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Dietary Diversity is a Predictor of Acute Malnutrition in Rural but Not in Urban Settings: Evidence from Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. Author DAA designed the study, performed the statistical analysis, and wrote the first draft of the manuscript. Author MBM supervised all aspects of the study. Authors MBM and AL revised the manuscript. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: To document the relationships between child dietary diversity and acute malnutrition (wasting) in urban and rural Ghana, controlling for maternal, child and household socio-demographic characteristics.
Study Design: Cross sectional survey
Place and Duration of Study: Urban and rural Ghana, between September and November 2008.
Methodology: The analysis uses data from the 2008 Ghana Demographic and Health Survey. Data on children aged 6-36 months (n = 1,187) and their mothers who provided reports of child food consumption were analysed. The mother reported the child's consumption of 16 food types/groups in the 24 hours prior to the survey. A value of 1 was assigned for each food group consumed, and these were summed to create the dietary diversity score (DDS). Logistic regression was used to investigate the relationship between DDS and childhood wasting.
Results: Among rural children, but not urban children, higher DDS was associated with a significantly lower likelihood of wasting after controlling for child, maternal, and household characteristics. A one-point increase in DDS was associated with an 11%

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reduced odds of being wasted (OR = 0.89, 95%, C.I. 0.80 - 0.99). There was also an interaction effect with a higher likelihood of wasting predicted by lower DDS when maternal BMI was low.

Conclusion: Dietary diversity has a modest but statistically significant association with acute malnutrition in rural but not in urban Ghana. Interventions to combat acute malnutrition in rural settings should include efforts to promote the consumption of a variety of food groups.

Keywords: Dietary diversity; nutritional status; wasting; urban-rural; Ghana.

1. INTRODUCTION

Lack of dietary diversity is a problem at any age, but it is particularly critical for older infants and young children during the complementary feeding period, who need food containing essential nutrients for normal physical and mental development. Those who eat foods from four or more food groups daily have the minimum recommended dietary diversity, under the assumption that they consume at least one animal-source food and at least one fruit or vegetable, in addition to a staple food [1]. However, for many children, this minimum is not achieved, particularly among poor households, where starchy staples are the mainstay. Older infants and young children in sub-Saharan Africa subsist typically on gruel and porridge, accompanied with seasonal vegetables and legumes, and few or no animal products [2,3,4,5]. The monotony of diet that is a hallmark of poverty is not just dreary; it results in poor nutrition and health [6].

Recognizing the importance of dietary diversity for child growth and development, the World Health Organization (WHO) has recently included dietary diversity as a specific recommendation in the updated guidelines for complementary feeding of breastfed children aged 6 to 23 months [1]. The increased recognition of dietary diversity as an important element in healthy nutrition calls for more research in this area.

The relationship between the concepts ‘food security’ and ‘dietary diversity’ is close. Food security refers to a state of not living in hunger and not risking severe deficiency in energy and nutrient intake [7,8]. Studies from South America and Africa show that dietary diversity is positively associated with young children’s intake of energy and key nutrients and the avoidance of food insecurity [2,4,9,10,11,12,13]. Dietary diversity could therefore be a reasonably good indicator of food security, and relatively easy to measure at both the individual and household levels [7].

While dietary diversity is expected to contribute to good child health as reflected by good child growth, other factors are also at play. Alongside poor nutrition, inadequate hygiene, living conditions, income and medical care can lead to otherwise preventable infection and disease [14]. Thus, when stunting, wasting and underweight are observed, the causes are likely to be multiple and interdependent. This raises a critical point: the state of a child’s health is often a result of the interactions of factors at the individual and family levels such as access to food, feeding patterns, and factors at the social and physical environmental levels, such as access to health care and to clean water.

A further consideration is that there tends to be a socio-geographic clustering of risk factors for poor health. Rural living conditions and their association with relatively poor health (in comparison to urban living conditions and health) have given rise to rural health as a research arena in its own right [15]. This is not to deny the fact that urban environments may pose threats to health that are less salient in rural environments. The point, rather, is that rural and urban living environments tend to place different kinds of demands on their inhabitants and offer different kinds of resources to cope with demands.

While life may be arduous wherever one resides, the difficulties tend to be patterned on a rural/urban dimension. Rural children tend to be comparatively poorer than urban children and socioeconomic status is strongly associated with health [16]. Overall, living standards and health in general are poorer in rural than in urban children in African countries [17]. This tends to be true also for child nutritional status in many developing countries [18,19, 20].

Of course, health is variable *within* rural and *within* urban children, and the degree to which the geographical environment affects health is somewhat dependent on individual differences such as income, education, gender, race, ethnic group [21]. As already implied, there is strong evidence that environmental factors interact with individual factors to affect health. For example, the gap in child health between the richest and the poorest households is greater in urban than in rural children [19].

Some studies have examined the association between dietary diversity and child health, attempting to take into account the different child-rearing contexts in urban compared to rural living. Findings are inconsistent. While analysis of Ethiopia Demographic and Health Surveys shows that dietary diversity is positively associated with child stunting in both urban and rural children [11], Hatloy and colleagues found in Mali that the association was only significant in urban children, and then only for underweight and stunting, but not for wasting [22]. Perhaps the most encompassing studies of urban/rural differences in child malnutrition in Sub-Saharan Africa are those of Fotso [23,24], undertaken in 15 countries with Demographic and Health Surveys (DHS) data. With stunting as the indicator of malnutrition, he observed higher levels of socioeconomic inequalities in stunting in urban than in rural children [23]. Across the 15 countries, stunting was more prevalent in rural than in urban children, but the differences were minimal after adjustment for socio-economic status (SES) [24]. In contrast to Fosto's conclusion that urban/rural gaps in stunting are accounted for by SES differences, many other studies using DHS and other datasets have observed that differences across rural and urban children persist after controlling for SES and other important covariates [18,19,25,26,27]. It is noteworthy that many dietary diversity studies have not examined urban/rural differences in malnutrition [2,4,9,10,11,12,13], perhaps in concert with the DHS, which never reports inter-country urban/rural comparisons due to varying definitions of urbanity/rurality from country-to-country.

Thus, much remains to be understood about urban and rural patterns in child dietary diversity, its relationship with stunting, wasting and underweight, and the role played by other factors such as living conditions. The lessons from the literature are that cross-country comparisons are fraught with methodological difficulties, that interactions between individual and environmental factors should be accounted for, and that newer analyses are needed, using up-to-date definitions of stunting, wasting and overweight.

This paper presents an analysis specific to Ghana, using the latest available data (GDHS, 2008) and malnutrition definitions, and conducting separate but comparable analyses for urban and rural settings. The study question was 'what are the relationships of dietary diversity to childhood wasting in urban and in rural Ghana, when control variables related to maternal, child and household characteristics are accounted for?

2. MATERIALS AND METHODS

2.1 Source of Data

This study used a nationally representative dataset from Demographic and Health Surveys (DHS) carried out in Ghana in 2008 [28]. These are publicly available data. The choice of 2008 data set was informed by the fact that they were the most recent data available, and most importantly, they contain the necessary child feeding variables needed for this analysis. The Ghana DHS 2008 was collected by the Ghana Statistics Services (GSS) and Ghana Health Service (GHS) with technical assistance from ICF Macro, using the Ghana 2000 population census as the sampling frame. The surveys were designed to be representative at the national, regional and rural–urban levels. A two-stage probabilistic sampling design was used to select clusters (census districts) at the first stage. The second stage involved the selection of households from these clusters. All women and men aged 15–49 and 15-59 respectively in the selected households were eligible to participate in the surveys. The household response rate was 98.9% [29]. The ICF Macro Institutional Review Board (IRB) in Calverton, Maryland, USA and the Ghana Health Service Ethical Review Committee in Accra, Ghana (GHS-ERC) granted ethical clearance of the 2008 Ghana project. No further ethical clearance was required by the authors of this paper for the use of the completely anonymous dataset.

2.2 Study Sample

The total number of children aged 0-59 months in the 2008 was 2,992 and this analysis was restricted to the children aged 6-36 months (n =1,411). Two hundred and twenty-four children (15.9%) were excluded from the analysis who were missing anthropometric data or who had biologically implausible values (weight-for-height z-scores less than −5.0 and greater +5.0). The total sample in the descriptive analyses and in the regression analyses was 1,187 (393 urban and 794 rural children).

2.3 Measurements/Variables

2.3.1 Creation of dietary diversity score

A dietary diversity score (DDS) was created using data from 24-hour recall of food types/groups available in Ghana DHS data set. The DDS is a count of the number of food groups consumed by the child over the past 24 hours preceding the DHS interview of the mother, who reported the child's food consumption. The DDS has a range from 0 to 16, summed using these food groups: 1) tinned/powder or fresh milk; 2) baby formula; 3) baby cereal; 4) bread, rice, noodles, other made from grains; 5) potatoes, cassava, or other tubers; 6) eggs; 7) meat (beef, pork, lamb, goat, chicken etc.); 8) dark green leafy vegetables; 9) mangoes, papayas, other vitamin A fruits; 10) other fruits; 11) pumpkin, carrots, squash (yellow or orange inside); 12) liver, kidney, heart, other organs; 13) fish or shellfish(fresh or dried); 14) food made from beans, peas, lentils, nuts; 15) oils, fats, butter, products made from them; 16) cheese, yogurt, other milk products. A value of 1 was assigned for each of the nutritionally important types of food the child might have eaten. Details of the variables can be found in Table 1. The DDS was analysed as a continuous variable.

Table 1. Characteristics of variables used in creating the dietary diversity score for children 6-36 months old (n = 1187)

Variables	Total	Urban	Rural	*P*
	%	%	%	
Gave child tinned/powder or fresh milk	19.2	34.1	11.8	0.001
Gave child baby formula	5.6	9.5	3.7	0.001
Gave child baby cereal	9.0	19.4	3.9	0.001
Gave child bread, rice, noodles, other made from grains	75.0	79.1	73.0	0.020
Gave child potatoes, cassava, or other tubers	44.7	37.9	48.0	0.001
Gave child eggs	22.0	31.3	17.0	0.001
Gave child meat (beef, pork, lamb, goat, chicken, etc.)	19.1	29.8	13.9	0.001
Gave child pumpkin, carrots, squash (yellow or orange inside	11.6	13.2	10.8	0.230
Gave child any dark green leafy vegetables	42.3	35.1	45.8	0.001
Gave child mangoes, papayas, other vitamin A fruits	8.7	8.4	8.8	0.800
Gave child any other fruits	53.3	58.5	50.7	0.010
Gave child liver, kidney, heart, other organs	7.4	10.7	5.8	0.002
Gave child fish or shellfish (fresh or dried)	56.5	59.5	55.1	0.140
Gave child food made from beans, peas, lentils, nuts	22.7	21.6	23.2	0.540
Gave child cheese, yogurt, other milk products	7.6	13.8	4.5	0.001
Gave child oil, fats, butter, products made of them	44.0	52.2	39.9	0.001

**Food types consumed by the children over 24 hour period.*

2.4 Urban/Rural Designation

The DHS uses the definition of urban and rural location provided by the country being surveyed. In Ghana, the definition is set by the Ministry of Health and published by the Ghana Statistical Services in various official documents. A locality is a distinct population cluster which has a name or locally recognized status. Localities with a population of 5000 or more persons are classified as urban, while those with less than 5000 are classified as rural [30]. An important methodological note is that valid urban/rural comparisons between countries are not possible using DHS data, as definitions of urban and rural vary from country to country (and in some countries, from time to time).

2.4.1Outcome variables

The main indicators of child nutritional status include height-for-age, weight-for-age, and weight-for-height z-scores. Children with height-for-age, weight-for-age and weight-for-height z-scores less than -2 standard deviations (SD) of the WHO reference population were considered stunted, underweight and wasted (acutely malnourished), respectfully. The logistic regression analysis focused on weight-for-height (W/H) dichotomized with the cut-point W/H < -2 SD. Of the three indicators of child nutritional status, only W/H was associated significantly with DDS in bivariate analyses. Therefore, multivariate analyses were restricted to the outcome variable, W/H.

2.4.2 Other variables

A number of socio-economic variables were included in the regression analyses: maternal education, occupation and household Wealth Index. Maternal occupation was dichotomized into 'white collar' (professional/technical/managerial, clerical, sales and services) and 'agriculture/labour' (agriculture self-employed, agriculture, skilled manual labour and unskilled manual labour, household/domestic labour) [31]. Education was grouped into three categories (no education, primary, and secondary+). The Wealth Index in the DHS is based on assets ownership and housing characteristics of each household: type of roofing, and flooring material, drinking water, sanitation facilities, ownership of television, bicycle, motorcycle, car and so on. Principal component analysis was employed to assign weights to each asset in each household. The asset scores were then summed up and all individuals in a household were assigned the household Wealth Index score. The Wealth Index was then divided into quintiles: poorest, poorer, middle, richer and richest. These quintiles were used in our analysis.

Another important variable included in the analysis was the region variable. This variable was recoded into five categories namely, “Accra”, “South” (Western, Central, Volta, and Eastern regions), “Middle” (Ashanti and Brong Ahafo regions), “Northern (Northern region), and “Upper” (Upper East and Upper West regions) [32].

The following variables were also used in the analysis to account for maternal and child level characteristics which may have influence on the nutritional status of the child as well confound the dietary diversity score: maternal age, BMI, height, parity, anaemia level, size of child at birth, continued breastfeeding, use of feeding bottle, sex of child, birth order of child, and number of children under five years in the household. Some of these variables were recoded. Anaemia levels (an indication of maternal nutritional and health status) as defined by DHS [29] were coded into four categories: no anaemia, mild anaemia (10.0-10.9 grams/decilitre for pregnant women and 10.0-11.9 g/dL for non-pregnant women), moderate anaemia (7.0-9.9 g/dL), and severe anaemia (less than 7.0 g/dL). Size of child at birth as reported by the mother was collapsed into “Small or <average” (small and less than average), “Average or > average” (average and greater than average), and “Very large”. In addition, in the data, a yes response is coded “1” and no “0”, however, the response to the use of feeding bottle was recoded into yes= “0” and no = “1”. This is because the use of bottle feeding as a feeding method is considered detrimental to children at all ages, because of potential interference of bottle feeding with optimal breastfeeding practices and the association between bottle feeding and increased diarrheal disease morbidity and mortality [1].

2.5 Data Analysis Methods

The data analysis was performed using SPSS for windows, version 19.0. The analysis involved three stages. The first stage was descriptive analysis to provide general information on the characteristics of the sample. Differences in means between urban and rural for continuous variables were tested using independent samples t test and proportions tested using chi square test. These were followed by bivariate analysis of the associations between the DDS and the main indicators of child malnutrition: wasting, underweight and stunting. Associations were considered statistical significant at P-values < 0.05. Significant associations were subjected to further analysis. Wasting was the only variable that was significantly associated with dietary diversity, so further analyses were not carried out on stunting and underweight. All the above analyses took into account survey design effects (analyses adjusted for sampling weight, strata and cluster).

Multivariate methods were used to test whether associations between DDS and wasting remained significant after taking into account other potential predictors of wasting at the child level (breastfeeding status, sex, birth order), maternal level (education, age, occupation, height, BMI, parity) and household level (wealth index, number of children under five years, region). Two analyses were carried out separately for urban and rural children. To account for survey design effect, logistic regression was adjusted for sampling weight, strata and cluster. Multicollinearity was assessed but not observed [33].

In the UNICEF child health conceptual framework, diet is among the three most proximal factors influencing child nutritional status, the other two being home care and health care [14]. The framework does not address the potential effect modifying influence of rural versus urban living, but the empirical literature cited above suggests that the urban-rural dimension carries with it a host of contextual factors that may influence child diet in particular and child care more generally. Therefore the analytical strategy of this paper was to undertake stratified analyses examining the relationship of DDS to undernutrition in urban and in rural samples.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Descriptive statistics of maternal, child and household characteristics

Tables 2 and 3 present descriptive statistics for the variables used in further analyses. Males and females are evenly distributed in both rural and urban samples. The average age was the same for rural and urban children. The patterns of anthropometric indicators observed here are typical of most developing countries, especially among rural children. The mean z-scores are significantly lower in the rural children as compared to urban children. This was expectedly reflected in the prevalence of stunting, underweight, and wasting in Table 3. Stunting is markedly higher in rural children compared to urban children (31.3% versus 24.7%, $p < 0.018$). Underweight is also significantly higher in rural children compared to urban children (17.8% versus 12.5%, $p = 0.018$), so is wasting (13.0% versus 8.4%, $p = 0.020$). Maternal parity was significantly higher in the mothers of rural children compared to the mothers of urban children ($p < 0.001$), and the number of children under five years living in households was significantly greater in rural compared to urban households ($p < 0.001$). The mean DDS was significantly higher in the urban settings compared to rural settings (6.61±2.94 versus 5.57±3.19, $p < 0.001$).

Breastfeeding was more prevalent among rural women compared to urban women (71.4% versus 58.5%, $p < 0.001$). Bottle-feeding was not common; however, the prevalence was twice as high in the urban children compared to the rural children (12.2% versus 6.3%, $p < 0.001$).

There were significant disparities in maternal education between rural and urban children. About 19 percent of urban women reported no education as compared to 46 percent of rural women. Conversely, 58.3 percent of urban women reported at least some secondary education as compared to about 30 percent of rural women. Maternal BMI, an indicator of maternal nutritional status, was significantly higher in the mothers of urban children compared to rural children ($p < 0.001$).

Table 2. Descriptive statistics of study sample (Total n = 1187): continuous variables (means and standard deviations)

Variable	**Rural**		**Urban**		
Total sample, n	**794**		**393**		
	Mean	**SD**	**Mean**	**SD**	***P***
Child					
Age (mo)	19.69	8.63	20.03	8.39	0.520
Birth order	3.53	2.24	2.67	1.74	0.001
Height-for-age Z-scores	-1.18	1.67	-.89	1.79	0.006
Weight-for-age Z-scores	-.91	1.27	-.61	1.33	0.001
Weight-for-height Z-scores	-.40	1.48	-.19	1.49	0.019
Mother					
Age	29.10	7.04	29.35	6.19	0.530
Weight	55.44	8.95	63.67	12.14	0.001
Height	1.59	0.07	1.60	0.08	0.170
BMI (kg/m^2)	22.00	3.31	25.10	4.92	0.001
Parity	3.67	2.26	2.78	1.74	0.001
Household					0.001
Number of children U5 years	1.98	1.07	1.67	.80	0.001
Dietary diversity					
Dietary diversity score	5.57	2.94	6.61	3.19	0.001

**Continuous variables used in the analysis*

Two percent of urban households and 48 percent of rural households were in the poorest wealth quintile. Contrariwise, about 33 percent of urban household were in the richest wealth quintile as compared to only two percent of rural households. These differences were statistically significant ($p < 0.001$).

3.1.2 Bivariate analysis

This analysis was done to establish the association between DDS and the main indicators of malnutrition: stunting, underweight, and wasting. A statistically significant association was found between DDS and wasting (Wald = 12.48: $p < 0.001$). There were insignificant associations between DDS and stunting (Wald = 0.07; $p = 0.79$) and underweight (Wald = 3.0; $P = 0.083$).

3.1.3 Multivariate analysis

Table 4 presents logistic regression models of the association between DDS and W/H, accounting for other potential determinants of wasting. DDS was associated with lower likelihood of wasting in rural children (Model A), after controlling for child, maternal, and household level variables. A one point increase in DDS was associated with an 11% reduced odds of being wasted among children aged 6-36 months (OR = 0.89, 95%, C.I.: 0.80 - 0.99). In addition to DDS, only maternal BMI, parity, continued breastfeeding, birth order and region of residence were statistically significant predictors of wasting. A higher likelihood of wasting was predicted by lower maternal BMI, lower parity, later birth order, and continued breast feeding. Two additional logistic regression analyses were done to test for interaction effects between DDS and the other predictor variables in the urban and the rural samples (interactions were not included in the analysis shown in Table 4). In the additional analysis, only one interaction was statistically significant; in the rural sample only, DDS and

W/H were more strongly associated in low BMI women than in high BMI women (Beta = -0.32, O.R. = 0.73, 95% C.I. = 0.57 – 0.94).

Table 3. Descriptive statistics of study sample (total n = 1187): categorical variables (percentages)

Variable	Rural	Urban	*P*
Total sample, n	**794**	**393**	
Child			
Sex	%	%	
Male	51.3	49.1	0.490
Female	48.7	50.9	
Size of child at birth			
Small or < average	15.9	12.1	0.200
Average or > average	62.1	66.1	
Very large	22.1	21.9	
Still breastfeeding			
Yes	71.4	58.5	0.001
Use of feeding bottle			
Yes	6.3	12.2	0.001
Height-for-age <-2SD	31.3	24.7	0.018
Weight-for-age < -2 SD	17.8	12.5	0.018
Weight-for-height < -2 SD	13.0	8.4	0.020
Mother			
Level of education			
No education	45.8	18.8	0.001
Primary	24.7	22.9	
Secondary+	29.5	58.3	
White collar	28.5	64.9	0.001
Agriculture/labour	71.5	35.1	
Anaemia level			
No anaemia	36.7	42.4	0.170
Mild	41.8	38.0	
Severe/moderate	21.5	19.6	
Household level			
Wealth index			
Poorest	47.9	2.0	0.001
Poorer	27.6	10.4	
Middle	14.2	18.3	
Richer	8.4	36.6	
Richest	1.9	32.6	
Region			
Accra	1.9	22.1	
South	36.1	28.5	
Middle	22.8	32.1	
Northern	16.5	9.4	
Upper	22.7	7.9	

**Categorical variables used in the analysis*

The results presented in Model B show that DDS was not a significant predictor of childhood wasting in urban children, after controlling for all potential predictors. The only variables that were significant predictors of wasting in urban children were maternal education, Body Mass Index (BMI) and household Wealth quintile.

Table 4. Predictors of childhood wasting for children 6-36 months of age in rural and urban settings

Variables	Model (A): Rural					Model (B): Urban				
	Std error	**OR**	**C.I for ORS**	**Wald F**	***P***	**Std error**	**OR**	**C.I for ORS**	**Wald F**	***P***
Dietary diversity										
Dietary diversity score	0.06	0.89	0.80, 0.99	4.94	0.027	-0.068	0.97	0.85, 1.11	0.35	0.680
Wealth quintile										
Poorest vs. Richest	1.34	0.26	0.02, 3.59	1.93	0.310	1.24	26.84	2.34, 308.57	2.06	0.009
Poor vs. Richest	1.33	0.51	0.04, 6.92		0.610	1.06	2.39	0.30, 19.25		0.410
Middle vs. Richest	1.36	0.77	0.05, 11.27		0.850	0.69	1.94	0.51, 7.52		0.330
Rich vs. Richest	1.32	1.09	0.08, 14.80		0.950	0.48	0.97	0.37, 2.49		0.940
Maternal education										
No education vs. Secondary+	0.42	1.16	0.50, 2.67	0.47	0.730	0.45	4.06	1.69, 9.80	8.40	0.002
Primary vs. Secondary+	0.39	0.80	0.39, 1.64		0.540	0.68	0.55	0.15, 2.01		0.360
Maternal occupation										
Agric/labour vs. White collar	0.32	0.57	0.31, 1.07	3.12	0.080	0.51	0.98	0.37, 2.74	0.001	0.960
Region										
Upper vs. Accra	0.58	0.51	0.16, 1.60	3.51	0.240	1.10	0.47	0.06, 4.10	2.30	0.500
Northern vs. Accra	0.55	0.47	0.16, 1.38		0.170	1.15	0.06	0.01, 0.58		0.015
Middle vs. Accra	0.54	0.22	0.07, 0.62		0.005	0.51	1.11	0.41, 2.99		0.840
South vs. Accra	0.53	0.27	0.10, 0.76		0.014	0.67	1.38	0.37, 5.15		0.630
Still breastfeeding										
Yes vs. No	0.34	3.25	1.66, 6.38	11.90	0.001	0.54	2.13	0.72, 6.21	1.94	0.170
Sex of child										
Female vs. Male	0.28	1.60	0.92, 2.74	2.83	0.090	0.49	1.20	0.46, 3.13	0.14	0.710
Continuous predictors										
Maternal height	2.06	0.07	0.001, 4.03	1.67	0.200	2.20	1.49	0.02, 112.88	0.03	0.860
Maternal BMI	0.06	0.86	0.77, 0.96	7.24	0.008	0.04	0.93	0.87, 0.99	4.74	0.031
Maternal age	0.03	0.63	0.94, 1.04	0.24	0.630	0.05	0.98	0.89, 1.07	0.30	0.590
Maternal parity	0.64	0.16	0.05, 0.58	7.94	0.005	0.72	0.60	0.15, 2.49	0.49	0.450
Child birth order	0.64	6.83	1.94, 24.01	9.06	0.003	0.74	1.79	0.42, 7.71	0.55	0.430
No. Of children U5	0.19	1.33	0.91, 1.95	2.13	0.150	0.24	1.14	0.71, 1.81	0.23	0.590

**Determinants of child nutritional status used in the logistic regression analysis; OR; Odds Ratio, C.I; Confidence Intervals, U5; Under five years*

3.2 Discussion

Our analysis shows that low dietary diversity is significantly associated with wasting among rural children, and not among urban children. The association between DDS and W/H remained after household wealth and other covariates were accounted for in multivariate analyses. The DDS-W/H relationship was stronger for children with lower BMI mothers compared to higher BMI mothers, in the rural sample only (i.e., the trend was more pronounced in the rural low BMI group than in the rural high BMI group). We assume that this reflects unmeasured variation in the quantity of food consumed, which is not captured by the DDS. Rural households with low dietary diversity may nevertheless have access to ample quantities of calories, reflected in higher BMI in mothers and less wasting in children. This possibility could not be investigated in this present study, due to a lack of sufficiently detailed data in the DHS on nutrient intake.

Comparing these findings with others reported in the literature, in Ethiopia Arimond and colleagues observed that dietary diversity was positively associated with child stunting in both urban and rural children [11]. However in this same study, child feeding index was significantly associated with childhood stunting only in the rural sample. A study in Mali found that the association between dietary diversity and child nutritional status was significant only in urban children for underweight and stunting, but not for wasting [22]. This divergent mix of significant and non-significant associations observed despite the employment of different methodologies by these studies, suggests that dietary diversity is associated importantly with child nutritional status, but that the underlying mechanisms are complex.

In that regard, we note that mean DDS is higher in urban than in rural children such that some of the potential for a protective effect is already achieved in urban children. There might be a threshold for protection from wasting, with DDS above a certain level being of diminished importance to health. Our enthusiasm for this explanation is tempered somewhat by the fact that on a DDS scale ranging from 0 to 16, the urban/rural difference score is a modest 1.04. Nevertheless, Arimond et al. [11] found that for every increase in DDS, there is a significant association with child nutritional outcome.

It is also important to note that our DDS scale places equal weight on all 16 food group items, and this may introduce a bias if food group composition varies systematically between urban and rural areas, or if food group consumption tends to happen in clusters of food groups, that might in turn differ by urban/rural residency. As Arimond and Ruel [2] observed, high dietary diversity may be more or less nutritionally meaningful, depending on local diet patterns. Thus, if many food groups are given but in very small quantities, the diversity scores will have less nutritional meaning [2]. In the context of our study, although urban children are slightly advantaged in terms of number of food items eaten over 24-hours, they might have received these food items in smaller quantities, while the rural children received the food groups available to them in larger quantities. An alternative approach to the study of the relationship between DDS and child growth could be to use a statistical method capable of identifying underlying patterns in food group consumption. Muthén and Christoffersson [34] suggest a method for the simultaneous factor analysis of dichotomous variables in two groups, which might work well for the 16 DDS items, and could be one way to tackle the problem of understanding food group consumption patterns in various socio-demographic groups (e.g., urban versus rural, richest versus poorest, etc.). However analyses in that direction were beyond the scope of this paper.

There are some limitations associated with our analysis. The DDS score was created using DHS data, which does not provide information on the quantity of food consumed or the adequacy of nutrient intake. This limitation notwithstanding, previous studies have shown that high dietary diversity is associated with adequate nutrient intake [2,4,9,10,11,12,13,35,36,37]. Another limitation has to do with the fact that the data are from a cross sectional study, and a causal relationship between dietary diversity and child nutritional status cannot be established. It is worth noting that the statistical power in the rural analysis was greater than in the urban analysis due to sample size differences. This affects the width of the confidence intervals around the O.R. estimates. Yet the O.R. for DDS in the urban sample is so close to one that we conclude there was no association. Of some concern, also, is the use of maternal self-reports of child size at birth, which is the only measure of child size available for almost all children, as many births in Ghana do not include weighing the new born. While the DHS reports that maternal self-report of child size is a good proxy measure, they do not cite data in support of this assumption [29]. However, one study has compared maternal self-report of child birth weight with measured weight, and observed no significant differences [38], and another found that self-report birth weights are unbiased but less precise than recorded birth weights [39].

A potential limitation of our regression analysis is that we could not use instrumental variables to address the problem of endogeneity, which could arise if DDS is determined by factors that also influence the outcome variable (wasting). Maternal education and household wealth index are likely factors that may directly influence the DDS as well as children nutritional status. Failure to control for endogeneity can lead to biased coefficient estimates [40]. One way to address the problem of endogeneity is the use of instrumental variables and two-stage regression methods. To use this method, it is important to identify at least one variable that is associated with the DDS but not with wasting. However, none of the variables available in DHS data meet this criterion [41].

4. CONCLUSION

Dietary diversity has a modest but statistically significant association with wasting among children in rural but not in urban Ghana. Interventions to combat acute malnutrition in rural settings should include efforts to promote the consumption of a variety of food groups.

CONSENT

Not applicable.

ETHICAL APPROVAL

Not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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