Research Article Open Access

Risk Factors for Undernutrition in Children under Five Years Old: Evidence from the 2011 Ghana Multiple Indicator Cluster Survey

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Abstract

Background: Undernutrition is a major public health problem affecting the physical and mental development of infants and young children in Ghana. Inadequate dietary intakes and the prevalence of infections have largely been implicated. This study was conducted to assess the risk factors for Undernutrition in Children under-five years old in Ghana.

Methods: This was a secondary data analysis of the 2011 Multiple Indicator Cluster Survey which included anthropometric measurements of children under five years old. Using the modified United Nations Children's Emergency Fund conceptual framework for undernutrition, the variables of interest were extracted and classified into biological and non-biological variables. Bivariate and logistic regression analysis was conducted using SPSS 21 to identify the risk factors for stunting, underweight and wasting.

Results: The survey recruited 7,550 children, 22.7% were stunted, 13.4% were underweight and 6.2% were wasted. Child age, gender, reported size at child birth, breastfeeding status, having diarrhoea or fever in the preceding two weeks, number of children in the household, child health insurance status, household wealth, and ethnicity and religion of household health and region were risk factors for undernutrition. However, only child age and sex were risk factors for all three indicators (stunting, underweight and wasting).

Conclusion: Undernutrition in Ghana is a multi-sectorial problem largely influenced by the social determinants of health and health inequalities. To reduce the prevalence of undernutrition in Ghana, strategies and interventions should be targeted at building the capacity of health staff and strengthening existing systems. This should include intensifying public health messages on child care, integration and collaboration with key stakeholders in addressing socio-economic inequalities of households and communities as well as the regional discrepancies.

Keywords: Undernutrition; Risk factors; Wasting; Stunting; Underweight; Ghana

Background

Undernutrition is a major public health issue in developing countries especially in Sub-Saharan Africa [1]. Globally, it is the leading cause of deaths in children under five years and accounts for about 3.1 million deaths in children under five years old in developing countries [2,3]. In addition, it is estimated that 165 million, 101 million and 52 million children younger than five years were stunted, underweight and wasted respectively [4]. All children have the same growth potential for at least up to the age of seven years [5]. However, food insecurity, environmental factors, disease and the burden of poverty can change growth patterns. The causes of undernutrition in children are complex and inter related and have been summarised in Figure 1 of the modified UNICEF conceptual framework of child survival and development by Black et al. [6].

Diet and disease are the immediate predictors of undernutrition in children under five years old. Household food insecurity, inadequate maternal and child care practices, unhealthy household environment and inadequate health services largely determine if a child has adequate dietary intake or is exposed to infections [6]. These factors are further influenced by income and poverty which are key drivers of undernutrition in children. The growing prevalence of parasitic and bacterial infections in developing countries has largely contributed to undernutrition, which also tends to increase the duration and severity of infections [7]. This puts children at a risk of getting caught in the undernutrition-infection cycle [8].

Since undernutrition affects the physical and mental development of children. These disadvantaged children are likely to progress poorly in school, be less productive in adulthood, earn less and provide poor care for their children, resulting in the intergenerational cycle of poverty [9]. It is estimated that low income in developing countries like Ghana further risk losing between 2 and 3% of their annual Gross Domestic Product (GDP) from child undernutrition [10].
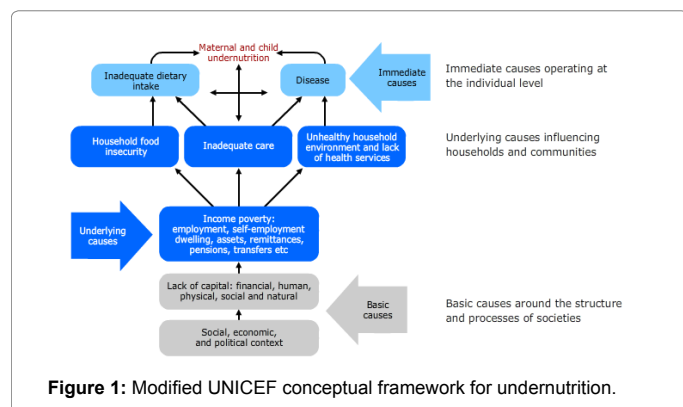
In Ghana, poverty is a major contributor to food insecurity with poorer households being more likely to have poorer food (quality and quantity) intakes [11]. Agriculture is a major contributor to the Ghanaian economy, but production has declined from 7% in 2009 to 2.6% in 2012 and this has negatively impacted in terms of food production and availability of food [12]. Undernutrition rates are not evenly distributed in Ghana and children in the three northern regions (Northern, Upper East and Upper West) of Ghana have lower weight related Z scores and an increased prevalence of acute undernutrition than those in the southern zone (Ashanti, Western, Eastern, Central,

Figure 1: Modified UNICEF conceptual framework for undernutrition.

Volta, Brong-Ahafo and Greater Accra regions) of Ghana [13]. Also, the distribution of rainfall pattern in the country is not even as the three northern regions experience unimodal rainfall whilst the rest of the country has a bimodal rainfall pattern and this negatively affects food security in these regions [14,15].

Urbanisation and the increase in population growth rates has led to an urban population growth increasing from 44% in 2000 to 50% in 2010 in Ghana [16]. Rapid urbanisation has resulted in the development of slums, poor housing and inadequate water supply [17]. This has had negative consequences on the wellbeing of the Ghanaian population. Also, the majority of rural households in Ghana do not have potable drinking water (31%) compared with those in urban areas where about 91% of the population have access. About 23% of the households in rural communities do not have access to any toilet facilities and 38.5% of children in these areas are considered vulnerable to diarrhoea and other infections [15].

The Government of Ghana has made efforts toward addressing undernutrition in children. It has been a signatory to many international declarations to improve child health and development. Nutrition intervention policies and programs have included food demonstration and nutrition education (1957-1966), attitude/behaviour change communication in nutrition (1966-1974), weaning foods and supplementary feeding programs (1974-1987), micronutrient deficiencies (1987-1990), exclusive breastfeeding programs (1990-2000), community based growth monitoring and promotion (2000-2008) and currently the Scaling Up Nutrition (SUN-2010) program . However, because most of these programs are donor driven, successive governments have not made commitments in terms of allocating sufficient human and financial resources for effective coordination and monitoring and evaluation of these programs, which has affected sustainability [18].

This study was conducted to provide an in-depth analysis of the 2011 Multiple Indicator Cluster Survey data to assess the risk factors of undernutrition in children under five years old. To the best of our knowledge no such analysis has been conducted and we believe that providing evidence of risk factors of undernutrition will help inform policy and decision making regarding resource allocation and nutrition programme interventions in the country.

Methods

Study design and study area

This is a secondary data analysis of the 2011 national Multiple Indicator Cluster Survey (MICS) conducted by the Ghana Statistical Service (GSS), that collected data on the health status of husbands or household heads (15-49 years), and women (15-49 years) with a child under five years old. Full details of the survey are available in the MICS report [15].

Ghana was stratified into ten administrative regions and then into rural and urban. The MICS was a two-stage sample survey. The primary sampling units were randomly selected from the 2010 Ghana population and housing census which was made up of 810 Enumeration Areas (EAs) [19]. Fifteen (15) households were randomly selected in each EA giving a total of 12,150 households of which 11,925 households with 7,550 children under five years old were surveyed. The selection was done using systematic random selection procedures.

Data collection and analysis

Data were collected by 20 trained field teams that spread across the country using face-to-face questionnaires between September-December, 2011. The questionnaires collected information on household, demographic and socio-economic characteristic. Nutrition related data included breastfeeding status, height and weight of children and demographic characteristics.

Clean data files were obtained from the GSS. Frequencies were run to observe distribution patterns and checks made for outliers. The unique identification variables in the household were; father, mother and child files were merged to create a common file. Analysis was carried out using SPSS version 21. Nutritional status is a reflection of health and measured using indices of height for age (HAZ), weight for age (WAZ) and weight for height (WHZ) based on z-scores. Stunting, underweight and wasting were defined as HAZ, WAZ and WHZ below minus two standard deviations (<-2 SD) [20]. These three are therefore the main indicators for undernutrition. Stunting reflects linear growth retardation and it's a measure of chronic undernutrition, wasting reflects acute undernutrition while underweight is a composite measure of both chronic and acute undernutrition.

The MICS used a household wealth index which was based on principal component analysis using household ownership assets such as electricity, television and DVD player, radio, laptop/desktop computers, mobile phone, refrigerator, washing machine, sewing machine, material for floor and roofing, water access and sanitation facilities. Economic inequality was measured by categorising the wealth into five quintiles with the lowest quintile being the proportion of 20% of the poorest household and the highest quintile representing 20% of the richest households in Ghana. The variables collected for education of mother and father refer to the highest level of school completed.

Bivariate analysis was conducted using chi squared tests to identify those biological and non-biological factors associated with stunting, underweight and wasting. The variables associated with undernutrition were then used to develop logistic regression models to identify the risk factors for stunting, underweight and wasting. For each of the nutritional indicator, a model was developed for the non-biological factors, i.e., socio-economic and demographic factors, and another for biological factors such as child age, gender, recent morbidity history. The final model used the variables identified as being significant in the above two models. Results of the multivariate analysis are presented as odd ratios. All tests were done using a 95% confidence interval with a probability value <0.05 being considered statistically significant.

Ethics

Ethical approval was given by Faculty of Medicine Ethics Committee of the University of Southampton, UK. Approval was also given by the GSS for the use of the 2011 MICS data. This was a secondary analysis of anonymous human data where no individual could be identified from the data set.

Results

Descriptive analysis

Table 1 shows a total of 7,550 children under five years old who were included in the study as well as the characteristics of the study population. Study characteristics such as; age of child, sex of child, reported size of child at birth, currently breastfed, diarrhoea in the last 2 weeks, cough in the last 2 weeks, etc. were reported in the study.

Measurement models

Table 2 is the bivariate analysis model that shows biological and non-biological factors, and their association with stunting, underweight and wasting. The study observed that 22.7% of the children under five years old were stunted, 13.4% were underweight and 6.2% were wasted. For the biological factors, the age of a child was statistically associated with undernutrition (All p=0.001). Fewer children under twelve months old were stunted compared with those in the other age groups but the opposite was true for wasting whilst fewer children less than six months were underweight compared with the rest. Also, the sex of child was associated with undernutrition with more boys being stunted, underweight and wasted than girls (All p=0.001). The reported size of a child at birth was inversely associated with stunting and underweight (both p=0.001) but not associated with wasting (p=0.219).

Whether a child was currently breastfed was associated with undernutrition. More children who were currently breastfed were underweight (p=0.008) and wasted (p=0.001) but the opposite was observed for stunting (p=0.001). Having diarrhoea in the preceding two weeks was positively associated with being stunted (p=0.001), underweight (p=0.001) and wasting (p=0.046). Similarly, children who had a cough in the preceding two weeks were associated with being underweight (p=0.003) and children who had fever in the preceding two weeks were positively associated with being underweight and wasted (both p=0.001).

Among the non-biological factors, location and region of residence were associated with undernutrition. More children in rural areas were associated with stunting (p=0.001) and underweight (p=0.001) than those in the urban areas. The region of residence was associated with stunting, underweight and wasting (All p=0.001). The prevalence of stunting and underweight were higher in the Northern and Upper East regions while the opposite was true for the Greater Accra region. The Upper West and Volta regions were highly associated with wasting. Increasing household wealth was positively associated undernutrition (All p=0.001). Similarly, whether a child had health insurance was associated with better nutrition (p<0.05).

Both mother's and father's age were associated with stunting (p=0.001) and underweight (p=0.035) and maternal age was also associated with wasting (p=0.046). The pattern was 'U' shaped with more children of younger or older parents being undernourished than those in the middle age groups. Additionally, maternal literacy was associated with stunting and underweight (both p=0.001) but not wasting (p=0.086)). More children whose mothers could not read at all were associated with stunted and underweight compared with those who could read part or all of a sentence. Unsurprisingly, increasing level of mother's education was also positively associated with a lower prevalence of stunting, underweight and wasting (All p=0.001). Father's educational level was associated with stunting and underweight (both p=0.001) but not wasting (p=0.480).

Marital status was also associated with stunting (p=0.012) and underweight (p=0.001) with fewer children whose mothers were currently or never married being stunted and underweight compared with children of mothers who were formerly married. Whether the husband had other wives was positively associated with stunting and underweight (both p=0.001). In addition, the number of children living at home was associated with stunting, underweight and wasting (All p=0.001) with greater children from households having five or six being stunted and wasted while the opposite was for underweight. Ethnicity was associated with undernutrition with more children from the Guan and Grusi headed household being stunted (p=0.001) and underweight (p=0.001). The prevalence of wasting was highest among the Mole/Dagbani and Grusi. Grusi were particularly vulnerable to stunting, underweight and wasting. The religion of the household head was also associated with stunting and underweight (both p=0.001) but not wasting (p=0.298). More children from the spiritualist/traditionalist households were stunted and underweight than those from other religions.

Table 3 shows a logistic regression analysis model. Only factors that were significant in the bivariate analysis model were included in the logistic regression model. Among the biological factors, there was an overall effect of age on stunting. Stunting increased with age and peaked at age group 24-35 months, where children were 6.1 times (95% CI 4.29-8.72) more likely to be stunted than their peers in age group 0-5 months. Also, the risk of underweight increased with a child's age and peaked at 24-35 months old (OR=4.51 95% CI 2.55-7.99). However, children within age groups, 36-47 months (OR=0.42, 95% CI 0.25-0.68) and 48-59 months old (OR=0.50, 95% CI 0.30-0.82) were protected against wasting as compared to children within the age group 0-5 months old. Similarly, females were 26%, 38% and 29% less likely to be stunted (OR=0.74, 95% CI 0.64-0.87), wasted (OR=0.62, 95% CI 0.51-0.75) and underweight (OR=0.71, 95% CI 0.60-0.84) respectively than their male counterparts. The reported size at birth was also a risk factor for stunting and underweight with risk increasing with decreasing reported size at birth.

Breastfeeding status was a risk factor for being underweight and wasted with children who were not breastfed being 61% (OR=0.39 95% CI 0.3-0.89) less likely to be underweight and 43% (OR 0.57, 95% CI 0.40-0.80) less likely to be wasted than those who were breastfed. Children who had no diarrhoea in the preceding two weeks were 27% (OR=0.73 95% CI 0.59-0.90) less likely to be underweight than those who had diarrhoea. Similarly, children who did not have fever in the preceding two weeks were 27% (OR=0.73 95% CI 0.59-0.89) less likely to be wasted than those who had fever.

Among the non-biological factors, region of residence was a risk factor for underweight. Children in the Northern and Upper East regions were 2.02 (95% CI 1.32-3.11) and 1.65 (95% CI 1.02-2.66) times more likely to be underweight than those in the Western region. Children from Brong Ahafo region were 58% (OR=0.42, 95% CI 0.21-0.83) less likely to be wasted than their colleagues in Western region. However, there was no significant association between Western region and other regions regarding stunting. Being in the richest quintile was protective against stunting (OR=0.42, 95% CI 0.28-0.63) as well as protective against underweight (OR=0.40 95% CI 0.23-0.70) when

Variables	Label	No.	%
Age of child (months)	0-5	818	10.8
	6-11	725	9.6
	12-24	1453	19.2
	24-35	1553	20.6
	36-47	1576	20.9
	48-59	1426	18.9
	Total	7550	100.0
Sex of child	Male	3757	49.8
	Female	3793	50.2
	Total	7550	100.0
Reported size of child at birth	Very large	644	8.5
	Larger than average	1308	17.3
	Average	1821	24.1
	Smaller than average	384	5.1
	Very small	134	1.8
	Total	4292	58.8
Variable	Label	No.	%
Currently breastfed	Yes	2712	36.4
	No	4747	62.9
	Total	7459	98.8
Diarrhoea in last 2 weeks	Yes	956	12.7
	No	6592	87.3
	Total	758	100.0
Cough in last 2 weeks	Yes	1570	20.8
	No	5979	79.2
	Total	7549	100.0
Fever in last 2 weeks	Yes	1427	18.9
	No	6122	81.1
	Total	7549	100.0
Location	Urban	3283	43.5
	Rural	4267	56.5
	Total	7550	100.
Region	Western	758	10.0
	Central	740	9.8
	Greater Accra	1142	15.1
	Volta	601	8.0
	Eastern	827	11.0
	Asante	1411	18.7
	Brong Ahafo	671	8.9
	Northern	852	11.3
	Upper East	325	4.3
	Upper West	223	3.0
	Total	7550	10.0
Household wealth quintile	Poorest	1730	22.9
	Second	1551	20.5
	Third	1559	20.6
	Fourth	1397	18.5
	Richest	1313	17.4
	Total	7550	100.0
Child has health insurance	Yes	4059	53.8
	No	3491	46.2
	Total	7550	100.0
Mother's age	15-19 years	232	2.1
	20-24 years	1058	14.0
	25-29 years	1738	23.0
	30-34 years	1820	24.1
	35-39 years	1263	16.7
	40-44 years	611	8.1
	45-49 years	328	4.3
	Total	7050	93.4
Father's age	<25 years	164	2.2
	25-29 years	792	10.5
	30-34 years	1309	17.3
	35-39 years	1358	18.0
	40-44y ears	1043	13.8
	45-49 years	706	9.4
	50-54 years	368	4.9
	55+ years	410	5.4
	Total	6151	81.5
Variable	Label	No.	%
Mother's literacy	Cannot read at all	4610	61.1
	Only parts of a sentence	575	7.6
	Whole sentences	1019	13.5
	Total	6203	82.2
Mother's education	None	2954	39.1
	Primary	1628	21.6
	Middle/JSS	2578	34.1
	Secondary+	390	5.2
	Total	7550	100.
Father's education	None	1964	26.0
	Primary	770	10.2
	Middle/JSS	2071	27.4
	Secondary+	579	7.7
	Total	5385	71.3
Marital status	Currently married	6372	84.4
	Formerly married	341	4.5
	Never married	337	4.5
	Total	7550	93.4
Husband has other wives	Yes	1201	15.9
	No	5171	68.5

	Label	No.	%
Husband has other wives Ethnicity of household head	Total	6372	84.4
Ethnicity of household head	Akan	3122	41.3
	Ga/Dangbe	618	8.2
	Ewe	1008	13.4
	Guan	726	9.6
Ethnicity of household head Religion of household head	Mole Dagbani	1452	19.2
	Grusi	297	3.9
	Others	327	4.3
	Total	7550	100.0
	Christian	4910	65.0
Religion of household head	Muslim	1495	19.8
	Spiritualist/Traditionalist	574	7.6
Religion of household head No. of children living at home	Other/None	571	7.6
	Total	7550	100.0
	1 child	1529	20.2
No. of children living at home	2 children	1809	24.0
	3 children	1425	18.9
	4 children	1148	15.2
No. of children living at home	5 children	664	8.8
	6+ children	429	5.7
	Total	7003	92.8

Table 1: Distribution of the biological and non-biological characteristics of respondents (n=7,550).

compared to the poorest quintile. In addition, a child registered on health insurance had an increasing risk of being underweight (OR=1.56 95% CI 1.30-1.87) than children without health insurance. Muslims and traditional headed households were 42% (OR=1.42, 95% CI 1.14-1.77) and 46% (OR=1.46, 95% CI 1.15-1.85) more likely to be stunted than those from the Christian headed households.

Discussion

The findings of this study confirm that undernutrition in children less than five years old in Ghana is related to health and sanitation services, economic and regional differences which agree with previous findings [21]. The age of a child was a risk factor for both chronic and acute undernutrition. Stunting was higher in older children which is consistent with studies by Kabubo-Mariara et al. [22] and this may be due to micro and macro nutrient deficiencies, inadequate feeding practices, infections and exposure to pathogens in the environment [23]. Younger children 0-5 months old were less stunted and this may be because they are still being breastfed [24]. Fewer children aged 36-47 months and 48-59 months old were wasted compared with the younger age groups and this might have been due to recent food shortage or seasonal infections [23].

Gender was also found in this study to be a risk factor for both chronic and acute undernutrition. Males were more undernourished than females in this study, which is consistent with studies reported by Van de Poel et al. [25] and Wamani et al. [26]. Zere and McIntyre [27] have shown that females are advantageous in terms of anthropometry

		Stunting [a]			Underweight [b]			Wasting [c]		
Variable	Label	No.	%	p	No.	%	p	No.	%	p
Age of child (months)	0-5	795	7.8	0.001	801	6.7	0.001	795	11.4	0.001
	6-11	714	12.5		715	15.8		714	11.2	
	12-24	1411	26.4		1422	16.5		1418	7.7	
	24-35	1516	28.2		1519	13.5		1520	4.7	
	36-47	1522	27.9		1534	13.7		1531	2.8	
	48-59	1382	21.3		1384	12.2		1403	4.6	
	Total	7340	22.7		7375	13.4		7381	6.2	
Sex of child	Male	3635	25.3	0.001	3665	15.4	0.001	3665	7.3	0.001
	Female	3703	20.3		3709	11.3		3716	5.2	
	Total	7338	22.7		7374	13.4		7381	6.2	
Reported size of child at birth	Very large	630	15.2	0.001	632	8.9	0.001	625	6.6	0.219
	Larger than average	1280	19.9		1286	9.2		1287	7.5	
	Average	1774	22.7		1789	16.5		1782	8.9	
	Smaller than average	378	25.7		378	19.0		378	6.9	
	Very small	132	32.6		129	27.1		129	10.1	
	Total	4194	21.3		4214	13.7		4201	8.0	
Currently breastfed	Yes	2658	17.8	0.001	2672	14.9	0.008	2658	9.9	0.001
	No	4595	25.6		4616	12.7		4634	4.2	
	Total	7253	22.7		7288	13.5		7292	6.3	
Diarrhoea in last 2 weeks	Yes	939	29.9	0.001	942	19.2	0.001	936	7.7	0.046
	No	6400	21.7		6433	12.5		6444	6.0	
	Total	7339	22.8		7375	13.4		7380	6.2	
Cough in last 2 weeks	Yes	1542	24.3	0.112	1544	15.6	0.003	1549	7.0	0.134
	No	5796	22.3		5831	12.8		5832	6.0	
	Total	7338	22.7		7375	13.4		7381	6.2	

Variable	Label	No.	%	p	No.	%	p	No.	%	p
Fever in last 2 weeks	Yes	1404	24.1	0.186	1409	17.1	0.001	1407	8.2	0.001
	No	5934	22.4		5965	12.5		5972	5.7	
	Total	7338	22.7		7374	13.4		7379	6.2	
Location	Urban	3193	18.1	0.001	3196	10.5	0.001	3191	5.7	0.090
	Rural	4145	26.3		4178	15.5		4190	6.6	
	Total	7338	22.7		7374	13.3		7381	6.2	
Region	Western	713	22.6	0.001	718	14.3	0.001	722	7.6	0.001
	Central	723	23.1		727	13.5		728	5.5	
	Greater Accra	1110	13.7		1110	8.3		1119	3.1	
	Volta	589	22.1		590	10.8		597	8.5	
	Eastern	812	21.3		816	10.5		811	6.8	
	Asante	1370	21.7		1377	11.9		1367	6.6	
	Brong Ahafo	655	19.2		660	11.8		661	3.2	
	Northern	834	37.4		836	24.2		840	8.1	
	Upper East	318	31.4		322	19.9		319	7.2	
	Upper West	215	23.3		219	15.1		215	9.3	
	Total	7339	22.7		7375	13.3		7379	6.2	
Household wealth quintiles	Poorest	1670	33.2	0.001	1687	20.0	0.001	1694	7.6	0.001
	Second	1522	26.7		1532	14.8		1532	14.8	
	Third	1528	22.8		1526	13.2		1526	13.2	
	Fourth	1364	15.8		1372	10.3		1372	10.3	
	Richest	1255	11.6		1258	6.3		1258	6.3	
	Total	7339	22.7		7375	13.4		7375	13.4	

		Stunting			Underweight			Wasting		
Variable	Label	No.	%	p	No.	%	p	No.	%	p
Child has health insurance	Yes	3945	21.6	0.013	3969	11.4	0.001	3955	4.7	0.001
	No	3394	24.1		3406	15.6		3425	8.0	
	Total	7339	22.8		7375	13.4		7380	62	
Mother's age	15-19	226	23.5	0.001	230	16.5	0.035	226	9.3	0.046
	20-24	1026	25.0		1033	14.9		1031	7.3	
	25-29	1692	22.2		1697	13.5		1695	7.0	
	30-34	1775	19.8		1787	11.9		1782	5.3	
	35-39	1240	20.9		1237	11.9		1238	5.5	
	40-44	601	27.3		605	15.9		601	6.5	
	45-49	316	26.3		318	11.9		325	8.3	
	Total	6876	22.4		6907	13.2		6898	6.4	
Father's age	<25 years	162	26.5	0.001	162	18.5	0.001	162	7.4	0.371
	25-29 years	764	24.3		771	17.3		764	7.5	
	30-34 years	1277	21.5		1282	11.1		1273	5.6	
	35-39 years	1329	17.3		1327	10.2		1335	6.2	
	40-44y ears	1019	20.9		1027	13.6		1028	5.8	
	45-49 years	696	23.6		696	14.9		694	8.1	
	50-54 years	361	28.5		367	12.8		364	6.6	
	Total	6005	22.3		6032	13.3		6021	64	
Mother's literacy	Cannot read at all	4520	25.5	0.001	4538	15.0	0.001	4539	6.7	0.086
	Only parts of a sentence	554	18.1		560	9.3		556	4.5	
	Whole sentences	993	18.2		1003	10.6		995	5.7	
	Total	6067	23.6		6101	13.8		6090	6.4	
Mother's education	None	2869	27.0	0.001	2883	16.4	0.001	2885	7.7	0.001
	Primary	1589	25.2		1602	13.7		1605	5.1	
	Middle/JSS	2515	18.2		2523	10.8		2526	5.2	
	Secondary+	365	9.9		365	5.8		365	6.0	
	Total	7338	22.7		7373	13.3		7381	6.2	

Father's education	None	1917	25.7	0.001	1937	16.2	0.001	1922	6.9	0.480
	Primary	758	29.3		762	15.7		763	5.4	
	Middle/JSS	2025	18.3		2035	11.1		2030	6.3	
	Secondary+	560	12.9		557	7.4		557	5.9	
	Total	5260	22.0		5291	13.2		5272	6.3	
Marital status	Currently married	6221	22.1	0.012	6250	13.3	0.001	6237	6.5	0.210
	Formerly married	330	29.1		331	15.7		335	7.5	
	Never married	324	21.9		328	10.4		327	4.3	
	Total	6875	22.4		6909	13.3		6899	6.4	
Husband has other wives	Yes	1171	28.8	0.001	1178	17.4	0.001	1178	6.2	0.681
	No	5049	20.6		5072	12.3		5058	6.5	
	Total	6220	22.1		6250	13.3		6236	6.5	
No. of children living at home	1 Child	1478	18.9	0.001	1485	14.2	0.001	1479	8.7	0001
No. of children living at home	2 children	1763	22.7		1777	11.0		1777	4.5	
	3 children	1390	21.8		1399	12.1		1393	5.2	
	4 children	1128	22.1		1128	13.4		1131	5.4	
	5 children	654	25.7		653	12.6		655	9.6	
	6+ children	417	30.5		422	7.8		417	8.6	
	Total	6830	22.3		6864	13.3		6852	6.4	
		Stunting			Underweight			Wasting		
Variable	Label	No.	%	p	No.	%	p	No.	%	p
Ethnicity of household head	Akan	3022	20.2	0.001	3028	11.7	0.001	3037	5.4	0.021
	Ga/Dangbe	596	18.5		600	12.7		605	5.0	
Ethnicity of household head Religion of household head	Ewe	984	19.2		989	10.0		991	6.4	
Ethnicity of household head Religion of household head	Guan	709	33.9		713	18.7		713	5.6	
	Mole Dagbani	1422	26.4		1431	16.9		1423	7.9	
	Grusi	288	30.9		296	18.6		290	7.9	
	Others	318	17.9		318	8.5		321	7.5	
	Total	7339	22.8					7380	6.2	
	Christian	4763	19.7	0.001	4778	11.3	0.001	4789	5.8	0.298
	Muslim	1460	27.4		1472	17.6		1464	7.0	
Religion of household head	Spiritualist/Traditional	564	33.3		565	18.6		566	6.7	
Religion of household head	Other/None	552	25.5		560	14.8		562	6.9	
	Total	7339	22.7		7375	13.4		7381	6.2	

[a] A stunted child has a height-for-age Z-score that is below -2 SD based on the new WHO reference population
[b] An underweight child has a weight-for-age Z-score that is below -2 SD based on the new WHO reference population.
[c] A wasted child has a weight-for-height Z-score that is below -2 SD based on the new WHO reference population
P-value for bivariate (p-value at 0.05 levels)

Table 2: Bivariate analysis showing associations between biological and non-biological variables and stunting, underweight and wasting.

than males and this might be accounting for our findings in this current study. The reported size of a child at birth predicted chronic undernutrition. Van de Poel et al. [25] observed same finding during the 2003 Ghana demographic and health survey. The intergenerational cycle of growth failure might be accounting for this outcome as there is an increased likelihood of mothers with low maternal height and weight coupled with inadequate nutrition before and during pregnancy giving birth to smaller babies [28]. Our findings show that very small or smaller than average babies were at a greater risk of stunting and underweight than larger babies. This may be attributed to smaller babies more likely to have slower catch up growth compared with larger babies [29].

The region of residence of children under five years old was a predictor of both chronic and acute undernutrition. Underweight prevalence was high in the Northern and Upper East regions which agree with the studies by Harding et al. [13] and Van De Poel et al. [25]. This trend may be due to the rainfall pattern and the prolong periods of drought in the Northern part of Ghana. Past prevalence of undernutrition in these regions might be a contributory factor [5], resulting into an intergenerational vicious cycle of undernutrition.

The risk of stunting and wasting was lowest in the Brong-Ahafo which is unsurprising as it is the region regarded as the food basket of Ghana. Additionally, household wealth was a risk factor for chronic undernutrition which was in line with findings reported by Hong [30] and Van De Poel et al. [25] who found that children from better-off households had better nutritional outcomes than poorer households. Long term cumulative effect of food insecurity and poor accessibility to improved health, water and sanitation might be accounting for the higher prevalence of undernutrition in poorer households [31].

Children having health insurance was a risk factor for underweight. Having health insurance increases access to utilisation of health services in Ghana [32]. However, our findings on the contrary showed that having health insurance increased the risk of being underweight. This is probably because parents of 'sicker' children are more likely to get health insurance for their child. This study also reported currently breastfeeding, recent morbidity and number of children in a household as risk factors for acute undernutrition. Children who were currently breastfed were at higher risk of being underweight and wasted. In spite of the importance of breastfeeding, children are likely to become acutely undernourished if they are not fed on the appropriate complimentary foods [6] and this might be responsible for our observation. Fever is the leading cause of morbidity in children and accounts for 34% of under-five deaths [15]. A repeated episode of fever which is often due to malaria reduces the immune response of children increasing their vulnerability to infections [33]. Thus, children with fever are more likely to suffer from acute undernutrition than their peers without fever as reported in this study. Similarly, a recent history of diarrhoea was a risk factor for underweight. The prevalence of diarrhoea is common in developing countries like Ghana where water and sanitation facilities are inadequate and are associated with a decrease in weight [34,35]. Nearly a quarter of Ghanaian households do not have access to toilet facilities and portable water which leaves them with no choice than to defecate in the open [15], making children more vulnerable to diarrhoeal diseases and other infections.

In addition, having three or more children in a household increased the risk of undernutrition. This may be due to increased competition for household foods which may affect both the quality and quantity of food given at home. Adequate maternal attention and care may also decrease whilst overcrowding may increase as a result of an increase in number of children living in a household. These tend to make children more vulnerable to the spread of infections and morbidity and more likely to suffer from undernutrition [36].

We believe that our study is strong as findings are based on a national representative survey data that recruited a large sample size of 7,550 children under five years old using standardised data collection methods. It also included a wealth/asset index to capture economic or income status because it is difficult to obtain reliable and accurate data on income expenditure. However, our study was limited as it was conducted outside the food shortage season (March to June), hence this might have affected weight measurements of children. This study did not also analyse the dietary intakes as most of the information collected on the MICS was on micronutrient intake. Thus, no analysis on feeding practices in terms of frequency, amount and density of food consumed was conducted.

Conclusion

The findings of this study provide evidence of chronic and acute undernutrition still prevalent in children under five years old in Ghana. Independent risk factors for undernutrition were identified as sex, age, reported size at birth, breastfeeding status, number of children in a household, child having health insurance, fever, diarrhoea, household wealth, ethnicity and region of residence. In order to improve on the health and nutritional status of children in Ghana, a holistic and inter-sectorial collaboration and consultation between the

Variable	Label	Stunting			Underweight			Wasting		
		OR	95% CI Lower	95% CI Upper	OR	95% CI Lower	95% CI Upper	OR	95% CI Lower	95% CI Upper
Age of child (months)	0-5^	1.00			1.00			1.00		
	6-11	1.35	0.98	1.87	2.33	1.68	3.22	1.10	0.80	1.50
	12-24	3.84	2.94	5.00	3.35	2.49	4.49	0.90	0.68	1.20
	24-35	6.12	4.29	8.72	4.51	2.55	7.99	0.76	0.51	1.13
	36-47	4.04	3.00	5.43	3.24	1.91	5.51	0.42	0.25	0.68
	48-59	3.43	2.54	4.62	3.60	2.12	6.13	0.50	0.30	0.82
Variable	Label	Stunting			Underweight			Wasting		
		OR	95% C.I Lower	95% C.I Upper	OR	95% C.I Lower	95% C.I Upper	OR	95% C.I Lower	95% C.I Upper
Sex of child	Male^	1.00			1.00			1.00		
	Female	0.74	0.64	0.87	0.71	0.60	0.84	0.62	0.51	0.75
Reported size of child at birth	Very large^	1.00			1.00					
	Larger than average	1.46	1.10	1.93	1.15	0.82	1.61			
	Average	1.71	1.31	2.23	1.81	1.32	2.49			
	Smaller than average	2.28	1.63	3.17	2.59	1.78	3.77			
	Very small	2.17	1.38	3.42	3.06	1.89	4.95			

		OR			OR			OR		
Currently breastfed	Yes^				1.00			1.00		
	No				0.59	0.39	0.89	0.57	0.40	0.80
Diarrhoea in last 2 weeks	Yes^				1.00					
	No				0.73	0.59	0.90			
Fever in last 2 weeks	Yes^							1.00		
	No							0.73	0.59	0.89
No. of children living at home	1 child^							1.00		
	2 children							0.72	0.54	0.97
	3 children							0.79	0.59	1.05
	4 children							0.85	0.63	1.15
	5 children							1.25	0.92	1.70
	6+ children							1.08	0.75	1.56
Region	Western^	1.00			1.00			1.00		
	Central	0.83	0.57	1.22	1.16	0.73	1.84	0.80	0.50	1.30
	Greater Accra	0.65	0.37	1.16	0.82	0.40	1.66	0.60	0.31	1.17
	Volta	0.76	0.45	1.29	0.84	0.46	1.54	1.17	0.68	2.03
	Eastern	1.13	0.69	1.85	1.24	0.68	2.24	0.95	0.53	1.72
	Asante	1.07	0.69	1.65	1.44	0.84	2.45	0.92	0.53	1.61
	Brong Ahafo	0.63	0.38	1.03	1.03	0.57	1.84	0.42	0.21	0.83
	Northern	1.37	0.92	2.06	2.02	1.32	3.11	1.12	0.73	1.72
	Upper East	1.05	0.67	1.65	1.65	1.02	2.66	1.09	0.68	1.73
	Upper West	0.75	0.48	1.16	1.48	0.92	2.36	1.20	0.77	1.88
Household wealth quintile	Poorest^	1.00			1.00					
	Second	0.91	0.74	1.13	1.01	0.80	1.28			
	Third	0.86	0.66	1.12	1.02	0.76	1.38			
	Fourth	0.47	0.34	0.64	0.87	0.62	1.22			
	Richest	0.42	0.28	0.63	0.40	0.23	0.70			
Child has health insurance	No^				1.0					
	Yes				1.56	1.30	1.87			
Ethnicity of household head	Akan^	1.00								
	Ga/Dangbe	0.79	0.48	1.32						
	Ewe	0.70	0.47	1.05						
	Guan	0.98	0.69	1.39						
	Mole Dagbani	0.99	0.72	1.37						
	Grusi	1.40	0.92	2.12						
	Others	0.62	0.40	0.98						
Religion of household head	Christian^	1.00								
Religion of household head	Muslim	1.42	1.14	1.77						
	Spiritualist/Traditionalist	1.46	1.15	1.85						
	Other/None	1.12	0.82	1.54						

OR=Odd ratio, ^Reference population

Table 3: Logistic regression analysis showing relative risk of being stunted, underweight and wasted.

Ministry of Health/Ghana Health Service with relevant stakeholders such as the District Assemblies, the Environmental and Sanitation Department, the National Health Insurance Authority, the Ministry of Education, Ministry of Food and Agriculture is needed to design and implement result oriented policies and intervention programmes to tackle undernutrition in Ghana. Policies and nutrition intervention programmes should be geared towards boosting household income, increasing access to food supplies, improving water and sanitation facilities both in rural and urban areas as well as access to healthcare by all. Further inter-disciplinary research is needed to understand how behavioural and resource allocation of some ethnicities and regions respectively have higher prevalence of undernutrition in Ghana.

Authors' Contribution

RWM and PAA conceived and designed the study and analyzed the data and wrote the first draft. ZA critically revised the draft for important intellectual content. All authors read and approved the final manuscript.

Acknowledgement

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