

BMJ Open Prevalence and determinants of underweight and overweight/obesity among Ghanaian children: a cross-sectional study using DHS data in Ghana

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ABSTRACT

Background There is a global rise in the burden of childhood obesity, increasing the risk of early onset adult obesity. Most developing countries face the double burden of malnutrition; overnutrition as overweight/obesity and undernutrition.

Objectives To determine the current burden and determinants of childhood thinness, overweight and obesity using national survey data.

Design Data from a cross-sectional survey conducted in 2022 were used.

Setting Data from the seventh Demographic Health Survey conducted in Ghana were used.

Participants The participants included 4417 children ≤59 months.

Method The seventh Ghana Demographic Health Survey in 2022 employed a two-stage stratified cluster sampling design, selecting 618 clusters to create a nationally representative sample. Weight and height were measured using the SECA 874U scale and Shorrboard, respectively. Children's heights were measured recumbent (<24 months) or standing (>24 months). Multivariate logistic regression was used to assess the relationship between thinness and obesity, as well as the independent factors.

Outcome variable The outcome variable was obesity, determined by a WHZ of >+2SD.

Results The weighted prevalence of overweight/obesity and thinness in children under 5 years is 9.9% and 5.2%, respectively. Children who were overweight or obese had a mean age of 23.11 months, those who were thin or severely thin had a lower mean age of 21.02 months, and those with normal nutritional status were relatively older, with a mean age of 28.41 months. The Upper West, Northeast and Northern regions had the lowest densities of obesity. In the multivariate logistic regression model, children residing in Ashanti, Oti, Northern, North East and Upper East regions had significantly reduced odds of being obese compared with those in the Ahafo region. The average haemoglobin for those overweight/obese was 10.8 g/dL, and 10.7 g/dL for those who were normal

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The use of Ghana Demographic and Health Survey data ensured it was nationally representative.
- ⇒ The use of multivariate logistic regression analysis helped eliminate confounders.
- ⇒ The use of regional averages of obesity and thinness could mask outlier districts/areas within a region.

and marginally reduced, 10.5 g/dL for those who were thin.

Conclusion Regional disparities, maternal nutritional status, socioeconomic conditions and unsafe water sources were significant determinants of child nutrition outcomes. These findings call for targeted, multipronged interventions that integrate maternal-child nutrition, safe water, sanitation and regional context.

BACKGROUND

The nutritional status of children is a good indicator of their health and general well-being.¹ Malnutrition continues to be a significant global health and development issue, especially among children under 5 years. This has a particular impact on low- and middle-income countries like Ghana.² Though it is hardly mentioned as a direct cause, malnutrition is projected to be a contributory factor to over one-third of all child mortalities.³ Almost 14 million children are projected to die annually across the globe from malnutrition, with developing countries being the highest contributors.⁴

Malnutrition, a spectrum that includes both overnutrition and undernutrition, may be described as an imbalance in the intake and utilisation of nutrients and energy.



Undernutrition may manifest as wasting, underweight, stunting and micronutrient deficiencies. Overnutrition, however, may be revealed as overweight and obesity.¹⁵ A complex global malnutrition landscape has emerged in recent years as a result of multiple factors such as urbanisation, lifestyle and dietary changes. There is an emerging rise in overnutrition with a decline in undernutrition worldwide, with an estimated 38 million children under 5 years obese or overweight in 2019.⁶⁷

This picture is a mixed situation in Ghana where undernutrition remains high despite marginal improvements.⁸ Several decades ago, childhood malnutrition in Ghana was largely associated with being underweight, wasting and stunting. However, other forms of malnutrition that are becoming serious health concerns for some Ghanaian children are obesity and overweight. According to the Ghana Demographic and Health Surveys (GDHSs), the percentage of children under 5 years that are stunted has reduced between 2008 and 2014 from 28% to 19%. Nine per cent (9%) were wasted in 2008 but declined to 5% in 2014.⁹¹⁰ An estimated 4%–5% of these children were overweight between 2003 and 2008, with an expected rise. This is predicted by a steady surge of childhood overweight/obesity from <1% in 1988.¹¹ Also, a systematic review and meta-analysis study spanning 2001–2019 involving participants <20 years estimated that about 19% of Ghanaian children were either overweight or obese.¹² Children are classified as overweight if their Z-score values are more than 2SD above the median for weight-for-height, whereas those whose weight-for-age is <-2SD from the reference population's median are underweight.¹¹

Evolving trends of malnutrition may be attributed to several factors, including changes in lifestyle and dietary patterns among Ghanaian families. These changes have been linked to economic improvements and changes in demography, environment and culture, as may have been observed in the developed world.¹³ Healthy traditional diets that are typically rich in minerals, complex carbohydrates and roughage have been replaced with energy-dense nutrient-poor food.¹⁴ More so, urbanisation has led to a significant decline in physical activities among children. Ranging from faster and more convenient transportation to the rise in indoor activities such as watching television, children tend to use less energy as compared with previous decades. Therefore, the energy imbalance brought on by an increase in high-calorie food intake and a decrease in physical activity may be attributed to the primary cause of the rise in obesity and overweight among these children over the past few decades.¹²

Poor intake of food, in terms of both nutritional quality and quantity, and poor environmental conditions have been attributed as causes of undernutrition.³ Various studies suggest a number of factors such as birth weight, household wealth, mother's educational status, household size, rural residence and access to healthcare, as contributory to undernutrition.⁵⁸

Early childhood malnutrition has adverse effects on the health and general development of the child. While

childhood obesity predisposes the child to early cardiovascular diseases like hypertension, diabetes and dyslipidaemias, undernutrition affects the physical and intellectual development, school performance and eventual income-earning capabilities.⁸¹²

The 2014 GDHS report laid little emphasis on childhood overweight and obesity despite the declining underweight, wasting and stunting trends.¹¹ This study seeks to understand the prevalence and determinants of thinness, overweight and obesity among children under 5 years and the factors associated with them to help inform and shape relevant policies.

METHODS

Study design

This study used the 2022 GDHS data. The GDHS is a nationwide survey undertaken by the Ghana Statistical Service with technical assistance from the Demographic and Health Survey programme. The latest GDHS was undertaken in 2022 and is the seventh of GDHS. Data were collected from a sample of 18540 households from 618 clusters in all regions of the country. Demographic and household data were collected, and blood specimens for anaemia testing, anthropometry and other biomarker measurements were carried out on 4935 children aged 0–5 years. Further details of the study design, questionnaires, training and pre-testing can be found in the methodology section of the GDHS 2022 report.¹⁵

Sampling

The sampling frame was based on the 2021 Population and Housing Census. The GDHS used a stratified two-stage cluster sampling technique. The first stage involved selecting 618 target clusters, and the second stage involved listing households within the selected clusters, which served as a sampling frame for selecting household samples.

Sample size

The 2022 GDHS employed a stratified two-stage cluster sampling design to ensure representativeness at the national, urban-rural and regional levels. The sampling frame was derived from the 2021 Population and Housing Census, which provided a complete list of census enumeration areas classified by region and place of residence. Each of the 16 administrative regions of Ghana was divided into urban and rural areas, resulting in 32 sampling strata.

In the first stage, 618 enumeration areas; 304 urban and 314 rural were selected with probability proportional to size, using the number of residential households in each area as the measure of size. Where an enumeration area contained more than 300 households, segmentation was carried out, and one segment was randomly chosen to form a survey cluster.

In the second stage, a fresh listing of households was conducted in each selected cluster, from which 30

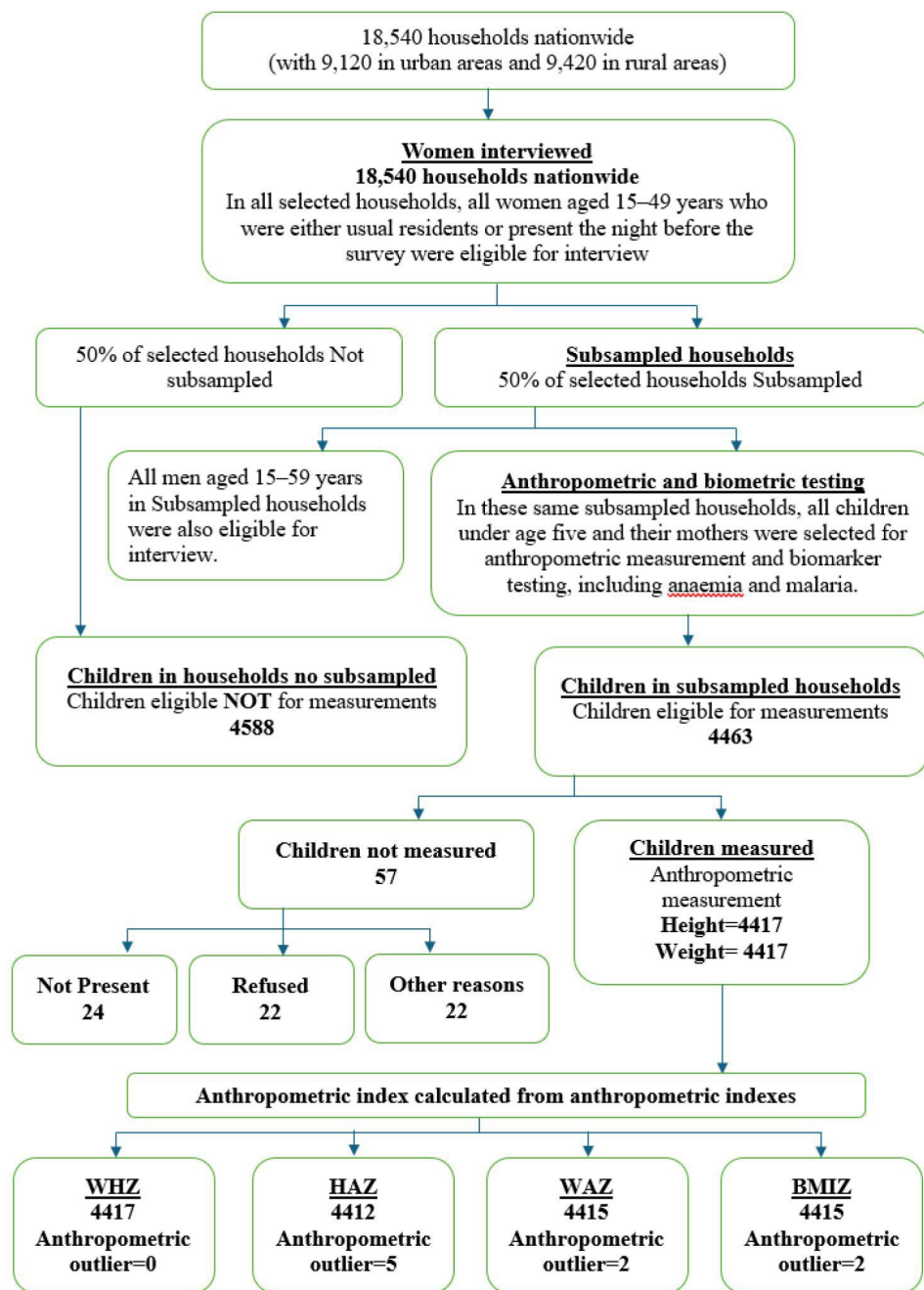


Figure 1 Flow chart showing the sample size and anthropometric measurements and indices. This figure shows the sampling process used by DHS. This involved the number of households, women and children below 23 months included in the analysis and the number excluded. BMIZ, body mass index Z-score; DHS, demographic health survey; HAZ, height-for-age Z-score; WAZ, weight-for-age Z-score; WHZ, weight-for-height Z-score.

households were systematically selected. This procedure yielded a total sample of 18540 households, comprising 9120 urban and 9420 rural households as shown in figure 1. All women aged 15–49 years who were either permanent residents of the selected households or who spent the night before the survey in the household were eligible for interview. In every second household, all men aged 15–59 years were also eligible to be interviewed, and in these same households, all children under the age of 5 and their mothers were selected for anthropometric measurements and biomarker testing.

To ensure adequate representation across the country, a minimum of 1080 households was allocated to each region, corresponding to about 800 completed interviews with women per region. Smaller regions were oversampled, while the larger regions such as Ashanti and Greater Accra were slightly under-sampled to maintain balance in the overall sample size. Sampling weights were applied in the analysis to adjust for these differences in selection probability and to correct for non-response.

We also defined outliers as implausible Z-scores based on WHO Anthro criteria (height-for-age Z-score (HAZ)



<-6 or >+6; weight-for-height Z-score (WHZ) <-5 or >+5; weight-for-age Z-score (WAZ) <-6 or >+5). After excluding outliers, our final analytic sample remained 4412 children. This was carried out by the DHS team before making the data publicly available.

Measurement

Weight and height were measured for all eligible children 6–59 months who were not excluded and whose parents consented. Weight was measured using a SECA 874U scale with a digital display and height was measured using a ShorrBoard measuring board. Children younger than age 24 months were measured lying down (recumbent length), while older children were measured standing (height). The WHZ <-3SD was classified as severely wasted, those <-2SD were classified as wasted, those $\geq +1$ and $\leq +2$ were classified as overweight and those >+2SD were classified as obese.^{16 17}

Study variables

DHS measured two anthropometric measures: height and weight. From these two anthropometric measurements, and age, the following anthropometric indices were calculated by the DHS team. Our study used the anthropometric indexes as calculated and available from the DHS and available in the downloaded dataset. Our study primarily used WHZ as the main index, in line with WHO standards. Also, we included in the analysis HAZ and WAZ as descriptive indicators, but our outcome variable was overweight/obesity and thinness defined by WHZ.

The main outcome variables were obesity and thinness in children under 5 years (aged 6–59 months). Obesity was defined as WHZ >+2SD. Weight for height was dichotomised to 1 if the WHZ was >+2SD and otherwise assigned 0.

Covariates were grouped into child, maternal and household characteristics. Child-level variables included age (0–5, 6–11, 12–23, 24–35, 36–47 and 48–59 months), sex, size at birth (very small, smaller than average, average, larger than average or very large), breastfeeding status (yes/no) and immunisation history (number of entries in the immunisation roster). HAZs were computed for descriptive purposes but were not retained in multivariate analysis to minimise collinearity with weight-for-height.

Maternal-level variables included maternal age (15–19, 20–29, 30–39 and 40–49 years), highest educational attainment (no education, primary, secondary or higher), body mass index (BMI) categorised as underweight (<18.5 kg/m²), normal (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²) or obese (≥ 30 kg/m²), health insurance coverage (yes/no) and parity (1–3, 4, 5 and ≥ 6 children).

Household-level variables included region of residence, place of residence (urban/rural), sex of household head, household wealth index quintiles (poorest, poorer, middle, richer, richest), type of toilet facility (improved/unimproved), source of drinking water (recategorised as

improved or unimproved according to WHO/UNICEF Joint Monitoring Programme definitions); Improved: home pipe water, public tap, borehole and Unimproved: well, spring, river/lake/pond, others. Type of cooking fuel (clean/unclean) and construction materials of the dwelling (floor and roof categorised as improved or unimproved).

Data linkage

The study used only the GDHS 2022 dataset and did not link it to any other data source.

Statistical analysis

STATA V.14.1 (Stata Corp) was used for statistical analysis and graphs. The choropleth map showing obesity prevalence by region was generated using the Quantum Geographic Information System V.3.34.3. Nutritional Z scores were calculated according to the WHO growth reference curves with the use of WHO ANTHRO software and Emergency Nutrition Assessment (ENA) for Standardised Monitoring and Assessment of Relief and Transitions. The WHO Anthro Survey Analyser is a software that aims to promote best practices on data collection, analyses and reporting of anthropometric indicators. It offers analysis for four indicators: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and BMI-for-age. ENA is a user-friendly analytical programme with automated functions for sample size calculations, sample selection, quality checks, standardisation for anthropometry measurements and report generation with automatic analyses. The proportion of obesity was calculated for the unweighted sample, and then the prevalence was determined using the weighted sample. Thereafter, descriptive statistical analysis was performed using weighted percentages for the categorical variables. The prevalence of obesity and its corresponding 95% CI were calculated for the overall children population as well as estimates across the categories of all the independent variables considered in the study. The Poisson regression model was used to assess the difference in the prevalence ratio of obesity across various characteristics of which the prevalence of obesity was calculated.

Statistical analysis estimates with p value <0.05 were considered statistically significant for a two-sided test. The difference in the prevalence ratio of obesity across the groups of exposure variables was assessed using simple Poisson regression.

Assessing factors associated with obesity using the household, woman and child characteristics was carried out using binary logistic regression to obtain crude OR then followed by a multivariable logistic regression analysis to obtain the adjusted OR (aOR) and corresponding 95% CI and p values. An interaction term was investigated for all variables included in the model. Post-estimation goodness of fit was calculated using the Hosmer-Lemeshow goodness of fit test to determine how well each model fits the data. To determine collinearity, the estat vif command after regress was used to calculate the variance inflation

Table 1 Estimates of participants' characteristics

	Thin and severely thin	Normal	Overweight and obese	All children
Number of all children, n (%)	229 (5.2)	3746 (84.9)	437 (9.9)	4412
Age, mean (SD), months	21.02 (15.3)	28.41 (17.1)	23.11 (16.9)	27.51 (17.2)
Weight, median (IQR), kg	7.9 (3.2)	11.1 (4.9)	11.9 (5.5)	11.1 (5.2)
Height, median (IQR), cm	77.9 (8.3)	85.2 (21.1)	82.2 (23.3)	84.7 (21.5)
BMI Z-score, median (IQR)	-2.5 (0.6)	-0.4 (1.1)	1.4 (0.7)	-0.34 (1.3)
Height for age Z-score, median (IQR)	-1.0 (-1.9)	-1.0 (-1.5)	-0.8 (1.7)	-1.0 (1.5)
Weight for age Z-score, median (IQR)	-2.3 (1.4)	-0.9 (1.2)	0.6 (1.3)	-0.9 (0.4)
Weight for height Z-score, median (IQR)	-2.5 (0.7)	-0.5 (1.1)	1.4 (0.1)	-0.4 (1.4)
Haemoglobin, mean (SD) g/dL	10.5 (1.5)	10.7 (1.3)	10.8 (1.5)	10.7 (1.4)
Male proportion (%)	6.1	83.3	10.6	100.0
Female proportion (%)	4.3	86.6	9.2	100.0

BMI, body mass index.

factor. A variance inflation factor >10 indicates a high degree of collinearity.

Patient and public involvement

There was no patient or public involvement in this research as secondary data were used.

Data availability

The data used in this study are freely accessible to the public at the DHS.¹⁸

RESULTS

Characteristics of study participants

Table 1 gives a summary of the study participants. Out of 4412 participants, 229 (5.2%) were thin/severely thin, 437 (9.9%) were overweight or obese, and the rest were normal. The mean age of participants was 27.51 months with an average thin child being 21.02 months, those overweight being 23.11 months and those normal having the oldest mean age of 28.41 months. The proportion of thin females was 4.3% against 6.1% of males, 9.2% and 10.6% of females and males, respectively, were overweight or obese, and the rest were normal. The median height and weight for those thin/severely thin was 77.9 cm and 7.9 kg respectively, 85.2 cm and 11.1 kg for normal, and 82.2 cm and 11.9 kg for the overweight and obese group. The median WHZ was -2.5 for the thin/severely thin, -0.5 for the normal group and 1.4 for the overweight/obese. Those who were thin or severely thin had marginally reduced mean haemoglobin (10.5 g/dL), with those of normal weight and overweight/obese having 10.7 and 10.8 g/dL, respectively.

Weighted prevalence of severely thin, thin, normal, overweight and obese by selected participant characteristics

Table 2 provides the prevalence of severe thinness, overweight and obesity among participants. Males made up 51.2% (2258) of participants. There is no association between sex, age, residence (rural/urban), the

prevalence of thinness, normal weight, overweight and obesity using the χ^2 test of association. Using the same test, there is an association between the region of residence and thinness. The Ashanti region had the highest odds of being severely thin (3.2), the Northeast region had the highest odds of being thin (6.5) and the Bono region's odds of 6.0 were the highest in being obese. There was an association between household wealth index and thinness. Coming from the poorest household was associated with the highest odds of being severely thin and coming from the richest household was associated with the highest odds of being overweight and obese, 10.8 and 4.1, respectively.

Figure 2 compares the graph of participants and the standard WHO graph, the relationship between age and BMI mean Z-score, and the relationship between wealth index quintiles and BMI mean Z-score. A and B in figure 2 are graphs that compare the BMI Z-scores curves for all participants against the standards from WHO. Though there are differences in the curves, they all follow a similar pattern. C is the bar chart showing the relationship between the BMI mean Z-score and the age in months. The 0–5 months age group had the highest BMI mean Z-score and the only age group with a positive mean BMI Z-score. D is a bar chart of the wealth index quintiles and BMI mean Z-score, with the highest BMI mean Z-score being within the richest wealth index quintile and the lowest within the poorer wealth index quintile.

Regional thinness and obesity densities

Figure 3 provides the regional prevalence of obesity and thinness in a choropleth map. Volta, Ahafo and Bono regions have an obesity prevalence above 2.8%. Upper West, North East and Northern regions have the lowest densities of overweight and obesity, with <1.85% and 6.95%, respectively. The Central region had no cases of severely thin children under 5 years. Only the Northeast, Ahafo and Ashanti regions had a prevalence of severely thin children above 1.3%. Upper West, Northeast,

Table 2 Weighted prevalence of severely thin, thin, normal, overweight and obese by selected participant characteristics

Characteristics	n (%)	Weighted prevalence					P value	
		Severely thin		Normal		Overweight		
		Z-score < -3SD	Thin	-2SD ≤ Z < -1SD	Normal	1SD < Z ≤ 2SD		Obese > 2SD
Overall	4412	1.1 (0.7 to 1.8)	4.3 (3.5 to 5.3)	84.0 (82.4 to 85.5)	8.2 (7.1 to 9.4)	2.3 (1.8 to 3.0)		
Prevalence by sex								
Male	2258 (51.2)	1.3 (0.7 to 2.3)	4.8 (3.8 to 6.1)	83.1 (80.8 to 85.1)	8.8 (7.4 to 10.4)	2.1 (1.5 to 3.1)	0.592	
Female	2154 (48.8)	1.0 (0.5 to 1.9)	3.9 (2.9 to 5.2)	85.1 (82.8 to 87.1)	7.6 (6.1 to 9.3)	2.5 (1.8 to 3.6)		
Prevalence by age								
0–5 months	500 (11.3)	1.9 (0.7 to 5.0)	3.4 (1.9 to 6.0)	73.8 (68.6 to 78.4)	13.0 (9.7 to 17.2)	7.9 (5.1 to 12.1)	0.105	
6–11 months	489 (11.1)	3.0 (1.6 to 5.7)	8.1 (5.4 to 11.9)	77.6 (72.1 to 82.3)	8.7 (5.8 to 12.9)	2.5 (1.4 to 4.5)		
12–23 months	1016 (23.0)	1.9 (0.8 to 4.6)	5.6 (3.8 to 8.0)	83.3 (79.9 to 86.3)	7.1 (5.4 to 9.4)	2.1 (1.1 to 3.8)		
24–35 months	835 (18.9)	0.6 (0.3 to 1.2)	4.4 (2.9 to 6.5)	84.6 (81.2 to 87.5)	8.8 (6.6 to 11.4)	1.7 (0.8 to 3.6)		
36–47 months	836 (19.0)	0.3 (0.1 to 1.0)	1.6 (0.9 to 2.9)	89.2 (86.4 to 10.2)	7.6 (5.7 to 10.1)	1.3 (0.6 to 2.8)		
48–59 months	736 (16.7)	–	3.9 (2.2 to 6.7)	89.1 (85.6 to 91.8)	6.2 (4.2 to 9.1)	0.9 (0.3 to 2.2)		
Prevalence by rural/urban residence								
Urban	1818 (41.2)	0.9 (0.4 to 1.9)	4.8 (3.4 to 6.6)	83.4 (80.8 to 85.7)	8.1 (6.4 to 10.2)	2.8 (2.0 to 4.0)	0.367	
Rural	2594 (58.8)	1.3 (0.7 to 2.4)	3.9 (3.2 to 4.8)	84.7 (82.5 to 86.6)	8.2 (6.9 to 9.8)	1.9 (1.3 to 2.6)		
Prevalence by region of residence								
Western	214 (4.9)	0.8 (0.2 to 3.3)	2.9 (1.5 to 5.8)	85.9 (78.7 to 90.9)	8.2 (4.4 to 14.7)	2.3 (0.9 to 5.6)	0.050	
Central	236 (5.4)	–	6.0 (3.4 to 10.3)	84.2 (78.2 to 88.8)	7.6 (4.8 to 11.9)	2.2 (0.9 to 5.3)		
Greater Accra	222 (5.4)	0.3 (0.0 to 2.1)	5.1 (2.1 to 11.8)	81.8 (74.9 to 87.1)	10.1 (5.8 to 16.9)	2.8 (1.3 to 6.0)		
Volta	184 (4.2)	1.3 (0.3 to 5.1)	4.3 (2.1 to 8.3)	83.1 (77.0 to 87.8)	8.4 (5.6 to 12.5)	2.9 (1.2 to 6.7)		
Eastern	214 (4.9)	0.5 (0.1 to 3.9)	2.9 (1.1 to 7.2)	85.0 (78.0 to 90.0)	9.6 (6.5 to 13.9)	2.0 (0.8 to 5.2)		
Ashanti	284 (6.4)	3.2 (1.4 to 7.1)	4.1 (2.4 to 7.0)	81.3 (75.7 to 85.9)	8.7 (5.7 to 13.1)	2.6 (1.3 to 5.2)		
Western North	187 (4.2)	0.5 (0.1 to 2.2)	1.1 (0.2 to 4.5)	89.0 (83.6 to 92.7)	7.5 (4.4 to 12.5)	2.0 (0.8 to 5.0)		
Ahafo	241 (5.5)	1.4 (0.5 to 3.7)	3.3 (1.4 to 7.5)	78.2 (77.2 to 83.1)	13.3 (10.1 to 17.4)	3.8 (2.0 to 7.2)		
Bono	194 (4.4)	0.7 (0.1 to 5.0)	2.6 (0.8 to 8.0)	83.7 (76.3 to 89.1)	7.0 (4.0 to 12.0)	6.0 (3.1 to 11.3)		
Bono East	299 (6.8)	0.6 (0.1 to 4.3)	3.6 (1.9 to 6.8)	85.0 (80.8 to 88.5)	8.5 (5.6 to 12.6)	2.3 (1.0 to 5.1)		
Oti	280 (6.4)	0.4 (0.1 to 2.6)	5.4 (3.2 to 8.9)	84.9 (80.8 to 88.2)	9.0 (6.1 to 13.1)	0.3 (0.0 to 2.3)		
Northern	455 (10.3)	1.2 (0.6 to 2.6)	5.9 (3.9 to 8.8)	85.4 (80.6 to 89.1)	6.1 (4.0 to 9.3)	1.4 (0.5 to 3.9)		
Savannah	373 (8.5)	0.3 (0.1 to 1.3)	2.3 (1.1 to 4.7)	87.1 (82.0 to 90.9)	7.5 (4.5 to 12.1)	2.8 (1.4 to 5.8)		
North East	413 (9.4)	1.4 (0.5 to 3.9)	6.5 (5.1 to 8.2)	86.2 (82.7 to 89.2)	5.1 (3.4 to 7.3)	0.8 (0.3 to 2.2)		
Upper East	299 (6.8)	1.3 (0.4 to 4.6)	2.2 (1.0 to 4.7)	88.5 (84.3 to 91.7)	5.5 (3.3 to 8.8)	2.5 (1.0 to 6.1)		

Continued

Table 2 Continued

Characteristics	n (%)	Weighted prevalence					P value
		Severely thin	Thin	Normal	Overweight	Obese	
		Z-score<-3SD	-3SD≤Z<-2SD	-2SD≤Z<1SD	1SD<Z≤2SD	>2SD	
Upper West	317 (7.2)	0.5 (0.1 to 2.1)	5.9 (3.9 to 9.0)	85.7 (81.5 to 89.0)	6.8 (4.3 to 10.5)	1.2 (0.3 to 4.2)	
Prevalence by household wealth index quintile							
Poorest	1406 (31.9)	2.0 (1.0 to 4.0)	3.8 (2.9 to 5.1)	84.0 (80.9 to 86.7)	8.4 (6.4 to 10.9)	1.8 (1.0 to 2.9)	0.029
Poorer	1074 (24.3)	0.8 (0.3 to 2.5)	5.4 (3.9 to 7.5)	85.2 (82 to 87.9)	7.1 (5.5 to 9.1)	1.5 (0.8 to 2.7)	
Middle	787 (17.8)	0.4 (0.2 to 1.2)	3.9 (2.3 to 6.5)	84.7 (80.8 to 87.9)	7.9 (5.8 to 10.8)	3.1 (1.9 to 5.1)	
Richer	641 (14.5)	1.8 (0.7 to 4.7)	3.7 (2.1 to 6.3)	86.2 (82.2 to 89.5)	6.8 (4.7 to 9.9)	1.5 (0.7 to 3.0)	
Richest	504 (11.4)	0.3 (0.0 to 1.2)	4.9 (3.0 to 7.8)	79.8 (75.0 to 83.9)	10.8 (7.6 to 15.2)	4.1 (2.5 to 6.9)	

Northern and Central regions had the highest prevalence of above 5.53% for thinness.

Logistic regression for overweight/obesity

Table 3 shows which factors are significantly associated with obesity. After adjusting for other factors, being resident in the Ashanti region was associated with 0.5 odds of being overweight or obese compared with being in the Ahafo region (CL 0.27 to 0.94, p value 0.030), Oti region had 0.38 odds (CL 0.20 to 0.75, p value 0.003), 0.29 odds for Northern region (CL 0.15 to 0.54, p value <0.001) and Northeast region had a 0.33 odds (CL 0.17 to 0.64, p value 0.001) of obesity compared with being resident in Ahafo region. Drinking spring water had an increased odds of 2.32 of overweight/obesity compared with drinking borehole water (CL 1.16 to 4.66, p value 0.018). Children of mothers who were overweight and obese had 3.03 (1.06 to 8.65, p value 0.039) and 3.51 (CL 1.18 to 10.43, p value 0.024) odds of being obese compared with children of mothers who were underweight.

Logistic regression for thin/severely thin

In table 4, after adjusting for other factors, children in Ashanti region had 5.30 odds (CL 1.53 to 18.38, p value 0.009) of being thin/severely thin compared with children in Western North, living in the Northern and Northeast regions were associated with 3.87 (CL 1.11 to 13.45, p value 0.033) and 3.94 (CL 1.17 to 13.33, p value 0.027) odds, respectively, of being thin or severely thin compared with being in the Western North region. Drinking water from the spring, river, lake or pond had increased odds (between 2.57 and 2.96) of being thin/severely thin when compared with drinking public tap water. After multivariate logistic regression, there was no association between the household wealth index and the odds of being thin or severely thin. Children of mothers who are overweight had 2.32 odds of being thin/severely thin compared with children of obese mothers (CL 1.13 to 4.78, p value 0.022). Being stunted and severely stunted was associated with reduced odds of being thin/severely thin, 0.06 (CL 0.02 to 0.15, p value <0.001) and 0.01 (CL 0.00 to 0.04, p value <0.001), respectively. Born smaller than average is associated with 2.25 odds of being thin/severely thin compare with those born normal weight or large or very large birth weight (CL 1.28 to 3.96, p value 0.005).

DISCUSSION

The nutritional status of children remains an important aspect of their overall health and well-being. The BMI of children is essential to the assessment of their nutritional state and general well-being.¹⁹ The prevalence of thinness, overweight and obesity among children aged between 6 and 59 months and their associated factors was investigated in this study, using data collected during the 2022 GDHS. The prevalence of overweight and obesity was determined to be 9.9%, almost two times as much as the prevalence of thinness/severely thinness (5.2%). This

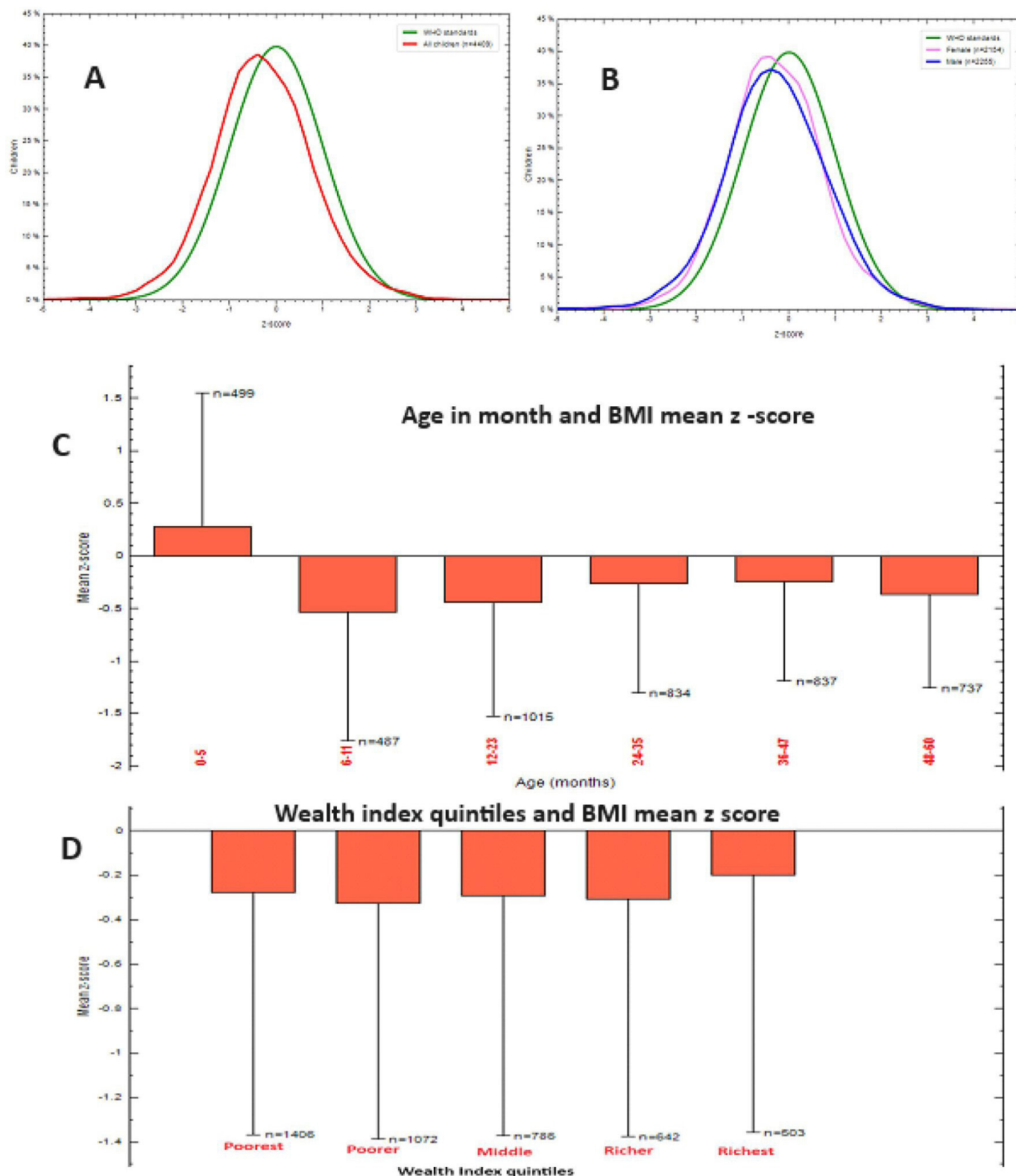


Figure 2 (A) BMI Z-score for all children, (B) BMI Z-score segregated by sex, (C) BMI Z-score segregated by age categories, (D) BMI Z-score segregated by wealth index quintiles. BMI, body mass index.

study thus reveals the current trend of the double burden of malnutrition with a drift towards overweight and obesity. This prevalence of overweight and obesity was determined to be higher than the rates of neighbouring Togo (2.1%), Nigeria (2.1%), Mali (2.6%), Benin (2.0%)

and Guinea (5.9%).⁷ Compared with Cameroon (8.0%), the prevalence of overweight/obesity in children under 5 years in Ghana is still higher. It is again higher than the pooled prevalence (5.1%) of childhood overweight and obesity across the sub-Saharan Africa region.²⁰

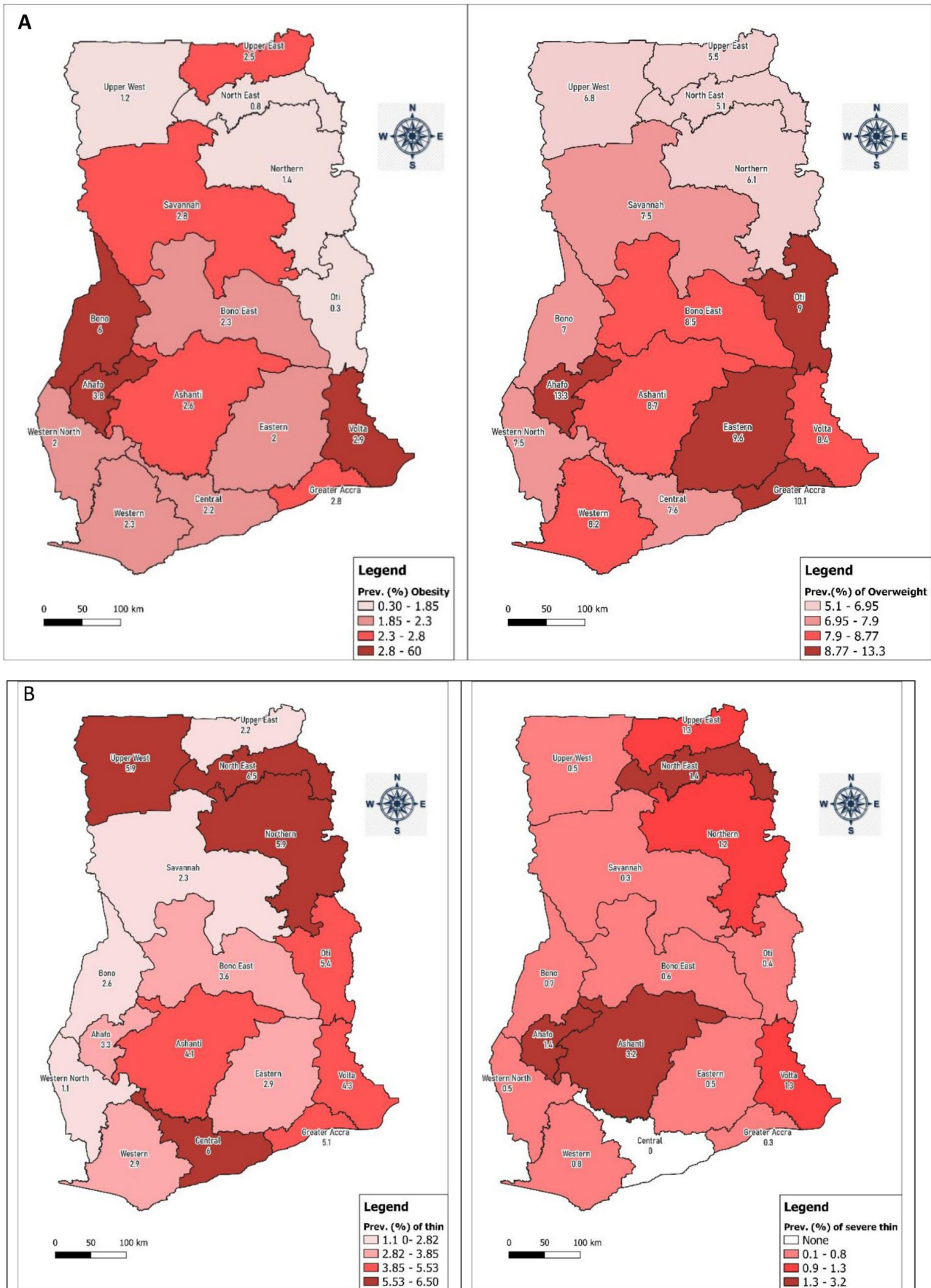


Figure 3 A double burden of overnutrition (obesity and overweight) in (A) and undernutrition (thin and severe thinness) in (B) in all of the regions of Ghana.

**Table 3** Factors associated with overweight and obesity

Characteristics	Univariable model		Multivariable model†	
	cOR (95% CI)	P value	aOR (95% CI)	P value
<i>Household and maternal characteristics</i>				
Place (rural or urban)				
Rural	0.91 (0.69 to 1.19)	0.476	1.24 (0.86 to 1.79)	0.244
Urban	1.00 (reference)			
Region				
Western	0.56 (0.30 to 1.04)	0.066	0.76 (0.36 to 1.63)	0.481
Central	0.52 (0.29 to 0.96)	0.035*	0.64 (0.32 to 1.29)	0.177
Greater Accra	0.71 (0.41 to 1.23)	0.228	0.55 (0.25 to 1.2)	0.134
Volta	0.62 (0.37 to 1.03)	0.065	0.62 (0.31 to 1.11)	0.102
Eastern	0.63 (0.37 to 1.06)	0.084	0.53 (0.28 to 1.02)	0.056
Ashanti	0.62 (0.38 to 1.01)	0.058	0.50 (0.27 to 0.94)	0.030*
Western North	0.51 (0.23 to 0.92)	0.029*	0.49 (0.24 to 1.03)	0.059
Ahafo	1.00 (reference)			
Bono	0.72 (0.43 to 1.22)	0.229	0.79 (0.40 to 1.53)	0.427
Bono East	0.58 (0.43 to 1.22)	0.029*	0.62 (0.33 to 1.15)	0.130
Oti	0.50 (0.29 to 0.84)	0.010*	0.38 (0.20 to 0.72)	0.002**
Northern	0.39 (0.23 to 0.68)	0.001***	0.29 (0.15 to 0.54)	<0.001***
Savannah	0.55 (0.33 to 0.93)	0.026*	0.55 (0.32 to 1.07)	0.052
North East	0.30 (0.18 to 0.49)	<0.001***	0.30 (0.17 to 0.64)	0.001**
Upper East	0.42 (0.26 to 0.66)	<0.001***	0.32 (0.19 to 0.66)	0.001**
Upper West	0.42 (0.25 to 0.69)	0.001**	0.51 (0.30 to 1.16)	0.126
Household water source				
Improved water source	1.00 (reference)			
Unimproved water source	1.00 (0.69 to 1.46)			
Household wealth index quintile				
Poorest	0.64 (0.42 to 0.96)	0.035*	1.02 (0.61 to 1.71)	0.931
Poorer	0.53 (0.34 to 0.82)	0.004**	0.96 (0.59 to 1.55)	0.869
Middle	0.70 (0.45 to 1.10)	0.119	0.78 (0.44 to 1.39)	0.401
Richer	0.51 (0.32 to 0.83)	0.007**	1.44 (0.79 to 2.60)	0.231
Richest	1.00 (reference)		1.00 (reference)	
Mother's body mass index				
Underweight (<18.5 kg/m ²)	1.00 (reference)		1.00 (reference)	
Normal (18.5–24.9 kg/m ²)	2.68 (1.09 to 6.57)	0.031*	2.25 (0.84 to 6.81)	0.103
Overweight (25.0–29.9 kg/m ²)	3.48 (1.43 to 8.46)	0.006**	2.90 (1.06 to 8.65)	0.042*
Obese (≥30 kg/m ²)	3.64 (1.62 to 9.10)	0.006**	3.27 (1.18 to 10.43)	0.030*
Covered by health insurance				
Not covered	1.00 (reference)			
Covered by health insurance	0.61 (0.38 to 0.97)	0.036	0.65 (0.24 to 1.80)	0.406
<i>Child factors</i>				
Age of child				
0–5 months	1.00 (reference)		1.00 (reference)	
6–11 months	0.48 (0.30 to 0.78)	<0.003**	0.43 (0.26 to 0.72)	0.001**
12–23 months	0.39 (0.27 to 0.56)	<0.001***	0.36 (0.25 to 0.53)	<0.001***
24–59 months	0.37 (0.26 to 0.52)	<0.001***	0.41 (0.27 to 0.63)	<0.001***

Continued

Table 3 Continued

Characteristics	Univariable model		Multivariable model†	
	cOR (95% CI)	P value	aOR (95% CI)	P value
Sex of child				
Female				
Male	1.09 (0.84 to 1.40)	0.493	0.84 (0.61 to 1.16)	0.294
Height for age Z-score (HAZ)				
Normal (HAZ ≥ -2SD)	0.57 (0.33 to 1.01)	0.054	0.84 (0.50 to 1.43)	0.509
Stunted (HAZ < -2SD to -3SD)	0.48 (0.25 to 0.93)	0.029*	1.81 (0.97 to 3.38)	0.064
Severely stunted (HAZ < -3SD)	1.00 (reference)		1.00 (reference)	
Size of child at birth				
Average, larger, very large	1.00 (reference)		1.00 (reference)	
Smaller than average	0.39 (0.21 to 0.74)	0.004**	0.36 (0.20 to 0.72)	0.003**
Very small	0.58 (0.27 to 1.25)	0.165	0.54 (0.23 to 1.26)	0.152

Statistically significant p-values are highlighted in bold.
 *p<0.05, **p<0.01, ***p<0.001.
 †Multivariable model adjusted for child, maternal and household variables.
 aOR, adjusted OR; cOR, crude OR.

However, it was lower than the prevalence rates of 15.6% and 12.9% overweight and obese, respectively, in Brazil.²¹ Furthermore, this prevalence rate is higher than the 2.4% recorded in the Ghana Multiple Indicator Cluster Survey in 2011.¹⁴ It points to an alarming quadruple surge in overweight/obesity among children under 5 years over a decade. The regional variation of obesity density showed that the Bono, Ahafo and Volta Regions were the greatest contributors to the problem. One of the six global nutrition targets in the ‘Comprehensive Implementation Plan for Maternal, Infant and Young Child Nutrition’, dubbed by WHO as ‘no increase in childhood overweight by 2025’, may be far from reach, given the current trend.²²

This study showed that children of mothers who are overweight and obese are three and almost four times, respectively, more likely to be overweight or obese compared with children of underweight mothers. This agrees with the findings of a systematic review and meta-analysis study where maternal obesity and maternal overweight were associated with significantly higher odds of childhood obesity (OR 3.64, 95% CI 2.68 to 4.95; OR 1.89, 95% CI 1.62 to 2.19, respectively). The risk of a child being overweight or obese (OR 2.69, 95% CI 2.10 to 3.46) and overweight (OR 1.80, 95% CI 1.25 to 2.59) in relation to an obese mother was significantly high.²³ Likewise, children whose mothers were underweight showed greater chances (aOR 2.34; 95% CI 1.65 to 3.38) of being thin/severely thin compared with children of mothers with normal weight.²⁴ This may be explainable by an intergenerational link between maternal and child nutrition influenced by conditions in the family, such as dietary habits/behaviours and household income levels. Hereditarily, small mothers also tend to produce small babies that may continue the cycle.²⁴ Interestingly, after adjustments for confounders, this study revealed that

children of overweight mothers had 2.32 times higher odds of being thin/severely thin compared with children of obese mothers.

With regard to undernutrition, there is no notable change in the prevalence of thinness compared with rates from the 2014 GDHS, which recorded 5.3%.¹⁰ The highest prevalence of severely thin children was noted in the Northeast, Ahafo and Ashanti regions. The reasons for these regional variations are not readily known. The Northeast and Ahafo regions were carved out of the Northern and Brong-Ahafo regions by a referendum in 2018. Thinness was more prevalent in the Upper East, Central, Northern and Brong-Ahafo regions in 2014.²⁵ The new regional demarcation may have disproportionate nutritional impacts.

There was a significant association between the region of residence and the odds of thinness. Children from the Northern, Northeast and Ashanti regions were more likely to be thin/severely thin in comparison with those from the Western North region. Again, the reason for this is not readily known to us. Anaemia, which is defined as haemoglobin levels <11 g/dL in children and pregnant women,²⁵ was prevalent among all categories of participants, the most common cause being iron deficiency.²⁶ The mean haemoglobin was 10.7 g/dL with a mean of 10.5 g/dL among the thin, 10.7 g/dL among normal weight, and 10.8 g/dL among overweight/obese children. This suggests that this micronutrient deficiency may persist irrespective of weight categories. Iron-deficiency anaemia among underweight and normal weight children may be related to low intake, but related to increased hepcidin levels mediated by chronic inflammation among the overweight/obese.²⁷

In reference to babies less than 6 months, children between 6 and 59 months had significantly lower chances

**Table 4** Factors associated with thin and severely thin

Characteristics	Univariable model		Multivariable model	
	cOR (95% CI)	P value	aOR (95% CI)	P value
<i>Household characteristics</i>				
Place (rural or urban)				
Rural	0.92 (0.64 to 1.34)	0.677	0.67 (0.42 to 1.07)	0.094
Urban	1.00 (reference)		1.00 (reference)	
Region				
Western	2.44 (0.66 to 8.98)	0.179	1.96 (0.47 to 8.11)	0.353
Central	4.04 (1.17 to 13.94)	0.027*	2.83 (0.75 to 10.71)	0.124
Greater Accra	3.58 (0.89 to 14.5)	0.074	2.37 (0.55 to 10.14)	0.120
Volta	3.76 (1.04 to 13.6)	0.043*	3.07 (0.75 to 12.58)	0.120
Eastern	2.27 (0.57 to 9.02)	0.242	2.22 (0.50 to 9.83)	0.293
Ashanti	5.02 (1.56 to 16.11)	0.007**	5.30 (1.53 to 18.38)	0.009**
Western North	1.00 (reference)		1.00 (reference)	
Ahafo	3.12 (0.87 to 11.21)	0.081	2.52 (0.65 to 9.70)	0.181
Bono	2.17 (0.45 to 10.48)	0.334	1.38 (0.28 to 6.77)	0.696
Bono East	2.80 (0.78 to 9.99)	0.114	1.74 (0.45 to 6.77)	0.422
Oti	3.90 (1.18 to 12.90)	0.026*	2.93 (0.78 to 10.95)	0.110
Northern	4.88 (1.54 to 15.52)	0.007**	3.87 (1.11 to 13.45)	0.033*
Savannah	1.74 (0.49 to 6.19)	0.395	1.27 (0.33 to 4.92)	0.725
North East	5.43 (1.74 to 16.97)	0.004**	3.94 (1.17 to 13.33)	0.027*
Upper East	2.29 (0.60 to 8.75)	0.226	1.59 (0.36 to 6.93)	0.537
Upper West	4.34 (1.34 to 14.08)	0.014*	3.32 (0.93 to 11.80)	0.064
Household water source				
Home pipe water	2.39 (1.14 to 5.04)	0.021*	2.36 (0.94 to 5.94)	0.069
Public tap	1.00 (reference)		1.00 (reference)	
Borehole	2.10 (1.09 to 4.06)	0.026*	2.36 (0.91 to 4.65)	0.082
Well	2.49 (1.09 to 5.67)	0.030*	2.36 (0.82 to 6.80)	0.112
Spring	3.99 (1.68 to 9.49)	0.002**	2.96 (1.29 to 6.79)	0.010*
River, lake, pond	2.27 (1.21 to 4.28)	0.011*	2.57 (1.10 to 5.98)	0.029*
Others ^a	2.03 (1.04 to 3.94)	0.037*	2.31 (1.04 to 5.16)	0.039*
Household wealth index quintile				
Poorest	1.38 (0.78 to 2.45)	0.265	1.22 (0.60 to 2.49)	0.582
Poorer	1.48 (0.81 to 2.71)	0.207	1.79 (0.79 to 2.99)	0.209
Middle	1.00 (reference)		1.00 (reference)	
Richer	1.29 (0.63 to 2.64)	0.481	0.78 (0.36 to 1.67)	0.522
Richers	1.21 (0.60 to 2.43)	0.597	0.82 (0.36 to 1.88)	0.646
<i>Maternal characteristics</i>				
Mothers' age in years				
15–19	1.45 (0.62 to 3.38)	0.393		
20–29	1.53 (0.84 to 2.79)	0.168		
30–39	1.16 (0.65 to 2.08)	0.621		
40–45	1.00 (reference)			
Number of children ever born				
1–3	1.00 (reference)			
4	0.48 (0.29 to 0.81)	0.006**		
5	0.37 (0.20 to 0.71)	0.003**		

Continued

Table 4 Continued

Characteristics	Univariable model		Multivariable model	
	cOR (95% CI)	P value	aOR (95% CI)	P value
≥6	0.98 (0.62 to 1.56)	0.927		
Currently pregnant				
No	1.00 (reference)			
Yes	0.48 (0.24 to 0.96)	0.038*		
Currently breastfeeding				
No	1.00 (reference)			
Yes	1.88 (1.30 to 2.73)	0.001**		
Mother's body mass index				
Underweight (<18.5 kg/m ²)	3.19 (1.42 to 7.20)	0.005**	2.23 (0.91 to 5.50)	0.081
Normal (18.5–24.9 kg/m ²)	2.60 (1.38 to 4.91)	0.003**	1.79 (0.85 to 3.79)	0.128
Overweight (25.0–29.9 kg/m ²)	2.45 (1.26 to 4.76)	0.008**	2.32 (1.13 to 4.78)	0.022*
Obese (≥30 kg/m ²)	1.00 (reference)		1.00 (reference)	
Child factors				
Age of child				
0–5 months	1.39 (0.64 to 3.02)	0.404		
6–11 months	3.10 (1.57 to 6.13)	0.001**		
12–23 months	2.00 (1.08 to 3.68)	0.027*		
24–35 months	1.29 (0.67 to 2.51)	0.449		
36–47 months	0.49 (0.22 to 1.06)	0.068		
48–59 months	1.00 (reference)			
Sex of child				
Female	1.00 (reference)		1.00 (reference)	
Male	1.26 (0.90 to 1.77)	0.173	1.47 (1.00 to 2.17)	0.053
Height for age Z-score (HAZ)				
Normal (HAZ ≥−2SD)	1.00 (reference)		1.00 (reference)	
Stunted (HAZ <−2SD to −3SD)	1.20 (0.69 to 2.11)	0.517	0.06 (0.02 to 0.15)	<0.001
Severely stunted (HAZ <−3SD)	2.06 (1.19 to 3.54)	0.009**	0.01 (0.00 to 0.04)	<0.001
Entries in immunisation roster				
0	1.00 (reference)			
1	3.14 (1.64 to 5.97)	0.001**		
2	2.05 (0.83 to 5.05)	0.119		
3	14.64 (1.35 to 158.65)	0.027*		
Size of child at birth				
Average, larger, very large	1.00 (reference)		1.00 (reference)	
Smaller than average	2.19 (1.27 to 3.79)	0.005**	2.25 (1.28 to 3.96)	0.005**
Very small	1.08 (0.50 to 2.36)	0.847	1.22 (0.53 to 2.84)	0.641
Child's birth order				
Single birth	0.08 (0.01 to 0.95)	0.045*		
First of multiple	0.08 (0.01 to 0.83)	0.035*		
Second of multiple	0.19 (0.02 to 2.32)	0.192		
Third of multiple	1.00 (reference)			

Statistically significant p-values are highlighted in bold.

*p<0.05, **p<0.01, ***p<0.001.

aOR, adjusted OR; cOR, crude OR.



of being overweight/obese. In line with this, babies between 6 and 11 months and between 12 and 23 months were two times and three times, respectively, more likely to be thin compared with those between 48 and 59 months. This may be due to challenges in adapting to complementary feeding, either in the form of untimely initiation or poor initiation. Typical complementary feeds in West Africa include plain porridge and mashed family meals, which do not meet the nutritional requirements of the infants.²⁸ In addition to this, more than 30% of Ghanaian mothers wean off their babies before they turn 2 years old, at a period when these babies may not have fully adjusted to their new meals.²⁹

Water from springs, ponds, lakes and rivers is considered an unsafe source of drinking water.³⁰ Children who drank from these sources had 2–3 times greater chances of being thin/severely thin compared with those who drank from public taps. It is noteworthy that drinking from home pipe water, boreholes and wells was not significantly associated with thinness. This may be supported by evidence linking unsafe drinking water to acute episodes of diarrhoea and concomitant wasting.³¹ Both unsafe drinking water and diarrhoeal episodes have been independently linked with thinness.³²

Children who were smaller than average at birth were determined to be two times as likely to be thin than those who were average or large. These children were again demonstrated to have lesser chances of being overweight/obese (aOR 0.36, 95% CI 0.20 to 0.72). This is similar to other research findings that linked low birth weight to higher chances of thinness and stunting later in childhood.³³ Low birth weight, prematurity or a constitutionally small baby may be reasons for a baby to be smaller than average at birth. Low birth weight and prematurity are known to have immediate and long-term sequelae that can impact the well-being of a child.

Strengths and limitations

As a strength, this study used nationally representative data comprising all 16 regions of the country; hence, the findings can be generalised to all Ghanaian children.

The following are some of this study's limitations. The DHS used a cross-sectional study design, so causality could not be established between childhood obesity or thinness and exploratory variables. Also, because this study used DHS data, other variables outside those DHS used could not be tested for association.

Conclusion

Regional disparities, maternal nutritional status, socioeconomic conditions and unsafe water sources were significant determinants of child nutrition outcomes. These findings call for targeted, multipronged interventions that integrate maternal-child nutrition, safe water and sanitation.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Ethical clearance for GDHS was granted by the Ethical Review Committee (ERC) of the Ghana Health Service and the Institutional Review Board (IRB) to ensure that the survey procedures were in accordance with Ghana's ethical research standards and the US and international ethical research standards. This study used a publicly available dataset on request from the DHS programme, <https://www.dhsprogram.com/>. The data used had no contact details or personal identifiers, hence no further ethical clearance was required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. The data used in this study are freely accessible to the public at the DHS website <https://www.dhsprogram.com>.

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