence of 14% among 24-59 months children [19]. Considering a non-response rate between 5-10%, the overall sample was rounded up to 200 children. However, the population for analysis included 192 children as 8 children with extreme z-scores were flagged out. The flagged z-scores were probably due to measurement errors; the exact date of birth of children whose z-scores were flagged was unknown and including them would bias the association being measured. The study still had enough power even after excluding children whose z-scores were flagged.

The child-mother/caregiver pairs were randomly sampled from the two communities proportional to the number of households in the community. The modified random walk started with the listing of vital landmarks such as schools, churches, mosques, public toilets and clinic/Community-Based Health Planning Services (CHPS) compounds in each of the communities. Subsequently, one of the landmarks was randomly selected (DA primary school for Nyankpala and a public toilet for Woribogu)

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ISSN 1684 5374

and the house closest to the landmark was chosen as the first house from which subjects were selected. From there, the selection continued in a clockwise direction till the required sample size for the community was obtained. Upon entering a house, if there was no eligible child, the next house was visited. In a home with several households with eligible children, one child aged 24–59 months from each of the different households was eligible to participate. Where a household had more than one eligible child, only one was randomly selected using a lottery. A household in this context referred to a group of persons who cook and eat from the same pot and do not merely stay under the same roof.

The rationale of the study was explained to the mother/caregiver of the child and thumb-printed informed consent was obtained before the survey. Before the field survey, permission was obtained from the chiefs and opinion leaders of each community. Participation in the survey was entirely voluntary and mothers/caregivers had the option of declining to answer specific questions or to decline participation if they did not wish to participate; however, none opted out of the interviews. All data were kept confidential and data protection was observed at all stages of the study.

Dietary diversity score: Dietary intake of the children was assessed with a single qualitative 24HR. As children younger than five years have a low cognitive ability to self-report food intake [20], mothers and caregivers were respondents for the children. Mothers and caregivers are often involved in the household meal preparation and child care; hence, they are in a better position to remember foods eaten by the child. The mother or caregiver who fed the child the preceding day was interviewed at home. They were asked to mention all foods and beverages the child had eaten the preceding 24-hours (from wake-up to wake-up) to the survey from home and outside of the home. The mother/caregiver was next probed for likely forgotten foods and then asked to give a detailed description of foods and beverages consumed, including ingredients for mixed dishes. The 24HR was used to complete the Food and Agriculture Organization's dietary diversity questionnaire consisting of 13 food groups [8] for each child. A score of 1 (one) was assigned when a child consumed at least one food item from a particular food group; in contrast, 0 was assigned when no food item from the food group was consumed. The individual dietary diversity score was then determined by summing the scores of all the food groups consumed by the child; the scores ranged from a minimum of 0 to a maximum of 13. Since the recall was qualitative, the scoring did not consider a minimum intake (in grams) for the food groups. The WHO 7 food group classification for minimum dietary diversity was not used because the indicator was validated for children 6-23 months [21] and does not apply to the study population in this study which consisted of 24-59 months old children.

Anthropometric measurements: Height and weight were taken following standard procedures [22]. The exact birth date of the child was recorded from a verifiable record (birth certificates, child health records, health insurance and baptismal cards). In instances where there was no verifiable source of the child's exact birth date (n=36), annual events were used to estimate the age of the child. The weight of the children was determined using a Seca electronic weighing scale (UNIscale; Seca) to the nearest 0.1kg while standing height was determined using a locally made measuring board with

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accurate markings to the nearest 0.1cm; the measuring board conforms with the UNICEF/WHO standards and was obtained from the district health directorate. The average of duplicate measures was used to compute z-scores: height-for-age z-scores (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ) for each child using WHO anthro 3.2.2. Stunting, wasting and underweight were defined as HAZ, WHZ and WAZ < -2SD, respectively with reference to the WHO 2006 Child Growth Reference Population [23].

Household food security status: The Household Hunger Scale (HHS) developed by FANTA [24] was used to assess the level of household food security. The scale consisted of three sets of questions with frequency responses coded 0, 1 or 2 corresponding to hunger frequencies of "never," "rarely or sometimes" and "often" respectively. The responses were re-coded to get a total score of 6. The scores were put into categorical variables of little to no hunger (HHS ≤1), moderate hunger (HHS=2 or3) and severe hunger (HHS ≥4) [24].

Covariates: A pre-tested semi-structured questionnaire was used to collect data on the demographic and socio-economic characteristics of the study population and their households. The questionnaire included child sickness (fever, diarrhoea and respiratory tract infection) in the past week preceding the survey, age of mother and father, parental education and occupation as well as the household size. Terciles of a household asset index was created through principal component analysis (PCA) using household durable assets similar to Filmer and Pritchett [25]. The household durable assets included a radio set, bicycle, television, box iron, electric iron, sewing machine, mattress, refrigerator, mobile phone, gas stove, motorcycle, computer (desktop or laptop), generator, jewellery/ornaments, car and truck/tractor. The index reflects household wealth concerning the ownership of durables. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy verified the use of PCA for the analysis; KMO=0.75 (good according to Field [26]) and all KMO values for individual variables were > 0.5, which is the acceptable limit [26].

Statistical analysis: Categorical population characteristics were presented as frequencies and percentages while the continuous data were presented as means and standard deviations. The association between DDS (continuous independent variable) and nutritional status (HAZ, WHZ and WAZ) was assessed with hierarchical multiple linear regression models using the GLM PROCEDURE in SAS. The effect measured was the regression coefficient. Potential confounders were *a priori* selected based on literature and included the child's sex and age, birth order of the child, feeding frequency, child illness, age of mother and father, parental education and occupation, household size, food security and income status of household [19, 27, 28]. Three (3) multivariate models were created where model 1 adjusted for child-level characteristics (age, sex, birth order, frequency of feeding per day and illness); model 2 adjusted for maternal factors (age, educational and occupational status); whilst model 3 finally adjusted for paternal and household factors (paternal age and occupation, household size, wealth index and food security). Further model diagnostics for the GLM PROCEDURE were conducted with the PROC REG PROCEDURE in SAS in which the variance inflation factors (VIF) were all < 2, well below the suggested cut-offs

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above which collinearity may be considered a problem [26]. The statistical models were checked for effect modification by sex, age and household food security, but none was statistically significant and were thus excluded from the final analysis. In the analysis, maternal educational status was re-categorized as literate and non-literate due to low frequencies in the educational status categories; likewise, the mother's age was analysed as < 25 years and ≥25 years based on its distribution. Household size was categorized as low (≤10), average (> 10 but ≤14) and high (> 14). All statistical analyses were done with SAS 9.4 (SAS Institute Inc., Cary NC.) and a two-tailed *P*-value ≤ 0.05 at 95% confidence interval was considered statistically significant.

RESULTS AND DISCUSSION

Population characteristics: A little over half (58.3%) of the sampled children were females and their mean age was 41.4 ± 9.7 months (**Table 1**). Averagely, the children ate 3 meals per day, and the mean birth order was 2.6 ± 1.7. About 11.5% of them experienced an illness that included any reported fever, diarrhoea and respiratory tract infection the week preceding the survey. Overall, the children were mostly (93.2%) of Dogomba ethnicity. Table 1 also indicates that the mean WHZ, WAZ and HAZ of the children were 0.1 ± 1.1, -1.2 ± 1.1 and -2.1 ± 1.5, respectively.

Table 2 shows that the age of the mothers (62.5%), as well as fathers (66.1%) of the children, was commonly between 25-40 years. Most mothers (76.0%) had never been to school and were predominantly traders (40.1%). On the other hand, farming was the common occupation of the fathers (41.7%). The average household size was 12.8 ± 5.6 and about a third of the children belonged to households with a household size ≥ 14. Furthermore, about 40.0% of the children's households were in the low household asset index category. The prevalence of food insecurity is higher in the lean season compared to the harvest season [29]; this may explain why the prevalence of moderate to severe hunger (25.5%) in the past month preceding the survey in this study was higher than that previously reported for the district by the World Food Programme [29] (Table 2).

Dietary Diversity: Although nutrient intake was not assessed, it is reasonable to speculate that the inadequate consumption of animal-source foods in the diet of the sampled children suggests poor quality of diet; plant-based diets are associated with high concentrations of phytates and other dietary inhibitors, leading to reduced bioavailability of micronutrients and dietary inadequacies [30] though are also low in first quality protein. Table 3 shows that the mean DDS of the children from the single 24HR was 6.3 ± 1.2 out of 13 food groups. Overall, all the children consumed starchy staples. The consumption of legumes and nuts (87.5%), vitamin C-rich vegetables (79.2%) as well as vitamin A-rich vegetables and fruits among the children was high. On the contrary, besides small fish eaten whole (88%) and dairy products (25%), < 10% of the children consumed any other animal source food. Ruel [31] indicates that small fish eaten whole (anchovies) contributes little to the micronutrient adequacy of children as it is often consumed in small quantities in soups and stews. Accordingly, the contribution of small fish eaten whole may be negligible in improving the dietary adequacy and nutritional status of the children in this study. Although the present study did not estimate nutrient intake from the 24HR, it is reasonable to assume that

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Volume 22 No. 7
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ISSN 1684 5374

micronutrient deficiencies may be a problem among the children as poor diet quality often leads to dietary inadequacy and micronutrient inadequacy with consequences of malnutrition [7]; this may partly account for the high prevalence of stunting and underweight among the children. The food consumption pattern of the children did not differ significantly by sex. None of the children had a DDS less than 4 with a majority (81.3%) of them obtaining a DDS of 5-7; however, only 2.6% of them had a DDS ≥ 9 (**Figure 1**). In this study, the DDS of the sampled children was similar across food security categories and no interaction effects were found between DDS and household food security in the multivariate linear regression analysis (**Figure 2**).

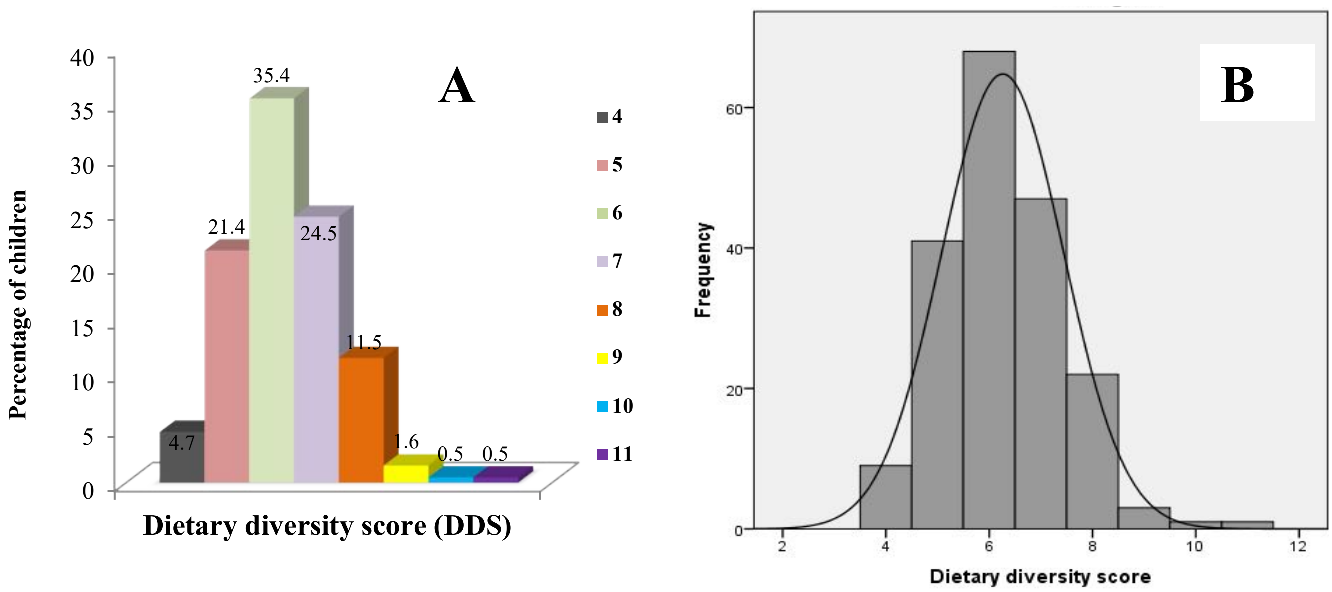

Figure 1: A distribution of the dietary diversity score (DDS) of the children aged 24-59 months (a) including a normality plot (b) in Tolon District (Field Survey, 2016)

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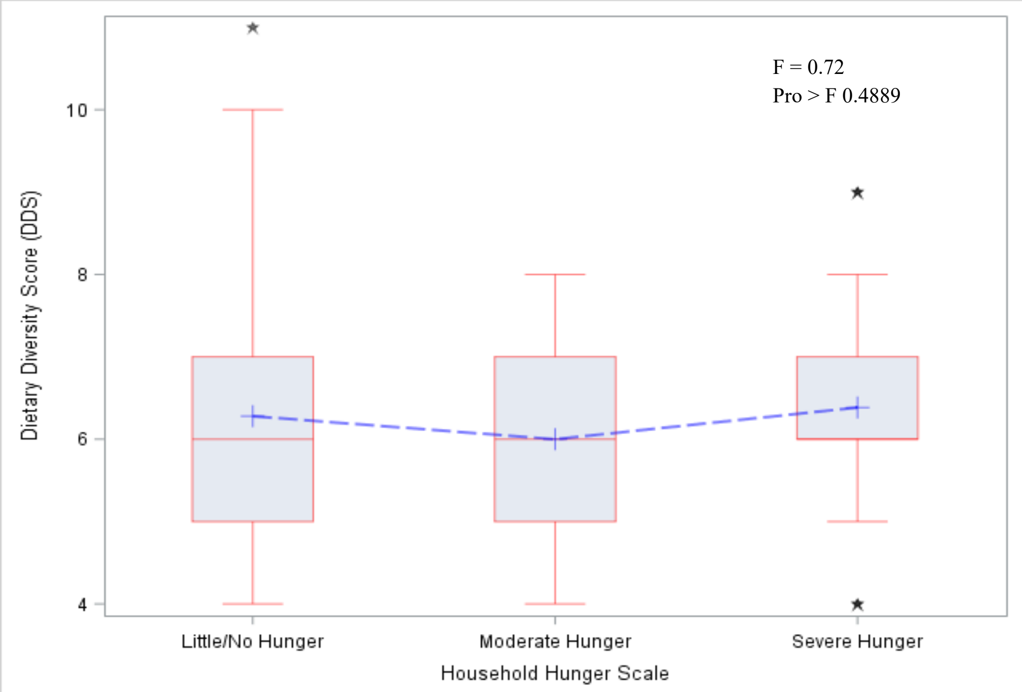

Figure 2: A boxplot of the dietary diversity of the sampled children aged 24-59 months across household food security groups; the blue line is a trend line connecting the mean dietary diversity score for children in each category of the household hunger scale

Nutritional Status of the Children: The results indicate that more than a half (58.3%) of the children were stunted; though the prevalence of stunting did not differ significantly by sex, close to two-thirds (61.6%) of the females compared to approximately a half (53.8%) of the males were stunted (**Figure 3**). The prevalence of wasting was 4.2% among the children and slightly more males (5.0%) were wasted than females (3.6%). Furthermore, the overall prevalence of underweight was 20.3% with slightly more males (22.5%) being underweight compared to females (18.8%). According to the WHO criteria [32], the prevalence rate of stunting was very high among the children, underweight was high and wasting was within the acceptable range. The prevalence of stunting in the present study is about twice the prevalence rate (33%) reported for children under five years in the Northern Region of Ghana by the 2014 GDHS [4]. However, the prevalence rate of underweight was similar to the prevalence rate (20.0%) reported by the GDHS for the region while the prevalence rate of wasting was a little below the regional rate (6.3%) in the GDHS [4]. A study by Saaka *et al.*[33] in the district found a prevalence of underweight (25%) similar to the present study. Similar to findings by Nungo *et al*. [34] in Kenya, slightly more females were stunted compared to males while underweight and wasting were slightly higher among males; Saaka *et al*. [33] also recorded a higher prevalence of underweight and wasting among males compared to females in northern Ghana.

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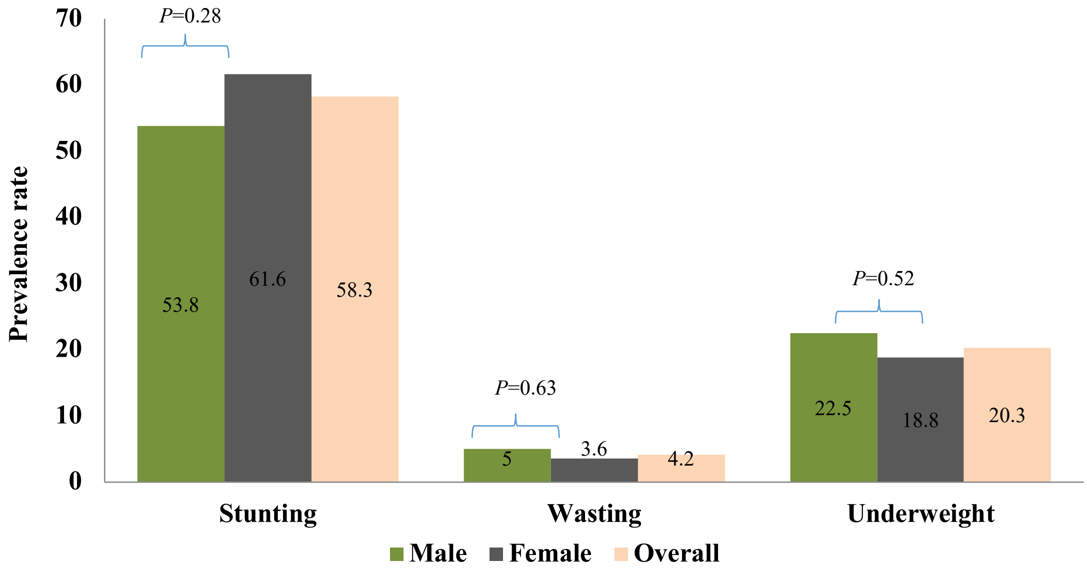

Figure 3: The prevalence of malnutrition among the children aged 24-59 months in Tolon District, Ghana (Field survey, 2016); P=Probability for chi-square test of independence for malnutrition and sex of the child

Overall, the prevalence rates of stunting and underweight reflect poor nutrition among the sampled children aged 24-59 months in the Tolon District. Poor dietary patterns may partly account for the high prevalence of stunting and underweight among the children; nutritional deficits in infants and young children are linked to long-term impairments in growth and increase the risk of infant and young child morbidity and mortality [2, 3]. Stunting is related to chronic dietary deficits and or recurrent or chronic poor health [35]; the high levels of stunting among the children may thus, be indicative of long-term nutritional deficits which yet affirms that improving dietary intake during the first 1000 days of life may prevent long-term nutritional deficits. Although food insecurity did not appear as a significant covariate in any of the statistical models, food security is one of the underlying determinants of malnutrition, and this may also partly explain the very high prevalence rates of stunting and underweight among the children. According to IZiNCG [36], the stunting rate suggests zinc deficiency may be a public health problem among the sampled children.

The association between DDS and Nutritional status among the children: The results showed a significant positive association between DDS and WHZ in the crude model (β=0.15, *P*=0.03), and adjusting for potential confounding variables did not change the observed association (β=0.16, *P*=0.03) (Table 4). Likewise, a significant positive association was observed between DDS and WAZ, but the association was only significant in the adjusted models, suggesting that other factors besides DDS contribute to WAZ. On the contrary, the association between DDS and HAZ though positive was not significant in both crude (β=0.03, *P*=0.73) and adjusted (β=0.10, *P*=0.29) models.

The results of the present study are comparable to those of Nti [17] who found a significant positive association between DDS and WHZ besides WAZ in a sample of 6-18 month-old children from southern Ghana. Contrary to previous studies [13–15, 17, 37], the association between DDS and HAZ was not statistically significant even after adjusting for potential confounding variables. In the current study, DDS was based on a single 24-hour reference period, reflecting recent dietary intake. Although habitual intake would have been better, the FAO [8] recommends a 1-day recall as it is less subject to recall bias, less cumbersome for the respondent and also conforms to the recall period used in many dietary diversity studies. A repeated 24HR would be suitable for capturing habitual diet; however, the number of repeated recalls required is often unrealistic [38]. More importantly, stunting reflects chronic nutritional problems. It is, therefore, not surprising that the association between DDS and HAZ was not statistically significant. Likewise, WAZ reflects both current and past nutritional problems and current dietary intake alone may not adequately account for it; this explains that an increase in the age of the child, higher birth order and maternal age younger than 25 years significantly reduced the WAZ of the child in the final model (*results not shown*). A continual improvement in wasting and underweight are desirable to improve stunting in the long term. Generally, the present findings suggest an urgent need for food-based intervention strategies for the prevention of malnutrition and improvement in short-to-medium term nutritional status (WHZ and WAZ) in the district. Such food-based programmes may include intervention programmes that can improve the consumption of animal source foods among young children. The findings also reinforce the need to strengthen the sensitization and education of mothers and caregivers on diversified diets for their younger children.

Some limitations should be considered when interpreting the present findings. Firstly, conveniently choosing the study communities did not offer the chance of including all eligible children in the district. It was plausible children with better or worst nutritional status and /or DDS were excluded from the study. However, the district is about 90% rural [18] and most communities in the district have a similar demographic structure. Although communities close to the University are more likely to have improved socio-economic conditions created by the micro-economic climate of the university, it was not anticipated that this would bias the findings. Dietary patterns are comparable across communities in the district; for instance, a study based on data from 2011 [39] among school-aged children from communities in the interior of the district also reported a predominantly plant-based diet for school-aged children with a mean DDS (5.9 ± 0.9) similar to this study. Thus, it was less likely that the possible source of selection bias would limit the validity of this study. The inability to estimate portion sizes and to include a minimum intake for scoring the DDS is the main limitation of the dietary assessment method. Studies have shown that qualitative recalls lead to over-reporting and consequently higher scores and misclassification of subjects [40].

Residual confounding is always possible in observational studies, but several possible confounding variables were adjusted for, based on the literature. The main limitation of the present study remains its cross-sectional design as the inferences of a possible causality are speculative since it is not possible to determine if a better DDS preceded a better nutritional status. As a prospective design would be better equipped to address

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Volume 22 No. 7
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ISSN 1684 5374

this problem, we limit the interpretation of our findings to describing associations. At best, the population for analysis in this study could be more representative of 24-59 months old rural children in the Northern Region of Ghana. Notwithstanding the limitations, the present study contributes to evidence of the association between DDS and the nutritional status of children aged 24-59 months. This study is apparently the first to evaluate the association between DDS and the nutritional status of children aged 24-59 months in northern Ghana.

CONCLUSION

The present findings indicate a very high prevalence of stunting and a high prevalence of underweight in the Tolon District of Ghana; however, the prevalence of wasting was within the acceptable range (< 5%) of the WHO. The high prevalence of stunting and underweight among the children requires urgent attention from the ministry of health and its development stakeholders. Although the dietary pattern of the children was predominantly plant origin, the findings of the present study suggest that improvement in dietary diversity may be an effective approach to improving wasting and underweight among young children. Sensitization programmes on dietary diversification need to be strengthened in child-welfare clinics. Intervention programmes such as backyard gardening, small ruminant rearing and income-generation activities may improve access to a diverse diet.

ACKNOWLEDGEMENTS

The authors would like to thank the women who willingly agreed to participate in this survey with their children. We also wish to acknowledge and thank all the community leaders for their support during the survey.

Ethical approval and consent to participate:
Permission was obtained from the chiefs and opinion leaders of the communities and thumb-printed informed consent was obtained from each of the women and/or their household heads. Respondents had the opportunity to stop participating in the survey at any time of their choice during interviews, but none opted out of the interviews. The study protocol was approved by the Scientific Review Committee of the School of Allied Health Sciences (protocol number 17-2016), University for Development Studies, Ghana.

Consent for publication: Not applicable

Authors' contributions: Conception and design: AF and JC; analysis and interpretation of data: AF and JC; the drafting of the article: AF and JC; critical revision for important intellectual content: AF and HR and final approval of the version to be published: AF and HR.

https://doi.org/10.18697/ajfand.112.22135

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Table 1: Descriptive statistics of the children

Variable	Overall (n=192)
Sex (female)	112 (58.3)
Age in months (mean ± SD)	41.4 ± 9.7
Age category of the child (n, %)	
24-35 months	51 (26.6)
36-47 months	81 (42.2)
48-59 months	60 (31.2)
Meal frequency per day (mean ± SD)	3.1 ± 0.5
Birth order of child (mean ± SD)	2.6 ± 1.7
Child sick[1] past week preceding survey (n, %)	22 (11.5%)
Ethnicity (n, %)	
Dagomba	179 (93.2)
Other[2]	13 (6.8)
Nutritional status z-score of the children	
WHZ (mean ± SD)	0.1 ±1.1
HAZ (mean ± SD)	-2.1 ±1.5
WAZ (mean ± SD)	-1.2 ±1.1
BAZ (mean ± SD)	0.3 ± 1.1

Unless otherwise stated, all values outside the bracket are frequencies and values inside the brackets are percentages; WHZ, weight-for-height z-score; HAZ, height-for-age z-score; WAZ, weight-for-age z-score**;** BAZ, body-mass-index for-age z-score MUACZ, mid-upper-arm circumference z-score**;** [1]Child sickness included any reported fever, diarrhoea and respiratory tract infection in the past week preceding the sur**vey.** [2]Gonja, Mamprusi and other tribes originating from Ghana

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 7 September 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 2: Household socio-demographic characteristics of the children

Variable	Overall (n=192)
The age group of the mother (n, %)	
≤ 25 years	59 (30.7)
>25 years	133 (69.3)
Level of education of mother (n, %)	
Literate	46 (24.0)
Non-literate	146 (76.0)
Occupation of the mother (n, %)	
Farmer	37 (19.3)
Trader	77 (40.1)
Paid job	24 (12.5)
Unemployed	54 (28.3)
The age group of the father (n, %)	
≤ 25 years	17 (8.9)
25 < age ≤40 years	127 (66.1)
>40 years	48 (25.0)
Occupation of the father (n, %)	
Farmer	80 (41.7)
Trader	40 (20.8)
Paid job	44 (22.9)
Other[1]	28 (14.6)
Household size (mean ± SD)	12.8 ± 5.6
Household size category (n, %)	
Low (≤ 10)	78 (38.5)
Average size (>10 but ≤ 14)	58 (30.2)
High (>14)	60 (31.3)
Household asset index (n, %)	
Low	78 (40.6)
Moderate	75 (39.1)
High	39 (20.3)
Household hunger scale (n, %)	
Little/no hunger	143 (74.5)
Moderate hunger	23 (12.0)
Severe hunger	26 (13.5)

All values outside the brackets are frequencies and values inside the brackets are percentages; [1]Casual paid work or unemployed

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Table 3: The mean dietary diversity and percentage of children consuming food from each food group stratified by child sex

Food Group	Frequency and percentage of children consuming each food group			*P*-value
	Female (n=112)	Male (n=80)	Overall (n=192)	
All starchy staples	112 (100.0)	80 (100.0)	192 (100)	-
All legumes and nuts	101 (90.2)	67 (83.8)	168 (87.5)	0.18
Dairy products	30 (26.8)	20 (25.0)	50 (26.0)	0.78
Organ meat	3 (2.7)	0	3 (1.7)	0.27
Eggs	8 (7.1)	6 (7.5)	14 (7.3)	0.93
Small fish eaten whole	101 (90.2)	69 (86.3)	170 (88.5)	0.40
All other flesh foods	8 (7.1)	6 (7.5)	14 (7.3)	0.93
Vitamin A rich dark green leafy vegetables	70 (62.5)	52 (65.0)	122 (63.5)	0.72
Vitamin A-rich deep yellow orange and red vegetables	57 (50.9)	37 (46.3)	94 (49.0)	0.53
Vitamin A-rich fruits	60 (53.6)	50 (62.5)	110 (56.4)	0.22
Vitamin C-rich vegetables	92 (82.1)	60 (75.0)	152 (79.2)	0.23
Vitamin C-rich fruits	4 (3.6)	0	4 (2.1)	0.14
All other fruits and vegetables	67 (59.8)	42 (52.5)	108 (55.4)	0.31
DDS (mean ± SD)	6.1 ± 1.0	6.4 ± 1.3	6.3 ± 1.2	0.14

Unless otherwise stated, values are frequencies outside the brackets and percentages inside the brackets; DDS, dietary diversity score

ajfand SCHOLARLY, PEER REVIEWED
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September 2022
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Table 4: Multiple Linear regression analysis of the association between dietary diversity and nutritional status among children aged 24-59 months in Tolon District, Ghana

Statistical model	Weight-for-height z-score			Weight-for-age z-score			Height-for-age z-score		
	β	**SE (β)**	***P*-value**	**B**	**SE (β)**	***P*-value**	**β**	**SE (β)**	***P*-value**
Crude model	0.15	0.07	0.03	0.11	0.06	0.09	0.03	0.09	0.73
Model 1	0.16	0.07	0.02	0.14	0.07	0.03	0.05	0.09	0.58
Model 2	0.15	0.07	0.03	0.16	0.07	0.02	0.08	0.10	0.39
Model 3	0.16	0.07	0.03	0.17	0.07	0.01	0.10	0.10	0.29

Model 1 adjusted for child-level characteristics (age, sex, birth order, child sickness in the past week and frequency of feeding per day); model 2 additionally adjusted for maternal factors (age, educational and occupational status); model 3 finally adjusted for paternal and household factors (paternal age and occupation, household food security, size and wealth index)

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