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Trends and inequalities in stunting and underweight among children aged 0–59 months in Ghana, 1993–2022

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Abstract

Background Stunting and underweight remain significant public health issues in many low- and middle-income countries, including Ghana. This study examined the trends and inequalities in stunting and underweight among children aged 0–59 months in Ghana between 1993 and 2022.

Methods We utilised data from the Ghana Demographic Health Survey rounds conducted between 1993 and 2022, among mothers of children aged 0–59 months. The World Health Organisation Health Equity Assessment Toolkit software was used to calculate various inequality measures, including Difference (D), Ratio (R), Population Attributable Risk (PAR), and Population Attributable Fraction (PAR). An inequality assessment was conducted for six stratifiers: child's age, maternal economic status, maternal level of education, place of residence, sex of the child, and sub-national region.

Results Stunting and underweight prevalence among children aged 0–59 months in Ghana both declined between 1993 and 2022, with stunting decreasing from 32.7 to 17.3% and underweight decreasing from 24.5 to 11.9%. Regarding children's age, between 1998 and 2022, the difference in stunting prevalence between older children and younger children decreased from -29.5 to -0.9 percentage points, and underweight rates from -10.0 to -2.6 percentage points, indicating reduction in inequality. Economically, the disparity in stunting between children of the richest and poorest mothers declined from 27.2 to 15.3 percentage points, and underweight from 19.6 to 8.3 percentage points by 2022, highlighting reduction in inequality. With educational level, the stunting gap between children of mothers with high and low education reduced from 24.7 in 1993 to 10.5 percentage points in 2022, while underweight decreased from 23.3 to 5.6 percentage points between the same period, suggesting a reduction of inequality in stunting and underweight between of higher educated mothers and those of mothers with no formal education. Regarding place of residence, the difference between children from urban areas and those from rural areas decreased from 15.3 percentage points in 1993 to 4.5 percentage points for stunting in 2022, and from 11.8 percentage points in 1993 to 2.2 percentage points for underweight in 2022, indicating reduction in inequality. Finally, the subnational region difference was 19.1 percentage points for stunting in 2022, and 12.0 percentage points for underweight in 2022, revealing reduced regional disparities in both stunting and underweight rates among regions.

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Conclusion Our findings on stunting and underweight prevalence among children aged 0–59 months in Ghana from 1993 to 2022 underscore notable progress and persistent inequalities. The inequalities observed across dimensions such as economic status, maternal education, and geographic region indicate the multifaceted nature of stunting and underweight. This situation calls for a continued concerted effort by Government and partner organisations in Ghana to address the underlying socioeconomic determinants of stunting and underweight, aligning with global commitments such as the Sustainable Development Goals.

Keywords Children, Inequality, Ghana, Global health, Stunting

Introduction

Stunting, a reduced growth rate in human development, is a critical determinant of child health and nutrition, characterised by a height-for-age measurement that is more than two standard deviations below the World Health Organization's (WHO) child growth standards [1]. This condition reflects chronic malnutrition, often resulting from inadequate dietary intake and repeated infections [2]. The effects of stunting lead to long-term consequences such as impaired cognitive development, diminished educational attainment, and increased susceptibility to diseases [3]. Globally, stunting affects an estimated 149 million children under five years old, with the highest prevalence observed in Sub-Saharan Africa, where about 30% of children are affected [6, 7]. This region bears a disproportionate burden of stunting due to factors such as poverty, food insecurity, and inadequate healthcare access [7]. In Ghana, the significance of addressing this issue is paramount for the nation's health and economic future [4, 5]. According to the latest data, stunting prevalence in Ghana was recorded at 17.3% in 2022, down from 32.7% in 1993, yet the progress has been uneven, highlighting the need for targeted interventions [8]. The World Bank estimates that stunting can cost countries up to 11% of their GDP due to lost productivity and increased healthcare costs [9]. Therefore, addressing stunting is a matter of improving child health and a critical investment in Ghana's future economic stability and growth.

In terms of underweight, a weight-for-age below two standard deviations from the median of the WHO growth standards, is a significant indicator of malnutrition among children aged 6–59 months [9]. It results from various factors, including inadequate dietary intake, frequent infections, poor maternal health, and socioeconomic disparities [3, 10]. The consequences of being underweight are profound, affecting not only children's physical growth and cognitive development but also their long-term health outcomes and productivity as adults [3]. Given its multifaceted nature and the critical development period, understanding the trends and inequalities in underweight prevalence is essential for formulating effective interventions and policies to improve child growth in Ghana. Globally, underweight remains a pressing public health issue, with approximately 144 million children

under five years classified as stunted and 47 million as wasted as of 2020 [11]. In sub-Saharan Africa, the situation is particularly dire, with 9% of children underweight [12]. While making strides in economic development and health interventions, Ghana still faces significant challenges in combating child malnutrition [13]. Recent statistics indicate that about 11% of children aged 6–59 months are underweight in Ghana, 18% stunted, and 5% wasted, which reflect chronic and acute malnutrition [14]. Concerns about undernutrition have increased and have significant long-term consequences on physical and cognitive development, and immediate health risks [3]. A comprehensive study on undernutrition is crucial for improving the overall well-being and development of children in Ghana.

To address the dual burden of stunting and underweight, the government of Ghana has implemented several programs and policies to improve child nutrition [14, 15]. Initiatives such as the National Nutrition Policy and the Ghana School Feeding Program have been established to enhance food security and promote healthy eating practices [16]. However, challenges persist, including inadequate funding, limited access to healthcare services, and sociocultural barriers that hinder effective implementation [17]. These challenges underscore the necessity for continuous evaluation of existing programs and the development of targeted strategies that address both immediate and underlying causes of stunting and underweight.

Previous studies on stunting and underweight prevalence in Ghana have provided valuable insights into trends, determinants, and inequalities [18–24]. However, these studies have limitations. Sewor and Jayalakshmi's analysis was restricted to 2003–2017 [17], while Novignon et al. focused on socioeconomic inequalities without considering other dimensions of inequality [18]. Adu et al. examined inequalities up to 2014, missing recent trends [21]. Hence, this study aims to address these gaps by providing a comprehensive analysis of stunting and underweight prevalence trends and inequalities among children aged 0–59 months in Ghana from 1993 to 2022. By examining a more extended period and considering a more extensive range of inequality dimensions, this study will contribute to a more nuanced understanding of the factors influencing stunting and underweight in

informing evidence-based interventions to improve child nutrition and development in Ghana.

Methods

Study design and data source

This study employed an ecological time-trend design, utilizing the Ghana Demographic and Health Surveys (GDHS) data conducted between 1993 and 2022. These surveys are nationally representative household surveys conducted periodically in Ghana. They collect data on various health indicators, including child growth and development. The GDHS employ a multi-stage cluster sampling technique. This involves dividing the country into geographic areas (primary sampling units or PSUs), randomly selecting a sample of PSUs, and then choosing smaller geographic units (secondary sampling units or SSUs) within each selected PSU. Finally, households are randomly selected within each SSU. Trained interviewers conduct face-to-face interviews with women of reproductive age and their households, covering demographic characteristics, reproductive health, child health, and family planning. The data were accessed through the World Health Organization's Health Equity Assessment Toolkit (HEAT) online platform. HEAT is a software application developed by the World Health Organization for comparing health inequalities in countries. HEAT facilitates the exploration, analysis, and reporting of health inequality data. It includes data from the Health Inequality Data Repository, allowing users to effectively assess and visualise health disparities. We used the inbuilt data from HEAT Plus to examine nutritional inequality patterns over the years in Ghana. HEAT is available at https://www.who.int/data/inequality-monitor/assessment_toolkit. However, it is essential to note that HEAT does not encompass all data from the GDHS; it specifically includes selected datasets relevant to health equity assessments. This study focused on the Childhood malnutrition dataset within HEAT to analyse stunting and underweight prevalence among children aged 6–59 months in Ghana. The study included 1,858 children in 1993, 2,604 in 1998, 3,243 in 2003, 2,594 in 2008, 2,909 in 2014, and 4,293 in 2022. The study was carefully designed, by following the recommendations made in the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) [22].

Outcome measure and dimensions of inequality

Stunting and underweight were the outcome variables. Stunting was quantified using standard deviation units (z-scores) relative to the median of the reference population. In this study, children with a height-for-age-z score more than two standard deviations below the median of the WHO reference population are moderately or severely stunted. For underweight, the WHO calculates

underweight prevalence by comparing a child's weight to age. A child is considered underweight if their weight-for-age z-score is below -2 standard deviations from the median. This means their weight is significantly lower than expected for their age.

There were six age groups of the children: 0–5 months, 6–11 months, 12–23 months, 24–35 months, 36–47 months and 48–59 months. HEAT categorised women's economic status into five groups: the poorest, poorer, middle-class, rich, and richest. This classification is based on wealth quintiles derived from household asset indices. Household wealth is calculated using various assets owned by the household, such as land, livestock, and durable goods. It is directly provided in the Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) datasets. Three groups were created based on the mother's educational status: no, primary, and secondary or higher education. The place of residence was either in an urban or rural area. The child's sex was noted as either male or female. Ghana's subnational regions have undergone several changes over the years. While the exact number and names of regions may have varied slightly, the country has historically been divided into administrative regions to facilitate governance and development. These regions often correspond to geographical, cultural, or historical divisions. Over time, the boundaries of some regions may have been adjusted, or new regions may have been created to address changing demographics or administrative needs.

Data analysis

For our analysis, we utilised the web-based version of the WHO Health Equity Assessment Toolkit, specifically designed to facilitate the exploration of health inequality data. This software contains the indicator of interest disaggregated by six dimensions of inequality, allowing for a comprehensive examination of stunting and underweight prevalence among children under five. Additionally, HEAT provides estimates, confidence intervals, and summary measures of inequality, enabling us to effectively assess inequalities in stunting and underweight prevalence and make informed conclusions based on the data. Age, region, child's sex, socioeconomic status, education level, and place of residence were the variables used. Using the designated stratifiers, estimates and confidence intervals (CIs) for stunting and underweight prevalence among children were calculated within the HEAT software. Four metrics were utilised to calculate inequality: Difference (D), Ratio (R), Population Attributable Fraction (PAF), and Population Attributable Risk (PAR).

D measures the absolute gap in stunting and underweight prevalence between two subgroups, comparing their respective rates straightforwardly. PAR estimates the proportion of a stunting and underweight that can

Inequality summary measures			
Measure	Type	Definition	Formula/Application
D (Difference)	Absolute	Measures the absolute difference in stunting and underweight rates between two groups.	$Y_{high} - Y_{low}$
R (Ratio)	Relative	Measures the relative inequality by comparing stunting rates between two groups.	$R = Y_{high} / Y_{low}$, where Y_{high} and Y_{low} are the stunting and underweight rates of children in the privileged and disadvantaged groups, respectively.
PAR (Population Attributable Risk)	Absolute	Measures the difference between the stunting and underweight rates of a reference category and the national average.	$PAR = Y_{ref} - \mu$, where Y_{ref} is the reference group and μ is the national average.
PAF (Population Attributable Fraction)	Relative	Represents the relative inequality of PAR as a percentage of the national average.	$PAF = PAR / \mu \times 100$, where μ is the national average.

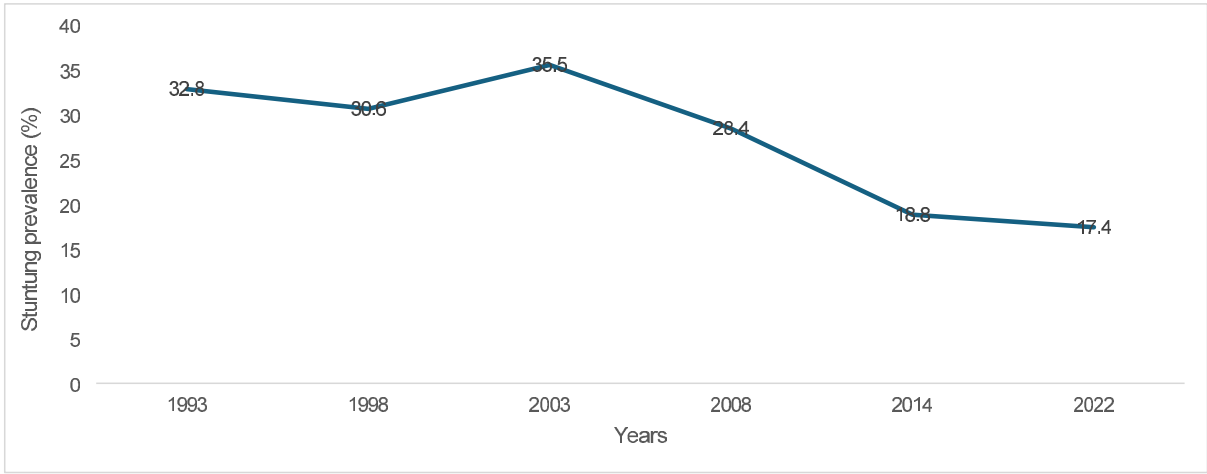


Fig. 1 Stunting prevalence among children aged 0–59 months in Ghana. Source: Authors’ analysis, 2024

be attributed to a specific risk factor within the population. The D and PAR are absolute measures, providing clear-cut values that indicate the actual gap in stunting and underweight prevalence or the proportion of stunting and underweight attributable to a specific risk factor. This distinction is essential, as absolute measures like D and PAR offer straightforward insights into the magnitude of inequality, while relative measures like R and PAF contextualise these differences within the broader population dynamics.

R compares the stunting and underweight prevalence of two subgroups by dividing the prevalence of one subgroup by the other, offering a relative measure of inequality. The PAF indicates the percentage of the total stunting and underweight that would be eliminated if the risk factor were removed. R and PAF are relative measures of inequality used to evaluate and compare the differences between various elements in relation to one another.

Both Difference and Ratio are unweighted measures, meaning they do not account for the population sizes of the subgroups and focus solely on the two groups being compared. These measures provide insights into the potential impact of reducing inequalities on overall stunting and underweight. For a comprehensive explanation of

the calculation of these measures, please refer to the literature [23]. The World Health Organisation acknowledged that to derive conclusions that are useful to policy, summary metrics must be included in absolute and relative forms. Complex measures consider the size of categories within a particular subset of the population, in contrast to simple measurements. The World Health Organisation metrics’ summary measurements and computations are thoroughly explained in the literature [24, 25].

Results
Trends in prevalence of stunting among children aged 0–59 months in Ghana, 1993–2022

Figure 1 shows the trend of stunting prevalence among children aged 0–59 months in Ghana. In 1993, the stunting prevalence was relatively high at 32.8%. By 1998, there was a slight decrease to 30.6%, indicating some improvement. The prevalence peaked in 2003 at 35.5%, suggesting a worsening situation. Following the peak, there was a gradual decline in stunting rates: 2008: 28.4% and 2014: 18.8%. The most notable improvement occurred between 2014 and 2022, with the prevalence dropping to 17.4%.

Trends in prevalence of underweight among children aged 0–59 months in Ghana, 1993–2022

Figure 2 shows the prevalence of underweight among children aged 0–59 months in Ghana from 1993 to 2022. Underweight prevalence decreased steadily throughout the years, from 24.5% in 1993 to 11.9% in 2022.

Trends in prevalence of stunting among children aged 0–59 months old in Ghana, 1993–2022

Table 1 shows the prevalence of stunting among children aged 0–59 months old in Ghana from 1993 to 2022 stratified by different socioeconomic and geographic dimensions. The table shows a slight decline in stunting prevalence among children aged 0–59 months in Ghana from 1993 to 2022. In all survey years, stunting prevalence was lowest in the youngest age groups (0–5 months and 6–11 months). Stunting prevalence in older age groups (12–23 months, 24–35 months, and 36–47 months) generally followed similar trends, gradually declining from 1993 to 2022. Over time (1993–2022), the greatest improvement was observed among children aged 24–35 months, decreasing by 27.4% points and the least improvement occurred among children aged 0–5 months decreasing by 0.6% points. The confidence intervals across all age groups suggest the differences in stunting prevalence were statistically significant. No data was available for children aged 36–47 months and 48–59 months in 1993.

Regarding economic status, the stunting prevalence remains higher among children from poorer households (quintile 1) than those from wealthier households (quintile 5) across all survey years. While there has been an overall decline in stunting rates, the gap between the poorest and richest quintiles has persisted or even

widened in some years. Over time (1993–2022), the decrease in stunting prevalence is almost halved across all economic statuses. The confidence intervals in all economic groups suggest the differences in stunting prevalence were statistically significant. For educational status, children from families with no education had the highest stunting prevalence in almost all the years, with the highest prevalence of 43.2% points in 2003, except in 2008 when stunting prevalence was highest among those whose families had primary education at 31.8% points. Comparatively, children of families with secondary or higher education had a continuously lower stunting prevalence with the lowest prevalence recorded in 1993 at 12.6% points. The confidence intervals across all groups suggest that the differences in stunting prevalence were statistically significant. Furthermore, children in rural areas had a persistently higher prevalence of stunting throughout the survey years, with the highest prevalence recorded in 2003 at 40.7% points than their counterparts in urban areas. However, this prevalence was narrowed in 2022. The confidence intervals between these two groups across all survey years suggest the differences in prevalence were statistically significant. Sex disparities were evident, with male children showing a higher prevalence compared to females throughout the survey years. Over time (1993–2022), children of both sexes showed a decreasing stunting prevalence by almost half. The confidence intervals across all survey years indicate that the differences in stunting prevalence were statistically significant. Finally, at the regional levels, the prevalence of stunting decreased across all regions, with children in the greater Accra region showing the persistently lowest prevalence across all survey years, except in 2022 when those in the eastern region had the

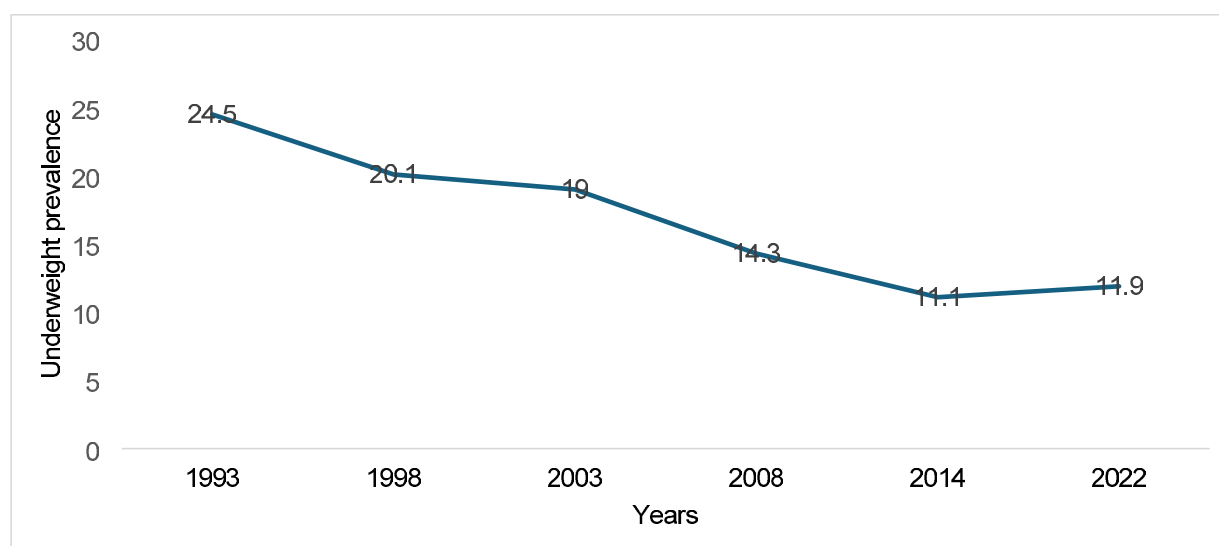


Fig. 2 Underweight prevalence among children aged 0–59 months in Ghana. Source: Authors' analysis, 2024

Table 1 Trends in prevalence of stunting among children aged 0–59 months old in Ghana, 1993–2022

Dimensions	Measures	1993 Pop- ula- tion	1993 Esti- mate (%)	1993 CI-LB	1993 CI-UB	1998 Pop- ula- tion	1998 Esti- mate (%)	1998 CI-LB	1998 CI-UB	1998 Pop- ula- tion	1998 Esti- mate (%)	2003 Pop- ula- tion	2003 CI-LB	2003 CI-UB	2003 Esti- mate (%)	2008 Pop- ula- tion	2008 CI-LB	2008 CI-UB	2008 Esti- mate (%)	2014 Pop- ula- tion	2014 CI-LB	2014 CI-UB	2022 Pop- ula- tion	2022 Esti- mate (%)	2022 CI-LB	2022 CI-UB
Child's age	0–5 months	370	13.8	10.5	18.0	299	8.0	5.3	11.8	307	13.9	10.3	18.4	234	7.2	4.3	11.8	333	8.3	4.7	14.0	428	13.2	9.4	18.4	
	6–11 months	335	13.4	9.9	17.9	294	12.0	8.7	16.2	347	17.5	13.6	22.1	266	14.5	10.3	20.0	281	8.4	5.4	12.9	430	11.5	8.2	15.9	
	12–23 months	609	37.8	33.8	41.9	605	30.2	26.3	34.4	638	36.2	32.4	40.2	531	31.1	26.8	35.8	588	17.3	14.0	21.1	920	17.2	14.5	20.3	
	24–35 months	544	52.0	47.8	56.2	489	37.6	32.9	42.6	645	47.2	43.3	51.0	493	33.4	29.1	38.0	577	29.1	24.6	34.0	813	24.6	21.1	28.5	
	36–47 months	NA	NA	NA	NA	478	43.3	38.6	48.2	710	41.6	37.5	45.7	517	33.5	28.8	38.5	571	22.4	17.8	27.7	869	18.8	15.7	22.4	
	48–59 months	NA	NA	NA	NA	440	37.5	33.0	42.2	596	36.5	32.3	40.8	552	32.1	27.9	36.7	559	17.7	14.0	22.0	833	14.2	11.2	17.8	
Economic status (wealth quintile)	Quintile 1 (poorest)	361	42.9	38.3	47.7	685	39.6	35.5	43.9	810	47.7	44.2	51.1	635	35.1	31.2	39.2	670	24.8	21.5	28.3	1002	22.8	19.8	26.0	
	Quintile 2	407	35.4	30.9	40.2	553	34.7	30.3	39.2	732	36.8	33.4	40.3	585	33.9	29.5	38.6	594	25.8	21.8	30.1	890	22.0	19.2	25.1	
	Quintile 3	393	36.9	31.9	42.2	535	33.2	28.8	37.9	663	37.9	33.7	42.2	481	28.6	23.7	34.0	605	17.9	14.4	22.0	808	16.9	13.6	20.8	
	Quintile 4	380	30.3	25.2	35.9	441	20.5	16.2	25.5	559	29.1	24.6	34.0	516	22.1	18.3	26.4	543	14.3	10.7	18.9	835	15.5	12.0	19.7	
	Quintile 5 (richest)	317	15.8	11.8	20.7	390	17.2	13.3	21.9	479	17.1	13.6	21.1	375	16.8	12.4	22.2	497	8.4	5.3	13.1	758	7.5	5.1	10.8	
Education	No education	708	37.3	33.5	41.2	970	37.5	34.2	40.8	1165	43.2	40.5	45.9	771	30.3	26.7	34.2	787	25.4	22.1	29.0	948	24.4	21.6	27.4	
	Primary education	1039	31.9	29.1	34.7	523	31.7	27.6	36.2	680	30.9	27.4	34.6	566	31.8	27.4	36.5	521	20.0	16.4	24.2	582	18.5	14.9	22.6	
	Secondary or higher education	111	12.6	7.5	20.5	1111	24.2	21.3	27.3	1126	29.0	26.0	32.2	1028	24.3	21.1	27.8	1361	13.1	11.2	15.4	2417	13.9	12.0	15.9	
Place of residence	Rural	1327	37.2	34.4	39.9	1959	34.5	32.1	37.0	2165	40.7	38.7	42.7	1585	32.5	29.7	35.4	1586	22.1	19.8	24.7	2197	19.6	17.7	21.7	
	Urban	531	21.8	18.5	25.6	644	18.9	15.6	22.7	1078	25.0	21.9	28.4	1008	21.8	18.6	25.4	1324	14.8	12.5	17.4	2096	15.1	12.8	17.7	
Sex	Female	915	29.3	26.6	32.2	1330	27.7	25.2	30.4	1622	32.6	30.2	35.1	1269	26.6	23.7	29.7	1381	17.0	14.9	19.3	2101	15.3	13.4	17.4	
	Male	943	36.2	33.1	39.4	1274	33.7	30.7	36.8	1621	38.4	35.9	40.8	1325	30.1	27.3	33.1	1528	20.4	18.1	23.0	2192	19.4	17.3	21.7	

Table 1 (continued)

Dimensions	Measures	1993		1998		2003		2008		2014		2022		2022												
		Pop- ula- tion	Esti- mate (%)	CHUB	CI-LB	CHUB	CI-LB	CHUB	CI-LB	CHUB	CI-LB	CHUB	CI-LB	Esti- mate (%)	Pop- ula- tion	Esti- mate (%)										
Subnational region	ahafo	187	33.2	27.1	39.8	202	22.2	15.6	30.6	360	35.2	29.3	41.6	274	25.1	19.6	31.6	284	17.2	13.5	21.8	98	16.5	13.0	20.6	
	ashanti	329	35.3	30.9	39.9	428	33.7	28.3	39.6	620	36.1	32.0	40.4	516	27.0	23.1	31.4	497	16.0	11.5	21.9	784	17.2	12.4	23.5	
	bono	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	136	17.0	11.5	24.3
	bono east	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	208	13.9	10.3	18.5
	central	200	29.0	22.1	37.0	280	32.6	26.3	39.6	283	38.1	32.2	44.5	256	33.6	26.5	41.5	344	22.0	17.0	27.9	440	16.5	11.5	23.1	
	eastern	206	32.5	25.2	40.8	360	28.5	23.1	34.6	338	33.6	28.7	38.8	225	38.6	29.1	49.1	273	17.0	12.1	23.4	334	10.4	7.8	13.9	
	greater accra	181	19.9	15.0	26.0	278	14.3	9.8	20.3	352	18.9	14.0	24.9	295	16.7	11.6	23.6	426	10.4	6.6	15.8	528	11.4	7.5	16.9	
	north east	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	148	29.3	23.5	35.9
	northern	188	43.6	33.2	54.7	170	44.1	35.8	52.7	422	54.0	48.8	59.1	366	32.4	26.8	38.5	364	32.7	28.1	37.8	477	29.6	24.8	34.8	
	oti	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	134	20.3	14.4	27.7
savannah	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	128	21.0	17.5	25.0	
upper east	136	31.6	24.0	40.4	174	42.5	36.7	48.5	161	35.9	29.3	43.1	122	36.0	29.9	42.7	118	14.3	11.2	18.1	212	21.1	16.1	27.1		
upper west	62	45.2	28.8	62.7	69	38.9	31.4	46.8	97	38.9	32.7	45.5	67	24.5	19.6	30.2	79	22.1	16.5	28.9	137	16.5	12.2	21.9		
volta	197	25.9	20.0	32.8	299	28.6	22.7	35.4	275	27.6	22.8	33.0	229	26.6	19.5	35.1	216	19.6	14.7	25.7	165	14.4	10.1	20.1		
western	172	38.4	31.0	46.3	343	33.0	26.4	40.3	335	33.8	28.6	39.3	244	26.8	18.0	38.0	308	18.2	13.3	24.4	262	13.5	9.4	19.0		
western north	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	102	10.6	7.1	15.7	

CI: Confidence intervals; LB: Lower-class boundary; UB: Upper-class boundary; NA: Not available

Table 2 Trends in prevalence of underweight among children aged 0–59 months old in Ghana, 1993–2022

Dimensions	Measures	1993		1993		1998		1998		2003		2003		2008		2008		2014		2014		2022		2022	
		Pop- ula- tion	Esti- mate (%)	CI-LB	CI-UB	Pop- ula- tion	Esti- mate (%)	CI-LB	CI-UB	Pop- ula- tion	Esti- mate (%)	CI-LB	CI-UB	Pop- ula- tion	Esti- mate (%)	CI-LB	CI-UB	Pop- ula- tion	Esti- mate (%)	CI-LB	CI-UB	Pop- ula- tion	Esti- mate (%)	CI-LB	CI-UB
Child's age	0–5 months	383	17.0	13.4	21.3	297	18.2	13.9	23.3	330	10.6	7.5	14.9	272	9.2	6.2	13.3	331	4.5	2.6	7.4	429	7.2	4.8	10.6
	6–11 months	335	20.6	16.5	25.4	611	24.1	20.5	28.1	360	22.1	17.5	27.5	279	18.0	13.6	23.4	281	13.8	9.4	19.7	432	14.0	10.6	18.4
	12–23 months	617	26.6	23.1	30.4	499	20.4	16.9	24.4	656	23.4	20.2	27.0	554	16.6	13.7	20.0	589	12.7	10.1	16.0	920	15.6	13.0	18.7
	24–35 months	558	29.7	26.0	33.8	487	20.4	17.0	24.4	661	20.2	17.3	23.5	511	15.0	11.8	18.7	577	14.9	10.9	20.1	815	13.5	10.9	16.8
	36–47 months	NA	NA	NA	NA	449	21.5	17.9	25.5	735	17.7	14.9	21.0	527	14.7	11.7	18.2	571	10.3	7.5	14.0	870	13.5	10.9	16.8
	48–59 months	NA	NA	NA	NA	297	18.2	13.9	23.3	613	17.4	14.3	21.0	564	12.1	9.4	15.4	560	9.2	6.6	12.8	833	9.7	7.4	12.7
Economic status (wealth quintile)	Quintile 1 (poorest)	366	30.9	26.2	35.9	697	28.0	24.9	31.3	857	28.1	24.9	31.6	664	19.5	16.3	23.2	669	15.7	13.0	18.9	1003	14.0	11.8	16.7
	Quintile 2	413	30.5	25.8	35.6	566	22.5	18.6	26.8	750	20.8	17.7	24.4	608	18.2	14.8	22.1	597	13.6	10.6	17.2	891	15.8	13.4	18.5
	Quintile 3	400	29.0	24.4	34.0	546	19.6	16.1	23.6	681	18.1	14.8	21.9	501	12.5	9.2	16.8	608	7.2	5.2	9.9	812	11.4	8.7	14.8
	Quintile 4	387	18.6	14.7	23.3	453	16.2	12.5	20.7	571	13.4	10.6	16.8	544	9.0	6.7	12.1	541	11.5	7.7	16.9	835	11.7	8.5	15.8
	Quintile 5 (richest)	327	11.3	8.3	15.3	394	8.2	5.6	11.8	497	8.5	6.1	11.8	390	9.6	6.6	13.7	497	6.6	3.7	11.5	758	5.8	3.6	9.2
Education	No education	718	31.6	28.3	35.2	990	25.1	22.5	27.9	1227	25.1	22.5	27.9	803	17.8	15.2	20.8	787	14.5	11.8	17.6	951	15.7	13.4	18.3
	Primary education	1059	21.4	18.9	24.2	529	20.3	16.6	24.5	690	15.4	12.6	18.6	596	13.9	11.1	17.2	522	11.7	9.0	14.9	582	13.4	10.1	17.4
	Secondary or higher education	116	8.6	4.8	15.0	1137	15.7	13.3	18.5	1155	14.1	11.7	16.8	1074	11.7	9.7	14.2	1362	8.5	6.6	10.9	2419	10.0	8.5	11.8
Place of residence	Rural	1352	27.9	25.4	30.5	2000	22.5	20.5	24.6	2242	22.1	20.2	24.1	1655	16.6	14.7	18.6	1588	13.2	11.2	15.5	2199	13.1	11.5	14.8
	Urban	541	16.1	13.6	18.9	657	12.9	10.1	16.3	1113	12.9	10.5	15.8	1053	10.9	8.8	13.5	1324	8.7	6.8	11.0	2101	10.9	8.9	13.2
	Female	931	22.7	25.4	30.5	1359	19.7	17.7	22.0	1667	17.0	15.0	19.3	1318	12.8	11.1	14.8	1387	11.7	9.6	14.1	2101	10.1	8.6	11.8
	Male	962	26.3	23.8	29.0	1297	20.5	18.1	23.3	1689	21.0	19.0	23.2	1389	15.9	13.8	18.2	1524	10.7	9.0	12.7	2198	13.8	12.1	15.7

Table 2 (continued)

Dimensions	Measures	1993 Pop- ula- tion	1993 Esti- mate (%)	1993 CHLB	1993 CHUB	1998 Pop- ula- tion	1998 Esti- mate (%)	1998 CHLB	1998 CHUB	2003 Pop- ula- tion	2003 Esti- mate (%)	2003 CHLB	2003 CHUB	2008 Pop- ula- tion	2008 Esti- mate (%)	2008 CHLB	2008 CHUB	2014 Pop- ula- tion	2014 Esti- mate (%)	2014 CHLB	2014 CHUB	2022 Pop- ula- tion	2022 Esti- mate (%)	2022 CHLB	2022 CHUB
Subnational region	ahafo	190	28.9	24.2	34.2	213	21.7	15.2	30.1	370	17.5	12.9	23.1	276	13.8	10.1	18.5	497	9.6	6.0	15.1	98	7.6	5.0	11.3
	ashanti	336	19.3	15.9	23.3	439	20.7	17.6	24.2	626	17.0	13.3	21.3	531	12.0	9.6	14.9	285	5.9	3.5	9.7	784	10.6	7.2	15.3
	bono	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	136	10.7	6.8	16.5
	bono east	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	209	11.4	7.8	16.4
	central	202	20.3	15.0	26.9	288	21.5	15.4	29.1	291	17.7	11.8	25.6	270	19.1	13.5	26.5	NA	NA	NA	NA	440	11.7	7.7	17.3
	eastern	213	16.0	11.2	22.3	362	16.4	11.4	23.0	341	12.3	8.0	18.4	245	10.2	7.2	14.3	NA	NA	NA	NA	334	10.7	6.6	16.8
	greater accra	181	14.4	9.1	22.0	285	8.6	5.2	14.0	366	9.1	6.0	13.7	307	7.1	4.3	11.7	346	13.8	9.2	20.2	530	8.5	4.6	15.0
	north east	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	148	19.4	15.2	24.5
	northern	192	41.7	35.5	48.1	172	34.5	28.0	41.6	444	30.7	25.9	35.8	387	21.4	16.8	26.9	426	8.7	5.4	13.5	477	19.5	15.4	24.3
	oti	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	134	15.5	10.1	23.1
savannah	upper east	138	33.3	22.1	46.9	175	25.6	21.6	30.0	203	34.0	30.8	37.5	127	27.6	20.4	36.2	118	11.2	8.3	15.0	213	12.5	9.0	16.9
	upper west	63	38.1	26.0	51.9	75	27.0	20.4	34.8	98	23.0	18.3	28.6	69	13.2	9.8	17.6	78	13.5	9.0	19.7	137	11.0	8.2	14.5
	volta	205	18.0	12.0	26.2	303	21.0	16.7	26.1	279	22.4	17.0	28.9	236	13.2	8.8	19.2	215	10.5	7.6	14.4	165	12.7	8.9	17.9
	western	173	32.4	24.9	40.8	345	18.5	14.0	24.2	337	15.2	10.8	20.9	259	11.9	7.6	18.1	308	10.5	7.6	14.4	264	9.1	5.8	14.0
	western north	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	102	7.5	4.3	12.7

lowest prevalence. The highest prevalence of stunting in 1993 was observed among children from the upper west region, whilst in 2022, the highest prevalence was among children in northern and northeast regions respectively. The confidence intervals across all survey years in the different regions suggest the differences in stunting prevalence were statistically significant. Regions including the northeast, oti, Savannah, and western North had no data for 1993, 1998, 2003, 2008, and 2014 indicated as NA (not available).

Trends in prevalence of underweight among children aged 0–59 months old in Ghana, 1993–2022

Table 2 show the trends in the prevalence and inequalities of underweight among children aged 0–59 months in Ghana from 1992 to 2022 across various demographic dimensions. The prevalence of underweight among children aged 0–5 months decreased from 17.0% in 1993 to 7.2% in 2022, showing significant improvement in this age group. For children aged 6–11 months, this group decreased from 20.6% in 1993 to 14.0% in 2022, indicating a positive trend but still relatively high. For 12–23 months old children, the prevalence was highest in 1993 at 26.6%, which reduced to 15.6% in 2022, reflecting a notable decline. The 24–35 months age group also showed improvement, decreasing prevalence from 29.7% in 1993 to 13.5% in 2022. There was a slight decrease for the 36–47-month-olds from 17.7% in 2003 to 10.1% in 2022, indicating improvements but still concerning. The 48–59 months old group declined from 21.5% in 1998 to 9.7% in 2022. The confidence intervals in all subgroups indicate that the difference in decreased prevalence over time was statistically significant.

For economic status, children of mothers from Quintile 1 (Poorest) decreased in underweight prevalence from 30.9% in 1993 to 14.0% in 2022, showing improvement but still indicating high vulnerability. The Quintile 2 group decreased from 30.5% in 1993 to 15.8% in 2022. The Quintile 3 prevalence dropped from 29.0% in 1993 to 11.4% in 2022. In Quintile 4, there was a decrease from 18.6% in 1993 to 11.7% in 2022. The Quintile 5 (Richest) group showed the most significant improvement, dropping prevalence from 11.3% in 1993 to 5.8% in 2022. The confidence intervals in all subgroups indicate that the difference in decreased prevalence over time was statistically significant. Regarding education status, children whose mothers had no education decreased in underweight prevalence from 31.6% in 1993 to 15.7% in 2022, indicating substantial progress. Those whose mothers had primary education group decreased from 21.4% in 1993 to 13.4% in 2022. Those whose mothers had secondary or higher education dropped in prevalence from 8.6% in 1993 to 10.0% in 2022, slightly increasing but remaining the lowest among educational groups. The confidence

intervals in all subgroups indicate that the difference with a decreased prevalence over time were statistically significant. For place of residence, children of mothers from rural areas experienced the highest decreased in underweight prevalence from 27.9% in 1993 to 13.1% in 2022, compared with their counterpart in urban areas decreasing only from 16.1% in 1993 to 10.9% in 2022. The confidence intervals in all dimensions indicate that the difference in decreased prevalence over time was statistically significant. For sex, male children had a relatively higher decreased in underweight prevalence from 26.3% in 1993 to 13.8% in 2022 compared with female children decreasing from 22.7% in 1993 to 10.1% in 2022. The confidence intervals in both subgroups indicate that the difference in decreased prevalence over time was statistically significant. Finally, for subnational level, regions like the Northern and Upper East regions consistently show high prevalence rates, with the Northern region at 41.7% in 1993 and 19.5% in 2022, indicating persistent challenges. Greater Accra and Western regions generally have lower prevalence rates, with Greater Accra decreasing from 14.4% in 1993 to 8.5% in 2022. The confidence intervals in all subgroups indicate that the difference in decreased prevalence over time was statistically significant.

Inequality in the prevalence of stunting among children aged 0–59 months old in Ghana, 1993–2022

The inequality measures from Table 3 reveal notable trends in factors associated with stunting among children aged 0–59 months in Ghana from 2003 to 2022, highlighting disparities across various dimensions. Regarding child's age, the D in stunting inequality between children aged 48–59 months compared with those aged 0–5 months reduced from –29.5 percentage points in 1998 to –0.9 percentage points in 2022. The confidence intervals suggest the difference in inequality between the two groups were statistically significant, except in 2022 suggesting that age-related differences in stunting rates are less pronounced. The ratio between children aged 48–59 months and those aged 0–5 months increased from 0.2% in 1998 to 0.9% in 2022. However, with R of less than 1 throughout the survey years suggests children aged 0–5 months are disproportionately affected with stunting, and the confidence intervals suggests the difference in inequality between the groups were statistically significant except in 2022.

For economic status, the D between children from the richest mothers compared with those from the poorest mothers decreased from 27.2 percentage points in 1993 to 15.3 percentage points in 2022, reflecting a low inequality. The confidence intervals across survey years suggest the difference between the groups were statistically significant. The R of children in quintile 5 (richest)

Table 3 Inequality of factors associated with stunting among children aged 6–59 months in Ghana by different inequality dimensions, 1993–2023

Dimensions	Measures	1993 Estimate (%)	1993 CI-LB	1993 CI-UB	1998 Esti- mate (%)	1998 CI-LB	1998 CI-UB	2003 Esti- mate (%)	2003 CI-LB	2003 CI-UB	2008 Esti- mate (%)	2008 CI-LB	2008 CI-UB	2014 Esti- mate (%)	2014 CI-LB	2014 CI-UB	2022 Esti- mate (%)	2022 CI-LB	2022 CI- UB
Child's age	D	NA	NA	NA	-29.5	-35.1	-24	-22.6	-28.4	-16.8	-24.9	-30.6	-19.2	-9.4	-15.4	-3.4	-0.9	-6.5	4.6
	PAF	NA	NA	NA	0	-0.1	0.1	0	-0.1	0.1	0	-0.1	0.1	-6.1	-6.2	-5.9	-18.4	-18.5	-18.3
	PAR	NA	NA	NA	0	-4.1	4.1	0	-3.5	3.5	0	-3.4	3.4	-1.1	-4	1.7	-3.2	-5.4	-1
Economic status	R	NA	NA	NA	0.2	0.1	0.3	0.4	0.3	0.5	0.2	0.1	0.4	0.5	0.3	0.8	0.9	0.6	1.4
	D	27.2	20.8	33.5	22.4	16.5	28.3	30.6	25.6	35.6	18.3	12	24.6	16.3	11.2	21.4	15.3	11.1	19.5
	PAF	-51.9	-51.8	-52	-43.8	-44	-43.7	-51.9	-52	-51.8	-40.9	-41.1	-40.8	-55	-55.2	-54.9	-57	-57.1	-56.9
Education	PAR	-17	-20.8	-13.2	-13.4	-17	-9.9	-18.4	-21.6	-15.2	-11.6	-15.2	-8	-10.3	-12.7	-8	-9.9	-11.7	-8.1
	R	2.7	2	3.7	2.3	1.8	3	2.8	2.2	3.5	2.1	1.5	2.9	2.9	1.8	4.7	3	2	4.5
	D	24.7	17.3	32	13.3	8.8	17.7	14.1	10	18.3	6	1	11	12.2	8.2	16.3	10.5	7	14
Place of residence	PAF	-61.5	-61.7	-61.3	-21.1	-21.2	-21	-17	-17.1	-17	-13.3	-13.4	-13.3	-27.3	-27.4	-27.3	-18.8	-18.8	-18.7
	PAR	-20.2	-26.3	-14.1	-6.5	-8.5	-4.5	-6	-8.1	-3.8	-3.7	-5.8	-1.7	-4.9	-6.3	-3.5	-3.2	-4.2	-2.2
	R	3	1.8	4.9	1.5	1.3	1.8	1.5	1.3	1.7	1.2	1	1.5	1.9	1.6	2.4	1.8	1.5	2.1
Sex	D	15.3	10.8	19.8	15.6	11.3	19.8	15.6	11.9	19.4	10.7	6.3	15.1	7.4	3.9	10.9	4.5	1.4	7.7
	PAF	-33.4	-33.4	-33.3	-38.3	-38.3	-38.2	-29.4	-29.5	-29.4	-23	-23.1	-22.9	-21.4	-21.4	-21.3	-13.4	-13.4	-13.3
	PAR	-10.9	-14	-7.8	-11.7	-14.5	-9	-10.4	-12.7	-8.2	-6.5	-8.6	-4.4	-4	-5.5	-2.5	-2.3	-3.5	-1.2
Subnational region	R	1.7	1.4	2	1.8	1.5	2.2	1.6	1.4	1.9	1.5	1.2	1.8	1.5	1.2	1.8	1.3	1.1	1.6
	D	-6.9	-11.1	-2.7	-6	-10	-2	-5.8	-9.2	-2.3	-3.5	-7.7	0.7	-3.4	-6.7	-0.2	-4.1	-7.1	-1.1
	PAF	0	-0.1	0.1	0	-0.1	0.1	0	0	0	0	-0.1	0.1	0	-0.1	0.1	0	-0.1	0.1
Subnational region	PAR	0	-2.1	2.1	0	-1.8	1.8	0	-1.6	1.6	0	-1.7	1.7	0	-1.3	1.3	0	-1.1	1.1
	R	0.8	0.7	0.9	0.8	0.7	0.9	0.8	0.8	0.9	0.9	0.8	1	0.8	0.7	1	0.8	0.7	0.9
	D	25.3	10.8	39.7	29.8	20.5	39.1	35.1	28	42.2	21.9	10.5	33.3	22.4	15.9	28.8	19.1	13.5	24.8
Subnational region	PAF	-39.3	-39.5	-39.1	-53.4	-53.5	-53.3	-46.8	-46.9	-46.7	-41	-41.1	-40.8	-44.9	-45.1	-44.8	-40	-40.2	-39.8
	PAR	-12.9	-18.5	-7.3	-16.4	-20.3	-12.4	-16.6	-20.6	-12.7	-11.6	-15.7	-7.5	-8.4	-11.2	-5.7	-6.9	-10.1	-3.8
	R	2.3	1.5	3.4	3.1	2.1	4.6	2.9	2.1	3.8	2.3	1.5	3.6	3.2	2	5	2.8	2	3.9

CI-LB: Confidence Interval Lower Bound; CI-UB: Confidence Interval Upper Bound; D: Difference; NA: Not Available; PAF: Population Attributable Fraction; PAR: Population Attributable Risk; R: Ratio

compared with those in quintile 1 (poorest) increased slightly from 2.7% in 1993 to 3.0% in 2022, indicating children in the poorest quintile are disproportionately affected with stunting. The confidence intervals across the different years suggest the difference in inequality were statistically significant.

With education, the D in stunting rates between children of mothers with high education and those with low education decrease from 24.7 percentage points in 1993 to 10.5 percentage points in 2022, indicating that children of higher educated mothers are less likely to be stunted. The R between the two groups decreased from 3% to 1.8% in 2022, indicating relatively a narrowing inequality gap, even though children of mothers with no education remains disproportionately affected. The confidence intervals across all survey years suggest the differences were statistically significant.

Regarding place of residence, the D between children from urban areas and those from rural areas decreased from 15.3 percentage points in 1993 to 4.5 percentage points in 2022. The confidence interval suggest the differences between the two groups were statistically significant. Also, the R between the two groups decreased from 1.7% in 1993 to 1.3% in 2022, however, inequality persisted disproportionately affecting children residing in the rural areas. The confidence interval suggest the difference in inequality were statistically significant.

In terms of the sex of the child, the D in inequality between male children compare with female decreased from -6.9 percentage points in 1993 to -4.1 percentage points in 2022, indicating that male children are more affected by stunting, with this measure being statistically significant. The ratio between the two groups (female vs. male) remains constant at 0.8%, indicating no change in inequality. However, the confidence intervals suggesting statistical significant, indicate male children continue to be disproportionately affected.

Finally, the subnational region showed the D in inequality decreased from 25.3 percentage points in 1993 to 19.1 percentage points in 2022, revealing reduction in regional disparities in stunting inequality. This means that children in certain regions like Northern and Upper East experience significantly higher stunting rates than those in other regions like Greater Accra and Western. The ratio also increased from 2.3% in 1993 to 2.8% in 2022, indicating children in certain, especially those in new established regions are disproportionately affected with stunting compared with those in the greater accra region. The confidence intervals suggest the difference in inequality were statistically significant.

Inequality in the prevalence of underweight among children aged 0–59 months old in Ghana, 1993–2022

The results presented in Table 4 provide a comprehensive analysis of the inequality measures associated with underweight prevalence among children aged 6–59 months in Ghana across various dimensions from 1992 to 2023. The difference in inequality between children aged 24–35 months compared with those 0–5 months old decreased from -10.0 percentage points in 1993 to -2.6 percentage points in 2022; the confidence intervals between the two groups suggest the difference was not statistically significant. The ratio between children aged 24–35 months compared with those 0–5 months decreased from 0.5% in 1993 to 0.7% in 2022; however, the confidence interval between the two groups suggests an inequality, with children aged 0–5 months disproportionately affected.

For economic status, the difference in underweight prevalence among women in the richest quintile compared with the poorest quintile decreased from 19.6 percentage points in 1993 to 8.3 percentage points in 2022; the confidence interval between the two groups indicates the difference in prevalence were statistically significant. The ratio between children in the richest quintile compared with those in the poorest quintile decreased from 2.7% in 1993 to 2.4% in 2022; the confidence interval between the two groups indicates there was an inequality, indicating that economic status significantly impacted underweight with children in the richest quintile less likely to experience underweight.

Regarding education, the difference in underweight prevalence among children whose parents had secondary education or higher compared with those whose parents had no education decreased from 23.0 percentage points in 1993 to 5.6 percentage points in 2022; the confidence interval suggest the differences between the two groups were statistically significant. The ratio between children whose mothers had secondary education or higher compared with those whose mothers had no education decreased from 3.7% in 1993 to 1.6% in 2022; the confidence interval suggest there was an inequality, with those whose mothers had no education disproportionately affected.

In terms of place of residence, the difference in underweight prevalence among children who resided in urban settings compared with those in rural settings decreased from 11.8 percentage point in 1993 to 2.2 percentage points in 2022, and the confidence indicate the differences between the two groups were statistically significant. Also, the ratio decreased from 1.7% in 1993 to 1.2% in 2022; the confidence interval suggest there is an inequality, with children who resided in urban setting less likely to be underweight.

Table 4 Inequality of factors associated with underweight among children aged 6–59 months in Ghana by different inequality dimensions, 1993–2023

Dimensions	Measures	1993 Estimate (%)	1993 CI-LB	1993 CI-UB	1998 Esti- mate (%)	1998 CI-LB	1998 CI-UB	2003 Esti- mate (%)	2003 CI-LB	2003 CI-UB	2008 Esti- mate (%)	2008 CI-LB	2008 CI-UB	2014 Esti- mate (%)	2014 CI-LB	2014 CI-UB	2022 Esti- mate (%)	2022 CI-LB	2022 CI- UB
Child's age	D	NA	NA	NA	-10.0	-15.2	-4.9	-6.8	-11.7	-1.9	-3.0	-7.6	1.6	-4.8	-8.6	-0.9	-2.6	-6.4	1.3
	PAF	NA	NA	NA	0.0	-0.2	0.2	-8.6	-8.8	-8.5	-15.8	-15.9	-15.6	-17.4	-17.6	-17.2	-18.7	-18.9	-18.6
	PAR	NA	NA	NA	0.0	-3.4	3.4	-1.6	-4.4	1.1	-2.3	-4.7	0.2	-1.9	-4.1	0.2	-2.2	-4.1	-0.4
Economic status	R	NA	NA	NA	0.5	0.4	0.8	0.6	0.4	0.9	0.8	0.5	1.2	0.5	0.3	0.9	0.7	0.5	1.2
	D	19.6	13.6	25.5	19.8	15.4	24.1	19.6	15.3	24.0	9.9	5.1	14.8	9.1	4.4	13.9	8.3	4.6	11.9
	PAF	-53.8	-54.0	-53.7	-59.4	-59.5	-59.2	-55.4	-55.5	-55.3	-33.5	-33.7	-33.3	-41.0	-41.2	-40.8	-51.7	-51.8	-51.6
Education	PAR	-13.2	-16.5	-9.9	-11.9	-14.6	-9.3	-10.5	-12.9	-8.2	-4.8	-7.6	-2.1	-4.6	-6.6	-2.5	-6.2	-7.8	-4.6
	R	2.7	1.9	3.8	3.4	2.3	5.0	3.3	2.3	4.7	2.0	1.4	3.1	2.4	1.3	4.3	2.4	1.5	4.0
	D	23.0	17.0	28.9	9.4	5.7	13.1	11.0	7.3	14.7	6.1	2.5	9.7	6.0	2.4	9.5	5.6	2.7	8.6
Place of residence	PAF	-64.8	-65.0	-64.6	-21.9	-21.9	-21.8	-25.0	-25.1	-24.9	-17.5	-17.6	-17.4	-21.8	-21.9	-21.7	-15.5	-15.6	-15.5
	PAR	-15.9	-20.9	-10.8	-4.4	-6.1	-2.7	-4.7	-6.4	-3.0	-2.5	-4.0	-1.0	-2.4	-3.5	-1.2	-1.8	-2.7	-1.0
	R	3.7	2.1	6.5	1.6	1.3	1.9	1.8	1.4	2.2	1.5	1.2	1.9	1.7	1.2	2.3	1.6	1.2	2.0
Sex	D	11.8	8.2	15.4	9.6	5.9	13.3	9.2	6.0	12.4	5.6	2.6	8.6	4.5	1.6	7.5	2.2	-0.5	4.9
	PAF	-34.4	-34.5	-34.3	-35.9	-36.0	-35.8	-32.3	-32.3	-32.2	-23.9	-24.0	-23.8	-22.1	-22.2	-22.0	-9.4	-9.4	-9.3
	PAR	-8.4	-11.2	-5.7	-7.2	-9.6	-4.9	-6.1	-7.9	-4.4	-3.4	-5.0	-1.9	-2.5	-3.7	-1.3	-1.1	-2.1	-0.1
Subnational region	R	1.7	1.4	2.1	1.7	1.4	2.2	1.7	1.4	2.1	1.5	1.2	1.9	1.5	1.1	2.0	1.2	1.0	1.5
	D	-3.6	-7.5	0.2	-0.8	-4.1	2.6	-4.0	-6.9	-1.0	-3.1	-6.0	-0.2	0.9	-1.9	3.8	-3.7	-6.1	-1.3
	PAF	0.0	-0.1	0.1	0.0	-0.1	0.1	0.0	-0.1	0.1	0.0	-0.1	0.1	-4.0	-4.1	-3.9	0.0	-0.1	0.1
Subnational region	PAR	0.0	-1.9	1.9	0.0	-1.6	1.6	0.0	-1.3	1.3	0.0	-1.3	1.3	-0.4	-1.5	0.7	0.0	-0.9	0.9
	R	0.9	0.7	1.0	1.0	0.8	1.1	0.8	0.7	1.0	0.8	0.7	1.0	1.1	0.8	1.4	0.7	0.6	0.9
	D	27.3	19.0	35.6	25.9	18.4	33.4	24.9	20.2	29.6	20.5	12.1	28.9	14.8	9.6	20.0	12.0	6.2	17.8
Subnational region	PAF	-41.4	-41.6	-41.2	-57.3	-57.4	-57.1	-52.0	-52.1	-51.8	-50.3	-50.5	-50.1	-47.1	-47.4	-46.9	-37.3	-37.7	-36.9
	PAR	-10.1	-15.1	-5.2	-11.5	-14.7	-8.4	-9.9	-12.8	-7.0	-7.2	-10.0	-4.4	-5.3	-7.9	-2.6	-4.5	-9.5	0.6
	R	2.9	1.9	4.5	4.0	2.4	6.7	3.7	2.5	5.6	3.9	2.2	6.8	3.5	2.0	6.0	2.6	1.5	4.6

CI-LB: Confidence Interval Lower Bound; CI-UB: Confidence Interval Upper Bound; D: Difference; NA: Not Available; PAF: Population Attributable Fraction; PAR: Population Attributable Risk; R: Ratio

For sex, the difference underweight prevalence among male children compared with female increased from -3.6 percentage points in 1993 to -3.7 percentage in 2022, and the confidence intervals suggest the differences between the two groups was statistically significant. The ratio between male children compared with female decreased from 0.9% in 1993 to 0.7% in 2022; the confidence interval indicates there was an inequality, with female children more likely to be underweight.

Lastly, the subnational region shows the difference in underweight among children who resided in Greater Accra compared with those in Northern region decreased from 27.3 percentage points in 1993 to 12.0 percentage points in 2022; the confidence between the two groups indicates the differences were statistically significant. The ratio between children who lived in Greater Accra compared with those in Northern region decreased from 2.9% in 1993 to 2.6% in 2022; the confidence interval indicate the presence of inequality with children in the Northern region disproportionately affected.

Discussion

The study on stunting and underweight prevalence among children aged 0–59 months in Ghana from 1993 to 2022 reveals a nuanced narrative of progress and persistent inequalities. Initially, the stunting and underweight rates decline steadily between 1993 and 2022 with decreasing from 32.8 to 17.4% and underweight decreasing from 24.5 to 11.9% respectively, mainly attributed to government efforts with support from partners in implementing interventions that could have resulted in the observed decreased. Some of these interventions includes community sensitization through radio talkshow programs and community engagement activities on the benefits of nutritional diets for young children, especially exclusive breastfeeding. This high prevalence not only reflects the nutritional deficiencies prevalent at the time but also highlights systemic issues such as inadequate healthcare infrastructure and socio-economic challenges faced by families. The slight reduction to 30.6% for stunting and 20.1% for underweight in 1998 suggested potential improvements, possibly due to early interventions or increased awareness of nutritional needs. However, the subsequent peak of 35.4% in 2003 observed for stunting prevalence raises significant questions about the socioeconomic and environmental factors that may have contributed to this setback. These fluctuations observed in both stunting and underweight prevalence could be linked to various challenges, including economic instability, health crises, or ineffective nutritional policies during that period. For instance, the impact of the global economic downturns or local conflicts could have exacerbated food insecurity. The decline to 17.4% for stunting and 11.9% for underweight by 2022 is commendable;

however, it underscores the need for sustained and targeted interventions to maintain this momentum, particularly considering the Sustainable Development Goals (SDGs) aimed at ending all forms of malnutrition by 2030 (SDG 2) [26]. The journey towards achieving this goal necessitates a multifaceted approach, integrating health, education, and socioeconomic policies to ensure child is left behind.

The age-related inequalities in stunting rates, which decreased for both stunting (between 1993 and 2022) and underweight (between 1998 and 2022) showed significant shift in the nutritional sector. This finding aligns with previous studies [27–29], indicating a growing recognition of the importance of early childhood nutrition. The decrease observed in our study suggests that younger children are catching up with older children complementing the efforts implemented by the Government of Ghana with support from partners, such as enhanced maternal and child health programs and community-based nutrition initiatives. The lack of statistical significance in 2022 indicates that age-related differences are converging, implying that while younger children are faring better, older children may not receive the same attention level. The ratio (R) of 0.9% points for stunting and 0.7% points for underweight emphasises that addressing age-related factors could prevent many stunting and underweight cases. This finding aligns with SDG 3, which aims to ensure healthy lives and promote well-being for all ages [30]. Targeting interventions for young and older children, especially in their critical early development years, is essential to achieving these goals. This includes nutritional support and educational initiatives aimed at parents to foster a nurturing environment conducive to healthy growth.

Similar to previous studies [31, 32], economic status remains a critical determinant of stunting and underweight prevalence, with the difference in stunting inequality standing at 11.9% points (from 27.2 to 15.3) and underweight inequality at 11.3% points (from 19.6 to 8.3), between 1993 and 2022, respectively. This persistent inequality points to systemic issues disproportionately affecting poorer households, like those with limited access to nutritious food, healthcare, and education [33]. The R of 3 for stunting and 2.4 for underweight in 2022 reveals that economic disparities account for a significant portion of stunting and underweight cases, reinforcing the necessity of addressing poverty as part of a broader strategy to combat malnutrition. This finding is directly linked to SDG 1, which seeks to end poverty in all its forms everywhere [34]. Policies to improve economic conditions for vulnerable populations will be crucial in reducing stunting and underweight rates and enhancing child health outcomes. This could involve implementing social safety nets, improving access to quality education,

promoting sustainable agricultural practices that ensure food security for all families, and enhancing cash transfers [35].

Maternal education is another vital factor influencing stunting and underweight prevalence. Our finding aligns with previous studies [36–38], reinforcing that maternal education is a cornerstone of child health. The consistent inequality differences in stunting (from 24.7 to 10.5) and underweight (from 23 to 2.4) rates between 1993 and 2022 among children of educated and uneducated mothers underline the critical role of education in shaping health outcomes. Educated mothers are more likely to have access to information about nutrition and health care, leading to better feeding practices and health-seeking behaviours for their children. The PAF of -18.8% for stunting and -15.5% for underweight indicates that educational disparities significantly contribute to stunting prevalence, suggesting that enhancing maternal education is a crucial intervention strategy. This aligns with SDG 4, which aims to ensure inclusive and equitable quality education for all [39]. Empowering women through education improves their health literacy and translates into better nutrition and health practices for their children. Furthermore, community-based programs that promote female education and provide support for mothers can have a profound impact on child health outcomes.

The place of residence continues to be a significant determinant of stunting and underweight, with urban children experiencing lower stunting and underweight rates compared to their rural counterparts. This finding aligns with previous studies [40], which consistently show that urbanisation often correlates with better access to healthcare and nutrition. The difference of 4.5% points and *R* of 1.3 for stunting inequality and the difference of 2.2% points and *R* of 1.2 in 2022, highlights the need for targeted interventions in rural areas where children are disproportionately affected. This disparity is critical for achieving SDG 10, which focuses on reducing inequalities within and among countries [41]. Addressing the unique challenges rural populations face, such as limited access to healthcare, clean water, and nutritious food, is essential for reducing stunting and ensuring equitable health outcomes for all children. Strategies could include enhancing infrastructure, increasing the availability of health services, and implementing community nutrition programs tailored to the specific needs of rural families.

Furthermore, the results of stunting and underweight differences by sex indicate that male children are more affected than female children, aligning with previous studies [42], with a difference of -4.1% points for stunting and -3.7% points for underweight in 2022. The *R* for stunting of 0.8 and underweight of 1.4 indicates a slight

differences of sex-specific vulnerabilities that must be addressed in health interventions.

Finally, the reduced regional inequality, highlighted by a difference of 19.1% points for stunting and 12 percentage points for underweight in 2022, reveals that children in certain regions face notable higher stunting rates. The *R* of 2.8 for stunting and 2.6 for underweight underscores the importance of regional factors in shaping health outcomes, necessitating tailored, region-specific interventions to address these disparities, especially targeting children of northern and north east eastern regions who are disproportionately affected. This approach aligns with SDG 11, which aims to make cities and human settlements inclusive, safe, resilient, and sustainable [43]. By recognising and addressing the unique challenges faced by different regions, policymakers can develop more effective strategies to combat stunting and improve overall child health.

Policy and practice implications

The trends and inequalities in stunting and underweight prevalence among children aged 0–59 months in Ghana from 1993 to 2022 underscore the urgent need for comprehensive policy and practice interventions that address the multifaceted nature of this public health issue. Policymakers must prioritise economic empowerment initiatives aimed at reducing poverty, particularly among the most vulnerable populations, as the results indicate that economic disparities are a significant contributor to stunting and underweight rates. Additionally, enhancing maternal education should be a focal point, as educated mothers are more likely to adopt healthier practices that benefit their children's nutrition. Targeted interventions in rural areas are essential to mitigate the ongoing disparities between urban and rural stunting rates, ensuring that resources and support are allocated where they are most needed. Furthermore, regional disparities highlighted by the study call for localised strategies that consider the unique socioeconomic and cultural contexts of different regions, thereby fostering a more equitable distribution of health resources. Finally, integrating nutrition-focused programs within existing health and education frameworks can create a holistic approach to tackling stunting and underweight, ensuring that all children in Ghana can achieve optimal growth and development.

Strengths and limitations

The WHO HEAT Online software offers several advantages for analysing stunting and underweight prevalence trends in Ghana using the GDHS data. Its user-friendly interface facilitates data exploration and visualisation, allowing researchers to identify patterns and disparities easily. Additionally, HEAT provides pre-programmed

algorithms for calculating stunting and underweight rates based on the WHO growth standards, ensuring consistency and accuracy in data analysis. Furthermore, the software's ability to integrate data from multiple sources enhances the study's comprehensiveness. However, it is essential to note that the HEAT software's capabilities are primarily focused on data visualisation and analysis. It may not offer advanced statistical modelling techniques or in-depth data-cleaning functionalities that might be required for more complex research questions. Additionally, the reliance on publicly available data through the GDHS may limit the scope of the analysis to the variables included in the surveys. Despite these limitations, the WHO HEAT online software remains a valuable tool for studying stunting prevalence, particularly when combined with complementary analytical methods and data sources.

Conclusion

Our study on stunting and underweight prevalence among children aged 0–59 months in Ghana from 1993 to 2022 highlights both significant progress and persistent inequalities. The decline in stunting and underweight rates from 1993 to 2022 indicates effective interventions; however, the fluctuations, particularly the peak in 2003 for stunting, reveal vulnerabilities within the health and nutrition systems. The inequalities observed across dimensions such as economic status, maternal education, and geographic region for both stunting and underweight underscore the multifaceted nature. To effectively combat stunting and underweight in Ghana, targeted, evidence-based interventions must be implemented to address the identified inequalities. Policies should prioritise economic empowerment initiatives to improve the livelihoods of the poorest households, thereby reducing the stark disparities in stunting and underweight prevalence. Enhancing maternal education through community-based programs can equip mothers with the knowledge and resources necessary to foster better nutritional practices. Furthermore, targeted interventions in rural areas are essential to bridge the gap between urban and rural stunting and underweight rates. Finally, a region-specific approach is recommended to address the unique challenges faced by different geographical areas, ensuring that all children, regardless of their socioeconomic background or location, have equitable access to health and nutrition services.

Abbreviations

D	Difference
HEAT	Health Equity Assessment Toolkit
DHS	Demographic Health Survey
ORT	Oral Rehydration Therapy
PAF	Population Attributable Fraction
PAR	Population Attributable Risk
R	Ratio

SDG	Sustainable Development Goal
WHO	World Health Organization

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Author contributions

AO, and CB contributed to the study design and conceptualisation. AO, and CB performed the analysis. AO, and CB developed the initial draft. US and BOA provided valuable feedback on the data interpretation, methodological approach, and manuscript clarity. All the authors critically reviewed the manuscript for its intellectual content. All authors read and amended drafts of the paper and approved the final version. AO had the final responsibility of submitting it for publication.

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Data availability

https://www.who.int/data/inequality-monitor/assessment_toolkit.

Declarations

Ethics approval and consent to participate

This study did not seek ethical clearance since the WHO HEAT software and the dataset are freely available in the public domain.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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