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Trends and inequalities in anaemia prevalence among children aged 6–59 months in Ghana, 2003–2022

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Abstract

Background Anaemia, characterised by a deficiency in red blood cells or haemoglobin, is a public health issue in Ghana, particularly among children. The prevalence of anaemia in this age group has been a longstanding concern due to its adverse effects on cognitive development, physical growth, and well-being. This study examined the trends and inequalities in anaemia prevalence among children aged 6–59 months in Ghana between 2003 and 2022.

Methods Data from the Ghana Demographic Health Survey conducted between 2003 and 2022 was used to analyse the prevalence of anaemia in children aged 6–59 months. The World Health Organization's Health Equity Assessment Toolkit software calculated several inequality measures, including difference, ratio, population-attributable risk, and population-attributable percentage. An inequality assessment was performed for six stratifiers: child's age, mother's economic status, maternal educational level, place of residence, child's sex, and sub-national region.

Results Anaemia prevalence among children aged 6–59 months in Ghana declined from 76.1% in 2003 to 48.9% by 2022. The results revealed an age-related inequality in anaemia prevalence among children in Ghana, with younger age group (6–11 months) consistently showing higher rates. The age-related inequality Difference was 24.6 percentage points in 2022, indicating that age is crucial to understanding anaemia risk. Economic-related inequality between children of mothers in Quintile 5 (richest) and Quintile 1 (poorest) increased from a Difference of 21.1 percentage points in 2003 to 32.7 percentage points in 2022 highlighting the stark inequalities across wealth quintiles. Education inequality between children of mothers with higher education and no education decreased from a Difference of 29.4 percentage points in 2003 to 25.3 percentage points in 2022, suggesting that children from less educated households are still at higher risk. Place of residence inequality between children of mothers living in urban areas and rural areas increased from a Difference of 12.3 percentage points in 2003 to 14.8 percentage points in 2022 reflecting urban-rural disparities. Sex-related inequality between male and female children decreased from a Difference of -0.3 percentage points in 2003 to -5.5 percentage points in 2022 indicating the absence of inequality based on sex of the child. Lastly, regional inequalities are pronounced, as indicated by an increase in the Difference from 21.2 percentage points in 2003 to 34.0 percentage points in 2022, highlighting that children in certain regions like the Northern and Upper East are more affected by anaemia.

Conclusion The decline in anaemia prevalence among children aged 6–59 months in Ghana, reflects substantial progress; however, notable inequalities persist across age, economic status, education, place of residence, and region. To address these disparities, strategies such as enhancing access to healthcare services in underserved regions,

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implementing community education programs to raise awareness about nutrition and health, and promoting economic empowerment initiatives can be effective. Additionally, community education can play a crucial role in offsetting the effects of low household education levels, fostering a more informed population that can advocate for better health practices and policies. By addressing these key areas, we can work towards reducing anaemia prevalence and improving child health outcomes across all populations in Ghana.

Keywords Anaemia, Children, Inequality, Ghana, Global Health

Introduction

Anaemia is a condition characterised by a decrease in the total amount of haemoglobin or the number of red blood cells, leading to a reduced capacity of the blood to carry oxygen to the body's tissues [1]. In children, anaemia can have severe consequences, including impaired cognitive and physical development, increased susceptibility to infections, and, in extreme cases, mortality [2, 3].

Anaemia remains a significant public health problem worldwide, particularly affecting low- and middle-income countries [4, 5]. The sub-Saharan Africa region bears the highest burden [6, 7], with Ghana reporting a 56–78.4% prevalence among children under five years old [8, 9]. Children aged 6–59 months are especially vulnerable to this condition, which can profoundly impact their health and development [10, 11]. Understanding and addressing the social determinants of health and health inequalities is crucial for reducing the high prevalence of anaemia among Ghanaian children.

Anemia among children is a complex condition with multifactorial etiology, extending beyond the commonly assumed link to iron deficiency. While iron deficiency anemia remains a significant contributor, especially in populations with limited access to iron-rich foods, other factors play crucial roles in the overall prevalence of anemia [12]. Infections, such as malaria and other parasitic diseases, are prevalent in Ghana and can lead to anemia of inflammation, where the body's immune response to infection inhibits iron utilization and erythropoiesis, exacerbating anemia [13]. Furthermore, nutritional deficiencies—including folate and vitamin B12—can also contribute to the development of anemia [14]. Socioeconomic factors, such as poverty and lack of access to healthcare, further complicate the landscape, as they can limit both the availability of nutritious food and timely medical interventions [15–19]. Rural-urban disparities in anaemia prevalence are common in many countries [20, 21]. Furthermore, children of mothers with lower education levels are often at higher risk due to limited empowerment to make health-related decisions [22]. In response to high prevalence of anaemia in children under 6-59 months, Ghana has implemented several national policies and strategies to reduce anaemia among children. These include a national long-term strategic plan for food and nutrition security for Ghana, the National Nutrition Policy, and the National Development Planning Commission [23]. This plan outlines Ghana's long-term goals and strategies to ensure its population access to sufficient, safe, nutritious food. It outlines the government's priorities and strategies for improving the population's nutritional status, including children. Specific measures include promoting breastfeeding, improving food fortification, and implementing school feeding programs [23]. Despite Ghana's efforts to address anaemia, challenges and gaps persist [24]. Limited access to nutritious food remains a significant issue, particularly in rural areas. Additionally, cultural practices and limited knowledge about iron-rich foods can hinder effective prevention and treatment. Insufficient healthcare infrastructure, especially in rural areas, can limit access to necessary diagnostic tests and interventions [24].

Previous studies on anaemia in Ghana have often focused on immediate factors like dietary intake and healthcare access [8, 9], overlooking the broader social and regional factors that significantly influence health outcomes. This limited perspective has hindered our understanding of the complex interplay between social determinants and anaemia prevalence. Our study aims to address this research gap by examining the trends and inequalities in anaemia prevalence among children in Ghana. Using the 2003–2022 Ghana Demographic Health Survey (GDHS) dataset will provide a more comprehensive understanding of the social determinants, health inequalities, and regional disparities associated with anaemia. Our findings will inform the development of evidence-based policies and programs such as formal education and targeted nutritional awareness programs, local dietary practices, cultural norms, and healthcare access disparities to address anaemia and improve child health in Ghana and other similar settings.

Methods

Study design and data source

This study utilised cross-sectional data from the GDHS conducted from 2003 to 2022. These surveys are nationally representative household assessments undertaken periodically in Ghana. They gather data on multiple health markers, encompassing child growth and

development. The GDHS utilises a multi-stage cluster sampling design. The sampling framework is heavily reliant on population statistics derived from national census data, which provide the necessary demographic information to accurately define the sampling frame. Specifically, the DHS incorporates census data to determine the selection of clusters, ensuring that the sample reflects the geographical and socio-economic diversity of the population. Trained interviewers perform in-person interviews with men and women of reproductive age, addressing demographic characteristics, reproductive health, child health, and family planning. The data were obtained via the World Health Organization's Health Equity Assessment Toolkit (HEAT) online platform. HEAT is a software tool created by the World Health Organisation. HEAT enables the examination, analysis, and reporting of health disparity data. It incorporates information from the Health Inequality Data Repository, allowing the users to evaluate and visualise health disparities efficiently. Our research employed disaggregated data from the GDHS health indicators accessible in HEAT. It is essential to acknowledge that HEAT does not include all data from the GDHS; it specifically comprises chosen datasets pertinent to health equity evaluations. This study examined the Childhood malnutrition dataset within HEAT to evaluate the prevalence of anaemia among children aged 6–59 months in Ghana. The study adhered to the guidelines outlined in the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) [25].

Outcome measure and dimensions of inequality

The dependent variable is the prevalence of anaemia. Childhood anaemia in children aged 6–59 months is determined as a haemoglobin concentration below 110 g/dL. The children were categorised into five age groups: 6–11 months, 12–23 months, 24–35 months, 36–47 months, and 48–59 months. Women's economic status was classified into five categories: the poorest, poorer, middle-class, rich, and richest. This classification is predicated on wealth quintiles obtained from household asset indices. Household wealth is assessed based on diverse assets possessed by the household, including land, livestock, and durable commodities. The information is explicitly available in the Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) datasets. Four groups were established according to the mother's educational attainment: none, primary, secondary, and higher education. The place of residence was classified as either an urban or rural locale. The child's gender was recorded as either male or female. In this study, we defined the subnational regions of Ghana based on the 16 administrative regions established as of 2022: Greater Accra, Ashanti, Central, Eastern, Western, Northern, Upper East, Upper West, Volta, Oti, Bono, Bono East, Ahafo, Savannah, North East, and Western North.

Data analysis

For our research, we employed the online version of the WHO Health Equity Assessment Toolkit, specifically designed to enable the examination of health inequality data. This software features an indicator of interest segmented by six dimensions of inequality, facilitating a thorough analysis of anaemia prevalence in children under five. Furthermore, HEAT offers estimates, confidence intervals, and summary measures of inequality, enabling a comprehensive evaluation of disparities in anaemia prevalence rates and allowing for educated inferences derived from the data. The factors employed included age, region, child's sex, economic status, education level, and place of residence. Estimates and confidence intervals (CIs) for anaemia prevalence among children were calculated using the designated stratifiers within the HEAT software. Four measures were employed to assess inequality: Difference (D), Ratio (R), Population Attributable Fraction (PAF), and Population Attributable Risk (PAR). D quantifies the absolute disparity in anaemia prevalence between two subgroups by directly comparing their relative rates. R assesses the prevalence of anaemia between two subgroups by calculating the ratio of one subgroup's prevalence to that of the other, providing a relative measure of disparity. Both Difference and Ratio are unweighted metrics, indicating that they disregard the population sizes of the subgroups and concentrate exclusively on the two groups under comparison. Conversely, PAR quantifies the risk of a health outcome attributable to a particular risk factor within the population, whereas PAF represents the percentage of the overall health consequence that would be eradicated upon removing the risk factor. These measures elucidate the possible effects of diminishing inequality on overall health outcomes. For a detailed elucidation of the calculation of these metrics, please consult the literature [26]. R and PAF are relative inequality measures used to assess and contrast disparities among different groups concerning each other. These relative measures allow for the contextualization of inequalities within the broader population dynamics, helping to understand how disparities in anemia prevalence relate to various socio-economic factors. In contrast, D and PAR serve as absolute measures, providing definitive values that reflect the exact disparity in anemia prevalence or the percentage of health outcomes attributable to specific risk factors. This distinction is crucial; while absolute measures like D and PAR deliver clear insights into the extent of inequality—such as a D value indicating a 15% higher prevalence

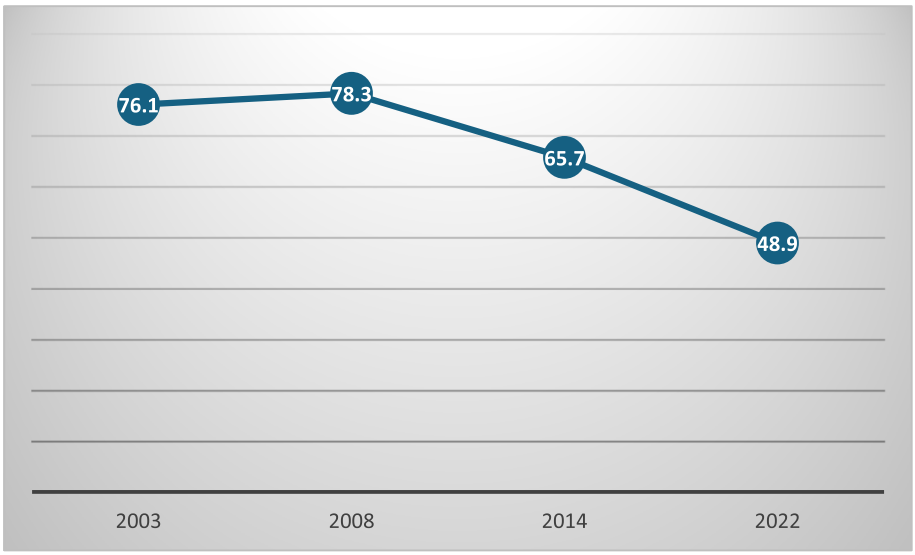

Fig. 1 Trends in anaemia prevalence among children aged 6–59 months in Ghana. Source: Authors analysis, 2024

of anemia in lower socio-economic groups compared to higher ones—relative measures like R and PAF contextualize these disparities, with R values above 1.5 indicating significant inequality and PAF values suggesting that over 30% of anemia cases could be linked to specific risk factors. By utilizing both types of measures, we can gain a comprehensive understanding of the magnitude and context of disparities in anemia prevalence. The World Health Organisation recognised that to formulate policy-relevant conclusions, summary measures must be presented in both absolute and relative terms. Complex measures consider the magnitude of categories within a specific subset of the population instead of simple measurements. The summary measurements and computations of the World Health Organisation measures are comprehensively detailed in the literature [27, 28].

Results

Figure 1 illustrates the prevalence of anaemia among children aged 6–59 months in Ghana from 2003 to 2022, revealing a general downward trend over the entire period. Starting at 76.1% in 2003, the prevalence showed a slight increase to 78.3% in 2008, indicating a worsening situation during those years. However, from 2008 to 2014, there was a significant decrease in prevalence to 65.7%, suggesting improvements in health interventions or nutrition. The most substantial decline occurred from 2014 to 2022, where the prevalence dropped to 48.9%.

Figure 2 presents the prevalence of anaemia among children aged 6–59 months in Ghana from 2003 to 2022, showing a general downward trend over the entire period for the various factors.

Age groups

The anaemia prevalence trends among children aged 6–59 months in Ghana reveal important insights into different age groups over the years. For the 6–11 months category, data is unavailable for 2003 and 2008, but the 2022 prevalence stands at 60.5%, indicating a potential increase in vulnerability among infants. Similarly, the 12–23 months group lacks data for earlier years, with a prevalence of 60% in 2022, suggesting a high and possibly stable level of anaemia. In the 24–35 months age group, prevalence has significantly improved, decreasing from 80% in 2008 to 66.1% in 2014, and further to 49% in 2022. The 36–47 months group also shows improvement, with prevalence declining from 75.7% in 2008 to 61.3% in 2014, and down to 44% in 2022. Lastly, for the 48–59 months group, there has been substantial improvement, with prevalence decreasing from 70.1% in 2008 to 53.2% in 2014, and further down to 35.9% in 2022.

Socio-economic status (Quintiles)

The trends in anaemia prevalence among children across socio-economic quintiles in Ghana from 2003 to 2022 highlight significant progress. Quintile 1 (the poorest) exhibited a high prevalence of 82.2% in 2003, which decreased to 79.4% in 2014 and further to 63.9% in 2022, demonstrating substantial improvement. Quintile 2 also showed a decline from 81.7% in 2003 to 74.9% in 2014, and then to 53.2% in 2022, indicating positive change. Similarly, Quintile 3 decreased from 79.2% in 2003 to 63.8% in 2014, and further to 48.1% in 2022, reflecting an encouraging trend. Quintile 4 saw a reduction from 68.8% in 2003 to 58.3% in 2014, and then to 43.2%

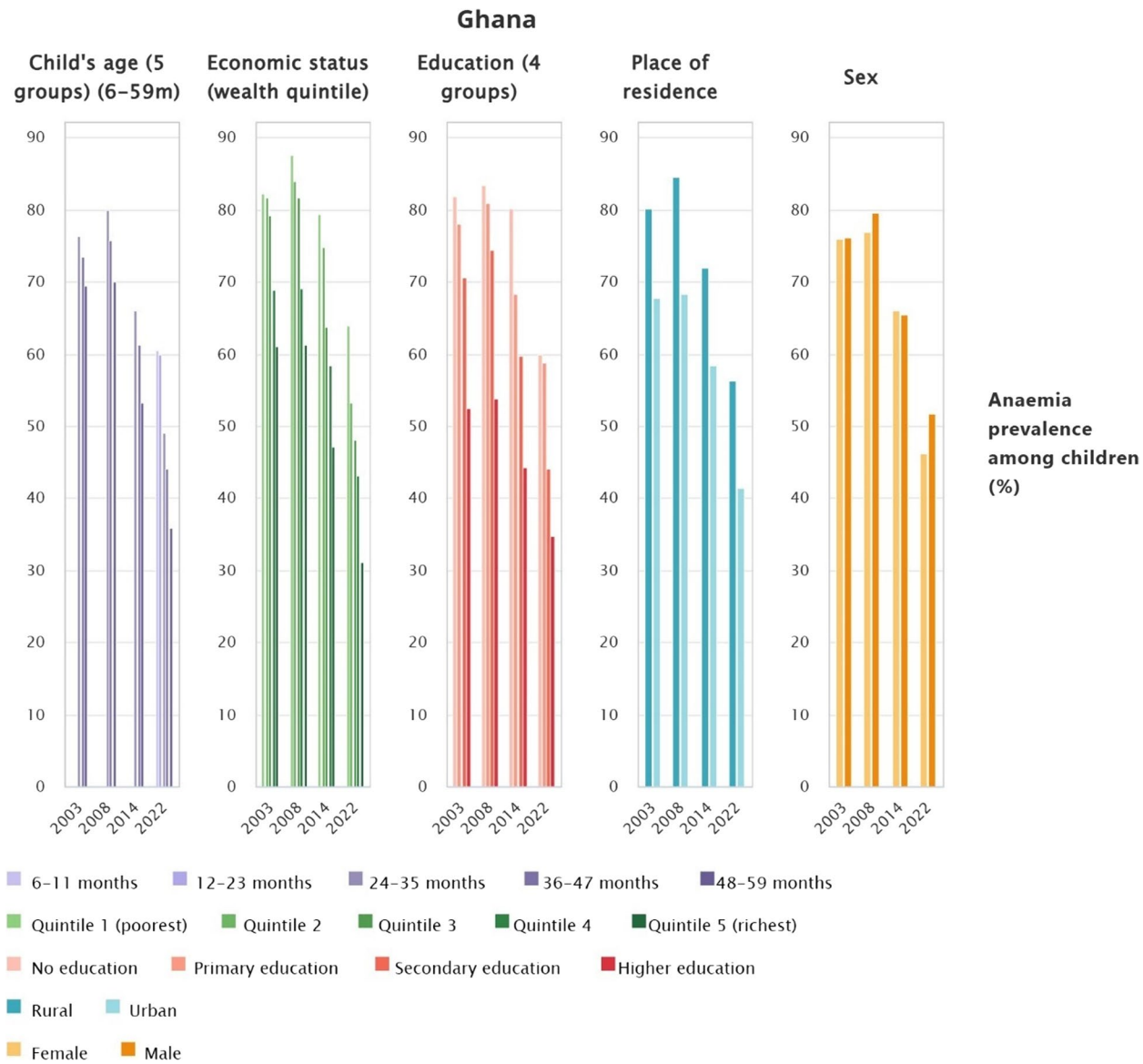

Fig. 2 Trends in the prevalence of anaemia among children aged 6–59 months by age, economic, education, place of residence and sex inequality dimensions in Ghana from 2003 to 2022. Source: Authors analysis, 2024

in 2022. Lastly, Quintile 5 (the richest) experienced a decrease from 61.1% in 2003 to 47.2% in 2014, and down to 31.2% in 2022, underscoring that wealthier households tend to have better health outcomes.

Education level

The analysis of anaemia prevalence among children in Ghana based on maternal education levels from 2003 to 2022 reveals significant improvements across all categories. For those with no education, the prevalence was high at 81.8% in 2003 but decreased to 80.1% in 2008 and further to 60% in 2022, indicating substantial progress. Similarly, the prevalence among those with primary education decreased from 78% in 2003 to 68.3% in 2014, and then to 58.7% in 2022. For secondary education, the rates declined from 70.6% in 2003 to 59.7% in 2014, and down to 44% in 2022, showcasing a favorable trend. Notably, those with higher education experienced a decrease from 52.4% in 2003 to 44.2% in 2014, and further to 34.7% in 2022, highlighting a clear correlation between higher education and lower anaemia rates.

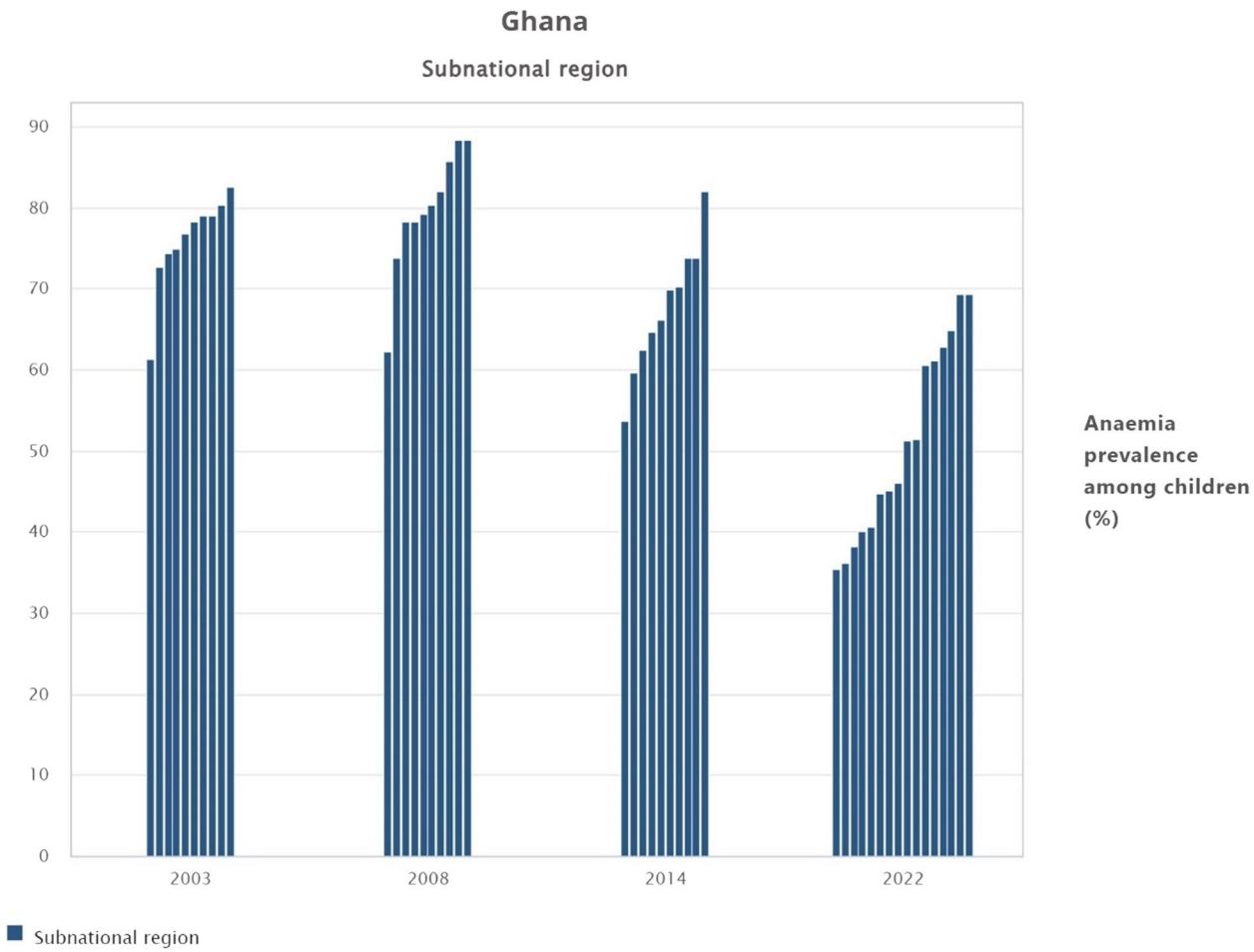

Fig. 3 Trends in the prevalence of anaemia among children aged 6-59 months by regional inequality dimension in Ghana from 2003 to 2022. Source: World Health Organisation Health Equity Assessment Toolkit, 2024

Urban vs. rural

The trends in anaemia prevalence among children in Ghana reveal notable differences between rural and urban areas from 2003 to 2022. In rural areas, the prevalence decreased from 80.1% in 2003 to 72% in 2014, and further to 56.2% in 2022, indicating significant improvement, although the rates remain higher than those in urban areas. Conversely, urban areas experienced a marked decline, with prevalence decreasing from 67.8% in 2003 to 58.3% in 2014, and down to 41.4% in 2022, reflecting a substantial reduction in anaemia rates.

Gender

The anaemia prevalence trends among children in Ghana reveal encouraging improvements for both females and males from 2003 to 2022. For females, the prevalence decreased from 75.9% in 2003 to 66% in 2014, and further to 46.2% in 2022, indicating a positive trend. Similarly, males experienced a decline from 76.2% in 2003 to 65.5% in 2014, and down to 51.7% in 2022, reflecting a comparable trend; however, it is notable that males consistently exhibit higher prevalence rates than females throughout the years.

Figures 3 and 4 shows the regional prevalence of anaemia among children aged 6–59 months in Ghana across different years (2003, 2008, 2014, and 2022). The trends in anaemia prevalence among children across various regions in Ghana from 2003 to 2022 highlight significant improvements, particularly in Ashanti and Brong Ahafo. In Ashanti, prevalence decreased from 79% in 2003 to 53.7% in 2014, and further to 40.6% in 2022, indicating substantial progress. Similarly, Brong Ahafo saw a decrease from 74.9% in 2003 to 62.5% in 2014, and down to 35.4% in 2022, reflecting significant advancements. The Central Region experienced a decline from 76.8% in 2003 to 70.2% in 2014, and then to 44.7% in 2022. Greater Accra also showed improvement, with prevalence decreasing from 61.3% in 2003 to 59.6% in 2014, and further to 36.2% in 2022. However, the Northern Region, while decreasing from 82.5% in 2003 to 82.1% in 2008,

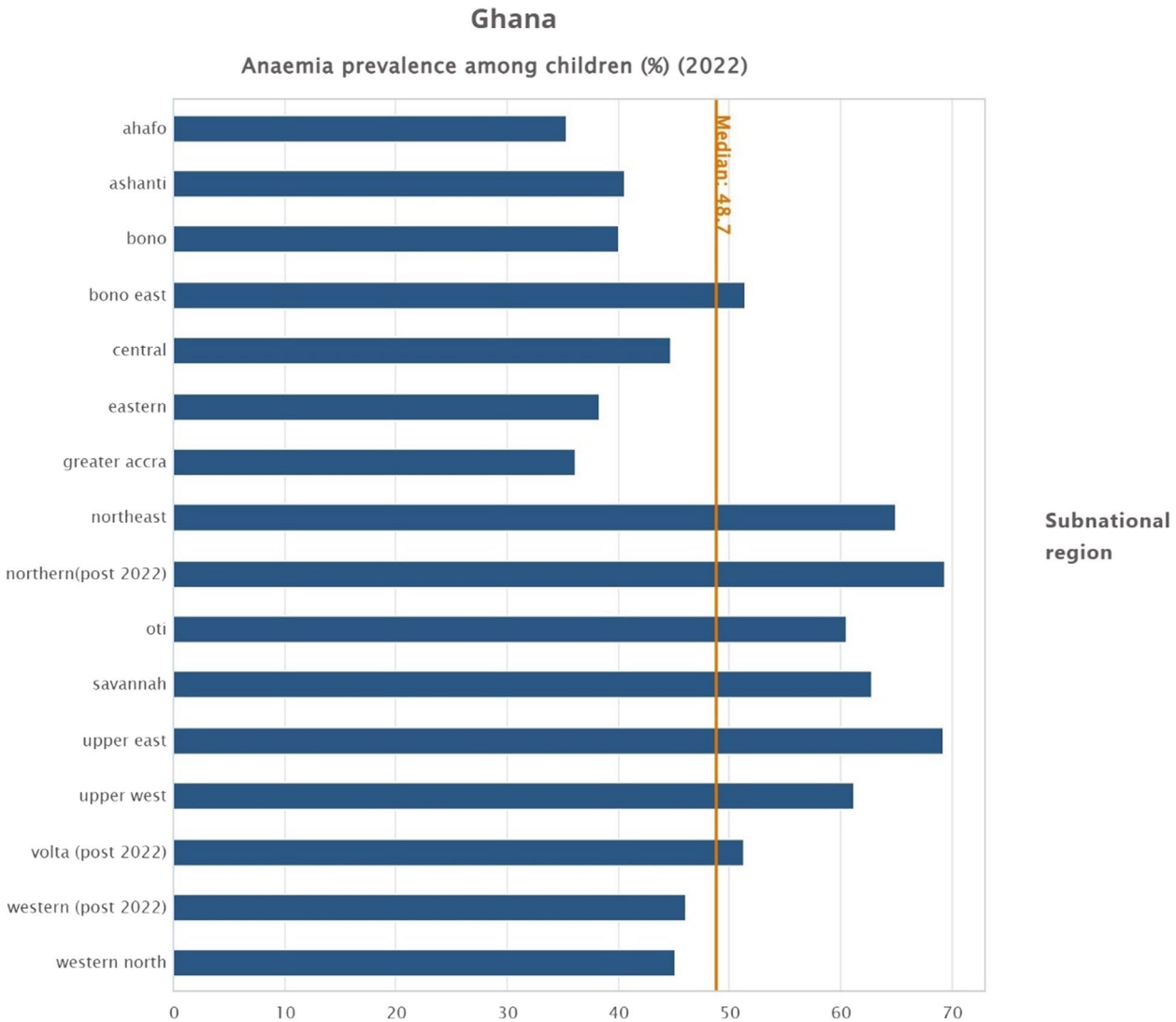

Fig. 4 Trends in the prevalence of anaemia among children aged 6-59 months by regional inequality dimension in Ghana in 2022. World Health Organisation Health Equity Assessment Toolkit, 2024

and then to 69.4% in 2022, still has the highest prevalence among all regions.

Table 1 presents inequality measures related to factors associated with anaemia among children aged 6–59 months in Ghana from 2003 to 2022. The results reveal an age-related disparity in anaemia prevalence among children in Ghana, with younger age group (6–11 months) consistently showing higher rates. The age-related inequality Difference was 24.6 percentage points in 2022, indicating that age is crucial to understanding anaemia risk. The decrease PAF of 26.7% suggests that anaemia cases could be substantially reduced if age-related factors were eliminated. Economic-related inequality increased from a Difference of 21.1percentage points in 2003 to 32.7 percentage points in 2022 highlighting the stark inequalities across wealth quintiles. The PAR and PAF indicate that the national average of anaemia prevalence could have been 14.9% points, or 19.7%, lower in 2003, 17.1% points, or 21.9%, lower in 2008, 18.6% points, or 28.2%, lower in 2014, and 17.7% points, or 36.3%, lower in 2022 without economic-related inequality. Education inequality decreased from a Difference of 29.4 percentage points in 2003 to a difference of 25.3 percentage points in 2022, suggesting that children from less educated households are still at higher risk. The PAR and PAF indicate that the national average of anaemia prevalence could have been 24.2% points, or 31.6%, lower in 2003, 24.6% points, or 31.3%, lower in 2008, 22.6% points, or 33.9%,

Table 1 Inequality measures of estimates of factors associated with anaemia among children aged 6–59 months in Ghana by different inequality dimensions, 2003–2022

Dimension	Measure	2003 Estimate (%)	2003 CI-LB	2003 CI-UB	2008 Estimate (%)	2008 CI-LB	2008 CI-UB	2014 Estimate (%)	2014 CI-LB	2014 CI-UB	2022 Estimate (%)	2022 CI-LB	2022 CI-UB
Child's Age (5 groups)	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	24.6	NA	NA
	PAF	NA	NA	NA	NA	NA	NA	NA	NA	NA	-26.7	-26.7	-26.6
	PAR	NA	NA	NA	NA	NA	NA	NA	NA	NA	-13.1	-16.0	-10.1
	R	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.7	NA	NA
Economic Status (Wealth Quintile)	D	21.1	NA	NA	26.4	NA	NA	32.2	NA	NA	32.7	NA	NA
	PAF	-19.7	-19.7	-19.6	-21.9	-21.9	-21.8	-28.2	-28.3	-28.1	-36.3	-36.3	-36.2
	PAR	-14.9	-19.1	-10.8	-17.1	-22.0	-12.3	-18.6	-22.8	-14.3	-17.7	-21.0	-14.5
	R	1.3	NA	NA	1.4	NA	NA	1.7	NA	NA	2.0	NA	NA
Education (4 groups)	D	29.4	NA	NA	29.5	NA	NA	35.9	NA	NA	25.3	NA	NA
	PAF	-31.6	-31.8	-31.3	-31.3	-31.5	-31.1	-33.9	-34.0	-33.7	-29.6	-29.7	-29.5
	PAR	-24.2	-41.6	-6.7	-24.6	-38.3	-10.8	-22.6	-33.8	-11.4	-14.6	-19.8	-9.4
	R	1.6	NA	NA	1.5	NA	NA	1.8	NA	NA	1.7	NA	NA
Place of Residence	D	12.3	NA	NA	16.2	NA	NA	13.7	NA	NA	14.8	NA	NA
	PAF	-10.9	-10.9	-10.8	-12.8	-12.8	-12.8	-11.3	-11.3	-11.2	-15.4	-15.4	-15.4
	PAR	-8.3	-10.6	-5.9	-10.0	-12.3	-7.7	-7.4	-9.4	-5.4	-7.5	-9.2	-5.9
	R	1.2	NA	NA	1.2	NA	NA	1.2	NA	NA	1.4	NA	NA
Sex	D	-0.3	NA	NA	-2.7	NA	NA	0.5	NA	NA	-5.5	NA	NA
	PAF	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-0.4	-0.3	0.0	0.0	0.0
	PAR	0.0	-1.5	1.5	0.0	-1.6	1.6	-0.2	-2.0	1.5	0.0	-1.6	1.6
	R	1.0	NA	NA	1.0	NA	NA	1.0	NA	NA	0.9	NA	NA
Subnational Region	D	21.2	NA	NA	26.1	NA	NA	28.4	NA	NA	34.0	NA	NA
	PAF	-19.4	-19.4	-19.3	-20.5	-20.5	-20.4	-18.3	-18.4	-18.2	-27.7	-27.9	-27.5
	PAR	-14.7	-19.7	-9.8	-16.0	-21.4	-10.6	-12.0	-16.3	-7.8	-13.5	-23.5	-3.6
	R	1.3	NA	NA	1.4	NA	NA	1.5	NA	NA	2.0	NA	NA

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

lower in 2014, and 14.6% points, or 29.6%, lower in 2022 without education-related inequality. Place of residence inequality increased from a Difference of 12.3 percentage points in 2003 to 14.8 percentage points in 2022 reflecting urban-rural disparities. The PAR and PAF indicate that the national average of anaemia prevalence could have been 8.3% points, or 10.9%, lower in 2003, 10.0% points, or 12.8%, lower in 2008, 7.4% points, or 11.3%, lower in 2014, and 7.5% points, or 15.4%, lower in 2022 without place of residence-related inequality. Sex-related inequality decreased from a Difference of -0.3 percentage points in 2003 to -5.5 percentage points in 2022 indicating the absence of inequality based on sex of the child. The PAR and PAF were zero in all survey years indicating the absence of sex-related inequality. Lastly, regional inequalities are pronounced, as indicated by an increase in the Difference from 21.2 percentage points in 2003 to 34.0 percentage points in 2022, highlighting that children in certain regions are more affected by anaemia. The PAR and PAF indicate that the national average of anaemia prevalence could have been 14.7% points, or 19.4%, lower in 2003, 16.0% points, or 20.5%, lower in 2008, 12.0% points, or 18.3%, lower in 2014, and 13.5% points, or 27.7%, lower in 2022 without regional inequality.

Discussion

The study highlights the importance of reducing anaemia in children for a healthy start in life. It reveals a decline in anaemia prevalence among children aged 6–59 months in Ghana from 2003 to 2022, peaking at 78.3% in 2008 before significantly dropping to 48.9% by 2022. The prevalence found in this current study is lower than the 54% reported by Aheto et al. (2023) [29] and 58.4% reported by Opoku et al. (2021) [30] in previous studies in Ghana but remains higher than the 37.9% reported by Mboya and colleagues in Tanzania [31]. This improvement can be attributed to enhanced healthcare access, improved nutrition, malaria control measures, and better sanitation efforts in Ghana [24]. Despite the progress, the 2022 prevalence is still above the global average of 39.8% [32], which may reflect disparities observed in our study. The highest anaemia prevalence is found among children aged 6–11 months, those from poorer families, children from households with no education, children in rural areas, and those living in the Northeast and Northern regions, suggesting targeted interventions are needed in these populations.

The highest prevalence of anaemia in children aged 6–11 months aligns with global trends, where younger children are more vulnerable due to higher nutritional demands and limited dietary diversity [32]. Studies in Ghana and other regions have consistently shown that anaemia is more prevalent in younger children, primarily due to inadequate complementary feeding during the weaning period and exposure to infections, which can increase the prevalence of anaemia among younger children [33]. This finding highlights the importance of strengthening and carefully monitoring infant and young child feeding practices, especially during the critical period of weaning from breastfeeding. While dietary factors are significant contributors to anaemia, it is essential to recognize that anaemia can also result from various other factors, including infections and overall health status. Therefore, a comprehensive approach that considers these multiple determinants is crucial in addressing anaemia in this vulnerable population.

In 2022, the data shows that the children of mothers from the poorest quintile have significantly higher anaemia rates compared to the richest quintile, a trend that has persisted since 2003. This consistent disparity highlights the strong correlation between household wealth and anaemia prevalence, with children from poorer households being more vulnerable to anaemia. Several factors could explain this difference, including limited access to nutritious foods, healthcare, and sanitation in poorer households and a higher prevalence of infections such as malaria. Compared to previous studies, this finding aligns with patterns observed in other low- and middle-income countries [7, 34]. A study in Ethiopia by Negussie and Nigatu (2019) found that children with mothers unemployed were more likely to be anaemic [35], possibly due to reduced access to health care and iron-rich foods. A report by Balarajan et al. (2011) also identified household income as a critical determinant of anaemia, noting that wealthier families tend to have more diversified diets and improved living conditions, which reduce anaemia risk [36].

The trend observed from 2003 to 2022 highlights the critical role of maternal education in shaping child health outcomes, particularly anaemia prevalence. Children of mothers with no education experienced significantly higher anaemia rates compared to those with mothers with higher education levels. Various studies have widely documented the association between education and health outcomes [35, 37]. Maternal education improves health literacy, leading to better nutritional practices, healthcare access, and disease prevention strategies [38]. Educated mothers are more likely to introduce iron-rich complementary foods, ensure timely health interventions, adopt effective hygiene and sanitation practices, and increase the utilisation of healthcare services [39, 40]. Studies across low- and middle-income countries support this trend [34, 41, 42]. For example, Harding and colleagues (2018) research found that maternal education was strongly linked to improved nutritional outcomes,

especially in low-resource settings, reducing childhood anaemia rates [41].

Anaemia rates in 2022 reveal a significant urban-rural disparity, with higher prevalence in rural areas compared to urban areas. This consistent trend from 2003 to 2014 highlights rural populations' ongoing challenges, which often grapple with limited access to healthcare services and resources. Rural regions typically have fewer healthcare facilities and providers, leading to delays in diagnosing and treating conditions like anaemia [43]. Additionally, as most poor people live in rural areas, children may have restricted access to diverse and nutritious foods, impacting their dietary intake [44]. Socioeconomic status further exacerbates these issues, as poverty and nutrition are closely linked. One study found that children in rural areas are twice as likely to be stunted compared to their urban counterparts, and rural households spend 20–30% less on food, with the majority of their budget al.located to grains [44]. The lack of significant gender disparity could indicate that boys and girls in these regions are equally exposed to the systemic challenges that lead to anaemia, such as limited access to iron-rich foods or healthcare services. This uniformity across genders highlights the need for broad, population-level interventions to improve healthcare access, promote nutritional diversity, and address poverty in rural and underserved communities.

Anaemia prevalence in children showed significant regional disparities in Ghana, with the Northeast and Northern regions reporting the highest rates, while regions like Ahafo and Greater Accra exhibited much lower rates. This trend of higher anaemia prevalence in the northern areas has been consistent since 2003, likely due to socio-economic inequalities, limited healthcare access, and greater exposure to infectious diseases like malaria. Similar results have been reported by Shenton et al., where poorer and rural regions tend to have higher malnutrition and anaemia rates due to less access to healthcare and nutritious foods [8]. The sixth round of the Ghana Living Standards Survey (GLSS 6) indicates that approximately 50.4% of the population in the Northern Region of Ghana lives in poverty [45], which may reflect the way children living in these areas consume nutrient-rich food to prevent anaemia. Comparatively, regions with better healthcare systems and economic advantages, like Greater Accra, demonstrate lower anaemia rates.

Policy and practice implications

The high prevalence of anaemia among children, particularly those aged 6–11 months and from poorer households, underscores the need for targeted nutritional interventions that address age-specific needs within the under-five category. For infants, focusing on introducing iron-rich complementary foods alongside continued breastfeeding is crucial, alongside educating caregivers on dietary diversity. For older children, school feeding programs and initiatives to improve dietary diversity and health check-ups are essential. Additionally, improving maternal education is essential, as it can significantly influence health literacy and lead to better nutritional practices and healthcare utilisation. Addressing socioeconomic disparities is crucial, as the correlation between poverty and anaemia rates highlights the importance of improving living conditions and economic opportunities for families, particularly in rural areas.

The persistent urban-rural disparity in anaemia prevalence calls for enhanced healthcare access in rural regions. Strategies should include increasing the number of healthcare facilities, improving patient transportation, and ensuring that services are equipped to tackle childhood malnutrition and anaemia. Community-based health education programs can raise awareness about anaemia and empower families to make informed dietary choices and seek timely healthcare. Strengthening health systems in high-prevalence areas through investment in infrastructure and training healthcare providers will be vital. Continued research and monitoring are essential to assess intervention effectiveness and inform data-driven public health strategies.

Strengths and limitations

The study has several limitations that should be considered when interpreting its findings. Firstly, the reliance on data from the GDHS may introduce biases inherent in self-reported information. Additionally, while the analysis provides valuable insights into trends and regional disparities in anaemia prevalence, the cross-sectional nature of the GDHS limits the ability to establish causal relationships between factors such as socioeconomic status, maternal education, and anaemia. The geographic variability within regions may also not be fully captured, potentially oversimplifying the challenges specific communities face. Furthermore, potential confounding variables, including environmental factors and cultural practices, and data on malaria infection might influence anaemia rates but were not adequately controlled for in the analysis. Finally, while the focus on anaemia is crucial, the study may overlook other related nutritional deficiencies that could provide a more comprehensive understanding of child health in Ghana. These limitations highlight the need for cautious interpretation of the results and the importance of further research to address these gaps.

Conclusion

The findings of this study highlight the ongoing challenges of anaemia prevalence among children in Ghana, particularly in vulnerable populations such as those aged 6–11 months, children from poorer households, and those living in rural areas. Despite a significant decline in anaemia rates from 2003 to 2022, the prevalence remains alarmingly high, exceeding global averages and indicating persistent disparities tied to socioeconomic factors and educational levels. The critical role of maternal education and household wealth in shaping child health outcomes underscores the need for targeted public health interventions that address these determinants. Additionally, enhancing healthcare access, improving nutrition, and implementing community-based educational programs are essential strategies for reducing anaemia rates and promoting overall child health. Addressing the multifaceted nature of anaemia, including factors like malaria, requires a comprehensive and coordinated approach involving health, education, and economic stakeholders. Continued research and monitoring will be vital to inform effective policies and interventions to combat anaemia and improve health outcomes for Ghana's children.

Abbreviations

D	Difference
HEAT	Health Equity Assessment Toolkit
DHS	Demographic Health Survey
PAF	Population Attributable Fraction
PAR	Population Attributable Risk
R	Ratio
SDG	Sustainable Development Goal
WHO	World Health Organization

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Authors' contributions

AO contributed to the study design and conceptualisation. AO performed the analysis. AO, FGW, KA, and CB developed the initial draft. 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

The dataset used can be accessed at 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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