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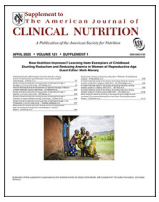

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A mixed-methods study of the drivers of stunting reduction among children under-5 in Ghana, 2003–2017

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A B S T R A C T

Background: Childhood stunting prevalence declined rapidly in Ghana in recent decades. Substantial economic growth over the same period will have contributed directly and indirectly to improved population health and nutrition in the country, but Ghana's progress in reducing stunting has outpaced that of multiple other countries with comparable or higher economic growth rates.

Objectives: We aimed to better understand Ghana's exemplary progress in stunting reduction by examining the national-, community-, household-, and individual-level factors associated with the steep decline in stunting prevalence in recent decades.

Methods: This mixed-methods study included literature review; secondary analysis of national household survey data, including Oaxaca–Blinder decomposition analysis; primary qualitative data collection and analysis; and a policy and program review.

Results: Estimated from household surveys, under-5 stunting prevalence in Ghana declined from 35.1% in 2003 to 17.5% in 2017 and mean height-for-age *z*-score increased by 0.50, with the country's high-burden northernmost regions achieving the most rapid progress. Our modeling predicted 64% of the observed 0.43 height-for-age *z*-score increase among survey index children, with increases over time in mosquito net ownership, skilled birth attendance and antenatal care coverage, mean maternal age, urban residency, and household wealth accounting for most of the improvement in child growth over time. Qualitative findings highlighted similar and additional distal (e.g., income, maternal education, employment, women's empowerment, and political stability); intermediate (e.g., water and sanitation, infrastructure); and proximal (e.g., disease prevention and control programs, maternal care, and diet improvements) factors associated with stunting reduction. Of 134 nutrition-related policies and programs identified in our review, 23 national initiatives were assessed as having contributed importantly to reducing stunting in Ghana, reflecting the effectiveness of multisectoral action.

Conclusions: Stunting reduction can be accelerated even further in Ghana through increased coverage of high-quality nutrition-specific interventions and greater health and nonhealth sector investments.

Keywords: stunting, linear growth, malnutrition, child health, Ghana

Introduction

Linear growth faltering remains a serious public health issue among infants and young children globally, with >1 in 5 children, or an estimated 148 million, too short for their age in 2022 [1]. Children who are stunted have a height-for-age *z*-score (HAZ) >2 SDs below the respective age- and sex-specific median value of the WHO growth reference standards [2] and are at higher risk of mortality, morbidity, and suboptimal development, with potential implications in adulthood and for their offspring [3,4]. Often beginning in utero as a consequence of maternal malnutrition [5], stunting in early childhood is also associated with suboptimal feeding practices and exposure to infectious diseases [3,4].

Centrally located in West Africa with an estimated population of 30.8 million in the 2021 census [6], Ghana achieved a considerable reduction in under-5 stunting prevalence in recent decades, declining from 32.6% in 2000 to 12.7% in 2022 according to modeled estimates from UNICEF, WHO, and the World Bank [7]. Substantial economic growth in Ghana will have directly and indirectly impacted population

Abbreviations: ANC, antenatal care; CHPS, Community-based Health Planning and Services; DHS, Demographic and Health Survey; FGD, focus group discussion; HAZ, height-for-age *z*-score; KII, key informant interview; MICS, multiple indicator cluster survey; SBA, skilled birth attendance.

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health and nutritional status in the country, with gross domestic product per capita doubling from $1020 in 2000 to $2031 by 2022 [8] and the proportion of the population living on <$2.15 per day falling from 43% in 2005 to 25% by 2016 [9], but the progress that Ghana has made in reducing stunting has outpaced that of multiple other countries with comparable or higher economic growth rates [10].

The aim of this study was to better understand Ghana's exemplary progress in stunting reduction by examining the national-, community-, household-, and individual-level factors associated with the steep decline in stunting prevalence in recent decades. The specific study objectives were to: *1*) quantitatively examine the determinants of stunting reduction nationally and in the highest-burden northern part of the country and to decompose long-term stunting change into relative contributions of key determinants; *2*) explore national- and community-level perspectives on stunting progress; and *3*) identify the landscape of major nutrition-relevant policies and programs that likely influenced that progress. Findings from a systematic examination of quantitative and qualitative evidence of how under-5 stunting prevalence improved so dramatically in Ghana could support action to ensure that the achieved gains are sustained and to promote the acceleration of future progress.

Methods

Study design

This study applied the same mixed-methods approach as previous case studies of stunting reduction "Exemplar" countries [10,11]. Methods included literature review, secondary analysis of household survey data, primary qualitative data collection and analysis, and policy and program review. A conceptual framework to guide the study design, data collection, and data analyses was adapted from the 1990 UNICEF framework on the causes of malnutrition and death in children [12] and a more recent adaptation underpinning the 2013 Lancet Nutrition Series [3] (Supplementary Figure 1). Ethics approval was obtained from the Ghana Health Service Ethics Review Committee and the Research Ethics Board at the Hospital for Sick Children (SickKids), in Toronto, Ontario, Canada.

Literature review

A systematic search of indexed and gray literature published between 1990 and 2020 was undertaken to find, collate, and synthesize information on contextual factors, national and subnational interventions, and policies and programs that may have impacted child stunting prevalence in Ghana. Multiple search terms relating to "stunting," "child," and "Ghana" were used in 14 online databases, as well as in searches of the resource pages of the national, regional, and headquarter websites of relevant UN agencies and international nongovernmental organizations (NGOs), and websites of relevant ministries of the Government of Ghana. The search of electronic databases [MEDLINE, Embase, AMED, CAB Abstracts, CINAHL, Cochrane CENTRAL, Campbell Collaboration, EPPI Centre Trials Register (TRoPHI), 3ie, JOLIS, WHOLIS, LILACS, Scopus, and Web of Science] returned 19,566 records. After duplicates were removed and records were screened for relevance and eligibility, 50 records were included in our review (Supplementary Figure 2).

Quantitative methods

Data and variables

Data used for descriptive quantitative analyses were drawn from Ghana's Demographic and Health Surveys (DHS) conducted in 2003, 2008, and 2014 [13–15] and from Multiple Indicator Cluster Surveys (MICS) conducted in 2006, 2011, and 2017 [16–18]. Multivariable regression analyses used data from the DHS 2003 and MICS 2017 surveys for each index child (i.e., the youngest child under 5 y old of the youngest mother in the household) for which a valid HAZ measurement was available, calculated using the 2006 WHO child growth standards [2]. Variables that aligned with our conceptual framework and were available within both the 2003 DHS and 2017 MICS surveys were selected for consideration as distal, intermediate, and proximal predictors of HAZ change over time.

Statistical analyses

Smoothed frequency distributions of child HAZ values were estimated for each survey year using kernel density plots to visualize population shifts in linear growth over time. Mean HAZ was plotted against age for each survey using smoothed local polynomial regression to examine shifts over time in the growth faltering process from birth to 59 mo of age [19]. We assessed levels and trends in stunting inequities by examining the differences in stunting prevalence between strata of important sociodemographic characteristics cross-sectionally and over time: household wealth quintile (derived from principal components analysis of asset data from the household surveys), urban compared with rural residency, maternal education levels, and child sex. Differences in change over time in stunting prevalence by region were assessed by comparing average annual rates of change.

To identify and quantify the respective contribution of factors associated with change in mean child HAZ between 2003 and 2017, we first pooled the household survey data from both years and used multivariable linear regression to identify factors associated with mean HAZ. We then applied the Oaxaca–Blinder decomposition method to predict the amount of HAZ change contributed by each associated factor by multiplying its regression coefficient by the change in the level of the factor over time [20]. We decomposed the change in mean child HAZ at the national level as well as subnationally, considering Ghana's 3 northernmost regions (Upper West, Upper East, and Northern) separately, given the more rapid pace of change in the north than in the country overall. All analyses were conducted with Stata version 14.0 (StataCorp LLC) and accounted for survey design and weighting.

Qualitative methods

Design

The qualitative component of the study was guided by the conceptual framework (Supplementary Figure 1) and included key informant interviews (KIIs) at the national level, involving representatives from government organizations, NGOs, bilateral or multilateral organizations, and academia; KIIs at the regional level, primarily involving Ghana Health Service (GHS) staff, schoolteachers, and community representatives such as social workers; and focus group discussions (FGDs) with mothers in the same communities where the regional KIIs were conducted. We recruited 2 categories of women for the FGDs: mothers with older children (born 2000–2010) and mothers with younger children (born 2010–2020).

For the regional-level KIIs, we selected 2 regions to capture geographical diversity and the extremes of stunting prevalence in Ghana: Greater Accra Region in the southern sector, where stunting prevalence was the lowest, and Northern Region in the northern sector, where stunting prevalence was the highest [21]. For the FGDs in the Greater Accra Region, we selected Ayawaso West municipality to

represent generally urban districts and Shai Osudoku district to represent generally rural districts. In the Northern Region, we selected Tamale Metropolitan Area (urban) and Tolon (rural) district. The urban–rural differentials were to enable us to understand the nuances of determinants of stunting reduction.

All KII and FGD participants were purposively selected, with the selection of regional-level and district-level participants facilitated by the Regional and District Nutrition Officers. The selection of the national KII participants was based on their extensive experience in the design, implementation, or evaluation of direct and indirect nutrition interventions across sectors; that of the regional KII participants was based on a minimum of 5 years of experience in community-level nutrition-related services or program implementation. The sample size for the KIIs was determined based on achieving thematic saturation and ensuring representation of diverse perspectives. For the relatively homogeneous populations within each district, 4–8 FGDs were deemed sufficient to reach saturation [22]. Refusal rates in the KIIs and FGD were negligible.

Data collection procedures

The qualitative component of our study sought to explore direct and indirect nutrition interventions and strategies deployed within and outside of the health sector that may have contributed to a reduction in stunting, identify important contextual factors that may have functioned as enablers of or barriers to stunting reduction, and document community-level insights and experiences related to the underlying and intermediate causes of stunting and the nutrition transition in Ghana.

For the national-level KIIs, recruitment involved sending letters and/or emails to selected participants, followed by phone calls to schedule interviews at a convenient time. These interviews focused on participants' macro-level perspectives and experiences in health and nutrition in Ghana. A total of 16 KIIs were conducted at this level, half of which took place in person. For the regional-level KIIs and district-level FGDs, letters were sent to the Regional and District Directorates of Health Services, before the Regional or District Nutrition Officers assisted with identifying the communities and potential study participants. A total of 24 regional-level KIIs (12 per region) and 16 FGDs (8 per region and 156 mothers overall) were conducted, which focused on how stakeholders in the communities implemented or received direct and indirect nutrition interventions inside and outside of the health sector as well as their experiences in the nutritional transition. All KII and FGD participants provided informed consent. Data were collected between March and April 2021.

Qualitative data analysis

The KII and FGD transcripts were audio-recorded, transcribed directly into English, and then imported into QSR NVivo software. Deductive and inductive analyses were performed based on the conceptual framework (Supplementary Figure 1). Transcripts were first read to gain familiarity with the content and a general understanding of factors that participants associated with stunting reduction; codes were attached to texts from the transcripts using the constant comparison method; similar codes were grouped into basic themes; and similar basic themes were then grouped into organizing themes. In addition, relevant quotes were identified to support the themes that emerged during the analysis. Finally, we identified notable differences and similarities in perspectives expressed by participants at the subnational level (KIIs at the regional level and FGDs at the community level) between the Greater Accra Region and the Northern Region, reflecting the variation in the magnitude and underlying drivers of trends in nutrition and health outcomes between the 2 regions.

Policy and program review

Supplemental to our study literature review, we searched government and donor websites and other online repositories of policy and program documents to compile an initial inventory of potentially relevant initiatives. We then characterized their objectives, components, and any evaluated outcomes and constructed a chronologic timeline that we then shared with select experts to help refine it and address any gaps. The revised timeline was subsequently incorporated into the national KII guide to elicit perspectives on the importance and likely impact of specific initiatives on stunting prevalence in Ghana, asking the national KII participants to categorize each as very important, important, maybe important, or not important for stunting reduction, based on their own professional knowledge, expertise, and experiences. An initiative was ultimately assessed having likely affected stunting prevalence in Ghana if ≥4 KIIs had classified it as very important or important.

Results

Descriptive quantitative findings

Under-5 stunting prevalence in Ghana declined from 35.1% (95% CI: 33.4, 36.8) in 2003 to 17.5% (95% CI: 16.7, 18.3) in 2017 (Figure 1), with mean HAZ increasing from −1.41 HAZ (95% CI: −1.48, −1.35) to −0.91 HAZ (95% CI: −0.97, −0.86). In addition to shifting rightward, the smoothed frequency distribution of under-5 HAZ values also narrowed over time, with more children clustering around the mean, suggesting less inequity in linear growth over time (Figure 2). Plotted by age and over time, there was little difference between survey years in mean HAZ around the time of birth or in mean

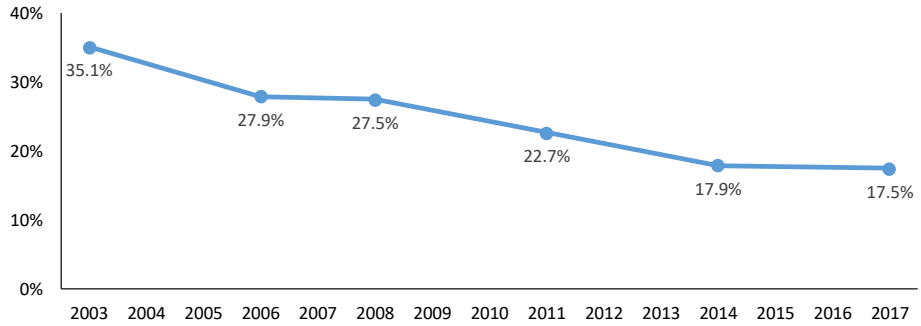

FIGURE 1. National under-5 stunting prevalence.

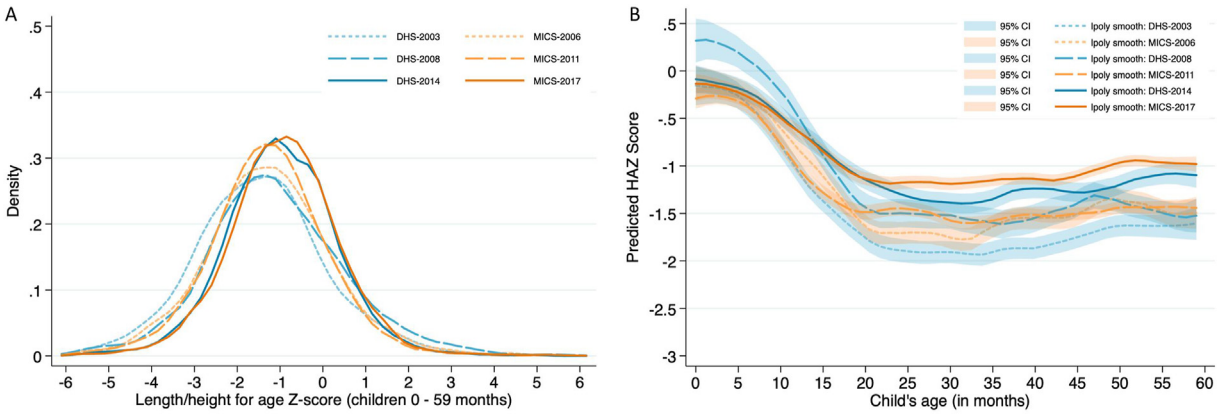

FIGURE 2. Trends in national under-5 height-for-age *z*-score distributions. DHS, Demographic and Health Survey; MICS, multiple indicator cluster survey.

HAZ among children younger than 9 mo (Figure 2). Among children aged 9 mo and older, however, mean HAZ was markedly higher at all ages in later than in earlier survey periods, with children aged 2 y and older showing less growth faltering in 2017 than in all previous survey years.

Under-5 stunting prevalence decreased in all of the country's regions over the 2003–2017 study period, but the decline was particularly steep in the northern parts of the country, despite Northern Region still maintaining the highest regional stunting prevalence by 2017 (Figure 3, Supplementary Figure 3). Trends over time in the HAZ frequency distribution and plotted mean HAZ by age for the 3 northernmost regions (Upper West, Upper East, and Northern) were broadly similar to those for the country as a whole, but improvements in terms of shape and position of the curves were greater in these northernmost regions (Supplementary Figure 4).

In addition to regional differences, we also observed heterogeneity in trends over time in stunting prevalence when stratified by other equity indicators. The difference in stunting prevalence between the richest and poorest wealth quintiles was 30% in 2003, but only 16% by 2017 (Figure 4). Stunting declined between 2003 and 2017 in all wealth quintiles, with households in the richest quintile consistently experiencing the lowest rates of stunting, but with the steepest decline in stunting observed among households in the poorest quintile. Similarly, stunting declined over time in both urban and rural households, with consistently lower stunting prevalence in urban areas, but with a steeper decline in rural areas. Stratified by level of maternal education, stunting declined among children of mothers in all education groups between 2003 and 2017, but most quickly among children whose mothers had no education. Stunting prevalence was consistently lower among girls but the decline over time was similar for both sexes.

Qualitative findings

Further insights identified from the KIIs and FGDs on the distal, underlying or intermediate, and immediate or proximal factors influencing stunting prevalence trends in Ghana are presented below, along with supporting quotations from participants and a summary of subnational variation in perspectives.

Distal factors

All types of respondents identified poverty, lack of income, or other indicators of low socioeconomic status as major drivers of high stunting levels, affecting access to sufficient quantity and quality of food, and to quality health care, with several participants highlighting better availability of and access to nutritious foods over time due to economic growth.

> "If there is an improved economy, people will be better equipped to feed their children well so, in areas where there is an improved economy for instance the construction of roads, access to the health facility, access to water, etc., – all those things play a part. We can say that in the last few decades, we've seen improvement in some of these areas where places where there was no access to roads, we've seen that there is access, people can drive freely and go to places that in the past, they may not be able to go. So, it has improved upon the economic situation." (Female, Academia)

> "The other area that I do think has played a role could be an improvement in economic growth in the country. More people are able to access diverse or quality diets. You know more food basically on the table because they can afford much more." (Female, International NGO)

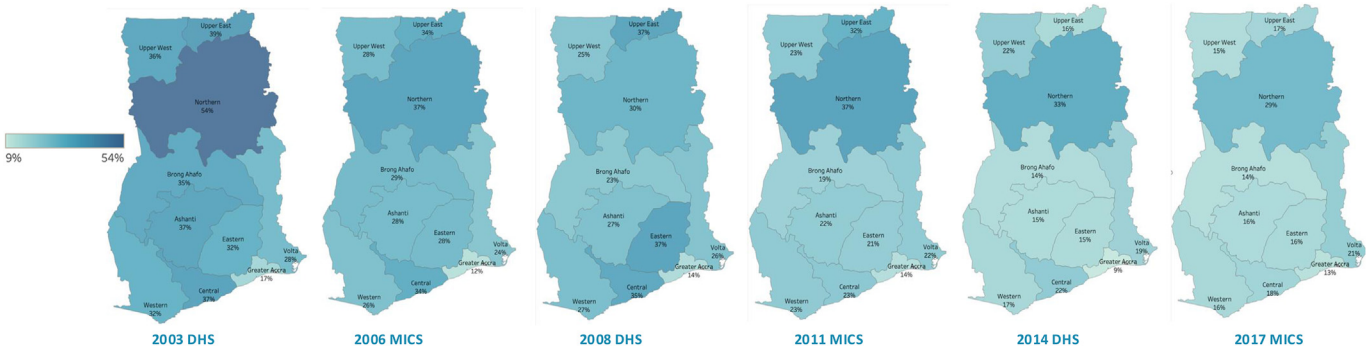

FIGURE 3. Regional trends in under-5 stunting prevalence. DHS, Demographic and Health Survey; MICS, multiple indicator cluster survey.

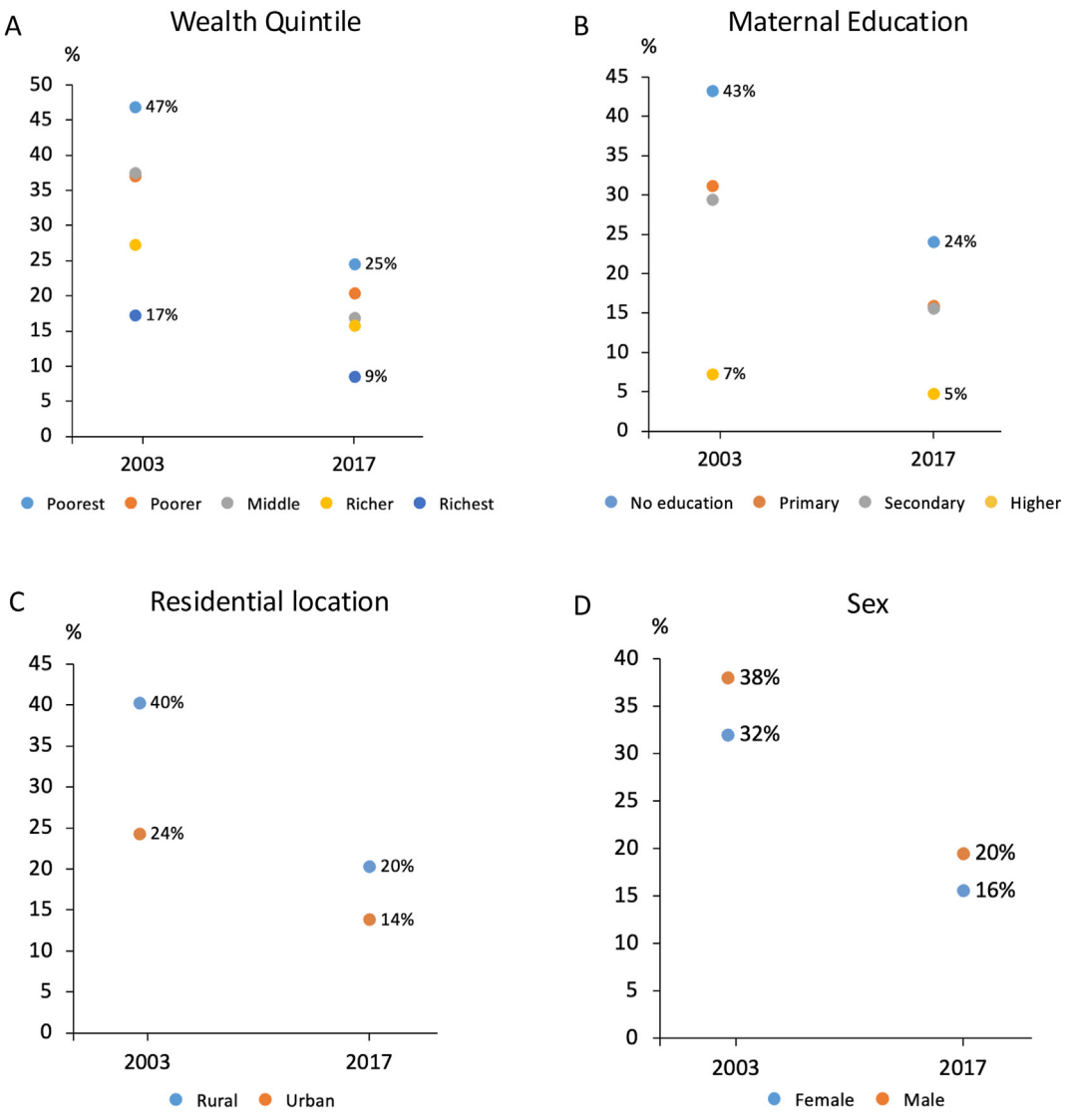

FIGURE 4. Trends in national under-5 stunting prevalence by equity dimensions.

Maternal education was another dominant socioeconomic theme across all levels of stakeholders, with broad consensus that low maternal education negatively impacts child nutritional status.

> "The evidence is that when we look at the linkage between mothers' education and stunting, we know that there is a big correlation between high education and better nutrition status. It is not just education for the girls and women but overall [education] because we know that with the nutrition it is not only for mother, but it is also a support system." (Female, International NGO)

> "An educated mother will know what type of food will be nutritious to their children. Education can influence the type of food a mother will give to their child" (Mother 2010–2020, Shai Osudoku-Greater Accra Region)

However, some respondents expressed that a mother's education could either improve or worsen child nutritional status: maternal education may be associated with improved economic status and better care of children, but alternately, an educated mother may too busy and therefore assign the care of the children to others.

> "…if there is a mother who probably works in a factory, or she has to go work and make ends meet. She probably will not be able to feed the kid maybe regularly as much as the infant needs so they will be feeding him [infant] with koko [porridge] or something which is high in carbohydrate, but it might not be necessarily good for the kid at that particular time." (Male, GO)

> "With a literate mother, she goes to work, and her child stays with someone [caregiver]. She doesn't know what the child feeds on in her absence. This can affect the nutritional status of the child." (Health Worker)

Employment was positively related to stunting reduction by all categories of stakeholders, with consensus among mothers, regional, and national stakeholders, but views differed on the impact that labor migration and remittances have on stunting. Labor migrants can help reduce stunting when they remit money back home to help with the care of the children left behind, but when the money is not used for caring for children, then stunting levels are not improved.

> "Most of the time people will migrate either within the country or internationally [to seek greener pastures] and once the person's income increases and the person remits it home, then it will have an effect on stunting. It will improve stunting." (Female, INGO)

> "There are a lot of migration across the country and women are left on their own and in some locations where they don't even own the land to do their

own cropping, it affects them with the food supply and then their economic power to procure [nutritious food].” (Male, Academia)

Women’s empowerment was highlighted by some national stakeholders as important, explaining that when women are empowered (e.g., in terms of finance, education, and decision making), this translates into improved feeding for every member of the household, including children. However, women’s empowerment was not discussed explicitly in any of the FGDs with mothers.

“Women’s empowerment encompasses many things like education, abuse at home, so many things. So definitely more empowered women at least theoretically we believe that when women are able to make decisions when they have resources, they usually channel it to the health of the family and their children. So definitely, women empowerment, more empowered women mean better-nourished children.” (Female, Academia)

Some respondents referred to cultural factors as being important contributors to stunting prevalence, including the existence in some areas of beliefs about spiritual causes of stunting, food taboos/restrictions (including in pregnancy and childhood), and preferential access of adults to meat. However, others also mentioned that an increase in advocacy to delay marriage has contributed to stunting reduction.

“If there are any changes, it will be the fact that there is a lot of advocacy going for marriages to delay, to make sure girls have probably finished school before they marry, and they have a job and all that.” (Male, LNGO)

Political stability was recognized by national stakeholders as an essential contextual factor contributing to stunting reduction, including people’s unrestricted movement, but this was not a dominant theme among regional stakeholders or mothers in the community. Some national and regional respondents did note that episodes of violent conflict, especially in the north of the country, negatively affect nutritional status through displacement and constrained availability of and access to food.

“Politically, I think the fact that we are in a stable democracy contributes to that [stunting reduction]. We live in a time where we don’t have restricted access to movement. Because there is a stable democracy, you can go anywhere. I don’t know whether you can say or do anything you want, but a stable environment allows you to be able to do a lot of things.” (Male, Academia)

“…conflicts contribute, because if you look over the year there have been a lot of, you know, cluster conflicts around the Tamale Metropolis, and people have moved from their original places to other places, I mean land issues have been a challenge and all these contributes to the problem.” (Metro Nutrition Officer)

Underlying factors

Regarding underlying or intermediate factors, stakeholders cited improved but insufficient access to potable water and continued lack of toilet facilities and ongoing open defecation as the main household factors leading to stunting in children.

“I think the situation has improved. A number of communities consistently are connected to running [potable] water. Several governments have made efforts to provide a constant supply of water to communities. Organizations like NGOs are also supporting in the drilling boreholes, mechanizing some of them and it’s been so good and progress for me.” (Male, INGO)

“Okay, I do not know, I cannot tell the past 20 years but from information gathered I am sure they have improved in terms of water, access to water […] but when it comes to sanitation or let’s say toilet facilities, there’s still a lot of room for improvement. Some communities still have challenges, they do not have [toilets], so they have to go out there and do their thing.” (Nutrition Officer)

“The children, we know how to take care of them, but lack of water is making it difficult because the time the child is supposed to eat and be healthy and if the mother is not at home to prepare the food for the child, the child cannot eat well and [wash] as you wanted. […] It is the lack of water that is making it difficult for us to take care of the children.” (Mother 2000–2010, Tolon-Northern Region)

Challenges to exclusive breastfeeding and constraints on access to food were cited by all types stakeholder groups as being associated with stunting, with some also commenting on declining breastfeeding and appropriate complementary feeding rates—due in part to not only women’s increased employment outside the home and limited maternity leave provisions but also the influence of breastmilk substitute manufacturers.

“We have made significant progress in reducing the proportion of people who were not doing exclusive breastfeeding (EBF). So, in other words, EBF rate has increased. But it has stagnated. It used to be <2% of Ghanaian mothers in the late ’80s, were exclusively breastfeeding. It increased significantly to ~63% and it started fluctuating…. The fact that more and more women are now in the work environment [and] maternity leave ends at 3 months, they have to leave their children. It’s not everybody who expresses and tries to continue EBF.” (Male, Academia)

“Most of them are able to hit the 6 months. Some corporate mothers are not able to do the 6 months. They will go to work after maternity leave which ends at 3 months, so they’ll come back and tell you they have to add some formula to [breastmilk] since they’ll be away for some hours. We stress on expressing milk, but the number of hours spent at work limits this.” (Senior Staff Nurse)

Agricultural challenges relating to climate change and land degradation as well as inadequate agricultural practices were discussed as drivers of food insecurity, along with high food prices, although multiple stakeholders expressed that food security had improved overall during the study period.

“I think we are all waiting for the comprehensive food security and availability assessment this year. It has been a very long time that that exercise has been done. Hopefully, it will be out soon, and we can get a very clear picture of the food security status of the nation. But just looking around, I see that yes. […] When you look at the government’s program of planting for food and jobs, there are improvements, so I will say yes.” (Female, Academia)

“I will want to talk about climate change. Yields have fallen and then we have the issue of illegal mining that has ravaged a lot of farming areas and that has negatively or that may have negatively affected stunting in some locations. This is because if you don’t have the yields, your income will not be right [enough] for you to procure what you don’t produce. […] Once you don’t have optimum nutrition you are prone to a lot of health problems.” (Female, GO)

“Because the soil is now tired and we are not practicing the good practices that we should put in place so that we can yield more, the land is not yielding much again. So, well, much effort has to be put in to make this food available, and for that matter, it makes it expensive. So, I don’t think there is a shortage of food, just that it is expensive.” (SHEP Coordinator)

All types of stakeholders noted that investments in infrastructure and personnel have increased the availability of health services, with multiple national and regional stakeholders, highlighting the Community-based Health Planning and Services (CHPS) program and wider access to both public health and clinical services. Regional

stakeholders also referred to the availability of nutrition education and counseling as an important factor affecting stunting prevalence.

> "There is better access [to health services] apart from buildings as in you know the structures. At GHS, we don't just stay in the structures, we go into the communities. So, the CHPS program, community health planning and services program which places health workers within the community and for them to work closely with community members has also improved access [to health services] and the CHPS officers do home visits. So even if the mother or child is not coming, they can be identified through our home visits. So, these also have helped a lot." (Female, GO)

> "Yes! I must say it has changed because previously or years ago they didn't have this number of health facilities but now […] and especially with the introduction of CHPS concept, it has improved so now every community falls under a CHPS zone where they can access to have public health services and also basic clinical health services, yes, so it has improved. Now we have 26 CHPS zones, we have 4 health centers, we have 1 district hospital." (Nutrition Officer)

Proximal factors

With respect to proximal factors, national stakeholders identified young maternal age, short birth intervals, and increased fertility as key maternal characteristics relating to poor child nutritional status. Most of these same factors were identified by the regional participants, who also flagged maternal nutritional status as important.

> "There is a lot of advocacy in terms of girls marrying later than they should because a lot of the time in a lot of the regions in both the south and the northern, we used to have ~25% of girls between the ages of 15 to 17, who would have a child when they are married and they are those mothers that endanger their children in terms of being able to treat them well and properly get them nourished." (Male, Local NGO)

> "The spacing too can have an effect because she can't give birth immediately after a year, you give birth again. Obviously, 1 of the children will be malnourished; the first child might end up being malnourished. Because when you do not space childbirth, you end up giving the second born more food than the first one and it will end up making the first one malnourished. So, I think the spacing has an effect." (UG Farms)

> "As I said if the mother's nutritional status is good, she is likely to have a healthier infant and if the child has a good start in life, it always a good starting place for the child to develop further." (Female, INGO)

National stakeholders also referred to intestinal worms, malaria, diarrhea, and measles as main diseases contributing to childhood stunting, along with an increasing shift of childhood diseases from communicable to noncommunicable. Malaria prevention was not a major topic of discussion among the regional stakeholders or mothers. However, other stakeholders spoke of malaria prevention in relation to disease prevention and the health of the mother in preparation for delivery and directly or indirectly relating malaria prevention to malnutrition.

> "With worm infestation, I think we have seen improvement. We know that periodically, government sponsors deworming programs, so we've seen improvement. At least when I was young, we could actually see worms in children's faces, but I haven't seen that for a very long time. Many mothers even know about this so if you are not careful, they will even deworm more than it is required." (Female, Academia)

> "Generally, infections and illness in children has improved due to immunization and vaccination rolled out in the country. So, we have seen an improvement in childhood diarrhea and all those things." (Female, International NGO)

> "With the disease burden, there is something that is coming up, now, it's like we are moving to more noncommunicable diseases. Because we now have children with diabetes, children hypertensive, those kinds of chronic diseases. But for disease trend, it is still the infectious diseases, the diarrheas, the malaria, and all those things." (Female, International NGO)

National stakeholders noted the importance of diet diversity and micronutrient supplementation to prevent malnutrition in children, and regional stakeholders highlighted efforts to provide nutritional education and counseling to mothers to improve children's dietary intake.

> "I think that nutrition advocates have done well in teaching mothers about (diet) diversity. So there seem to be an improvement." (Female, Academia)

> "For women in their childbearing age, they are given [folic acid]. All these things add on to ensure that we get a healthy infant. But for kids, a lot is also done at that level. When it comes to the food, there are Plumpy'Nuts but that also became a problem. And then the vitamin A supplementation also comes on and off." (Female, GO)

> ".... there is improvement in the nutritional status of the children, and it is based on the programs that we are talking about, the education on the locally available food, because if they do not get the right message, they will go and be looking for things that may not be nutritionally good for the child, and it may even cost them than if they were to focus on the locally available foods" [Community Health Nurse]

Variation in perspectives between the Greater Accra Region and the Northern Region

The notable differences and similarities between the perspectives of regional stakeholders in the Greater Accra Region and the Northern Region are summarized in Supplementary Table 1. For example, KIIs revealed that the 2 regions differed in various aspects, including access to basic amenities and feeding practices. Stakeholders from Greater Accra reported that households generally had better access to improved drinking water and toilet facilities compared with the Northern Region, where many households relied on unimproved sources such as dams, and open defecation was widespread. According to the regional stakeholders, feeding practices in Greater Accra emphasized complementary feeding with diverse foods, such as legumes and proteins, although those in the Northern Region reported a greater reliance on locally available staples, such as porridge and anchovies.

Stakeholders in the Northern Region noted that agricultural challenges were exacerbated by unpredictable rainfall and declining soil fertility, whereas those in Greater Accra pointed to urban farming as a resource, although financial constraints tended to limit food access. Health services were reported to have improved in both regions through the CHPS program, but stakeholders in the Northern Region identified greater challenges with understaffing and limited outreach programs. Cultural taboos surrounding food, although mentioned in both regions, were reported by stakeholders in Greater Accra as being more prevalent and linked to education levels. Finally, stakeholders in the Northern Region emphasized the significant role of climate in food availability, whereas in Greater Accra, climate was seen as less of a concern.

In Greater Accra, maternal nutrition challenges were linked to breastfeeding and child malnutrition, whereas the Northern Region faced more severe issues with anemia and low hemoglobin levels. Fertility rates declined in the North, but high fertility persisted in some areas, whereas larger family sizes in Greater Accra contributed to malnutrition. Malaria prevention in Greater Accra focused on antenatal education, whereas the North benefited from health promotion reducing

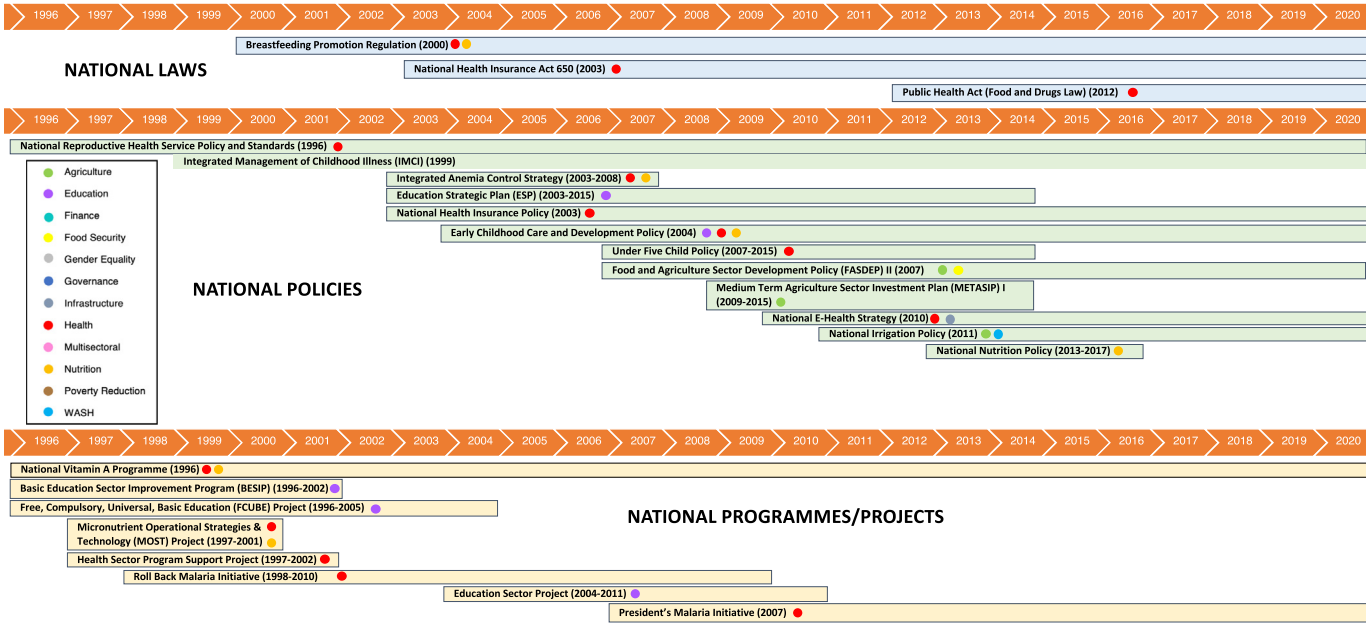

FIGURE 5. Key national initiatives directly and indirectly related to stunting reduction in Ghana

malaria cases. Dietary diversity was better in Greater Accra due to access to varied foods, whereas the North relied on enriching local staples.

In terms of similarities, regional stakeholders reported that both regions had made progress in food security, health services, and education, though to varying extents. Exclusive breastfeeding for 6 mo was promoted in both regions, with similar societal and family pressures posing barriers. The CHPS program had improved health care access, and outreach programs provided critical health information, including vitamin A supplementation. Education campaigns had influenced feeding practices and addressed cultural food taboos. Despite persistent challenges, efforts in both regions focused on improving dietary diversity, maternal and child health, and access to essential services.

Both regions showed progress in family planning, birth spacing, exclusive breastfeeding promotion, and maternal nutrition education, emphasizing diverse diets. Growth monitoring, counseling, and health outreach contributed to reducing malnutrition. However, limited access to fruits and vegetables persisted in both regions. Improvements in health services and community programs were central to enhancing maternal and child nutrition outcomes.

Policy and program review findings

Through our policy and program review, we identified 134 initiatives directly or indirectly related to nutrition, including 105 national initiatives. Of these, the KII participants assessed 23 national initiatives as having been very important or important to the decline in stunting over time in Ghana (Figure 5). Collectively, these are multisectoral initiatives, variously addressing health, nutrition, education, agriculture, food security, and water and sanitation.

Decomposition results

Our decomposition analysis of change over time in mean HAZ among index children predicted an increase of 0.28 HAZ between 2003 and 2017, which explained ~64% of the 0.43 HAZ change among index children that was observed from the household survey data (Figure 6). The explanatory factors contributing most to the predicted 0.28 HAZ change were the increase over time in household mosquito net ownership (accounting for 37% of the predicted change), the increase in the coverage of skilled birth attendance (SBA; 24%), and the increase in mean maternal age (12%). A greater proportion of the population living in urban areas in 2017 than that in 2003 and the increase in antenatal care (ANC) coverage each accounted for 7% of the predicted change over time in mean HAZ, whereas the increase in the mean household wealth index score accounted for 5% of the predicted change. The full national decomposition analysis results are presented in Supplementary Table 2.

Subnational decomposition revealed a somewhat different set of drivers of stunting reduction in the 3 northern regions compared to the rest of the country. Average child linear growth improved by 0.55 HAZ between 2003 and 2017 among index children in the northern regions compared with 0.43 HAZ nationally, with our decomposition analysis predicting a 0.32 HAZ change in the north, or 57% of the observed 0.55 HAZ change (Supplementary Table 3). Improved SBA coverage over time accounted for 40% of the predicted HAZ change in the north, followed by better access to improved water sources (21%), improved ANC coverage (20%), a higher proportion of mothers being literate (18%), and increased mean maternal age (8%). In contrast to the national model, the mean household wealth index score declined slightly over time in the northern regions and therefore contributed negatively to the predicted change over time in HAZ, and neither increased malaria prevention coverage nor increased urbanicity emerged as important correlates of stunting reduction in the north, as they did nationally.

Discussion

This mixed-methods case study of stunting reduction in Ghana in recent decades systematically examined trends in linear child growth and correlates of those trends nationally and at the subnational level, and across several other dimensions of equity. Stunting has declined substantially over time in Ghana and gaps in stunting inequities have narrowed. Child growth has improved along with scale up of malaria prevention initiatives and increasing coverage of maternal and newborn care. Higher mean maternal age and increasing prevalence of formal

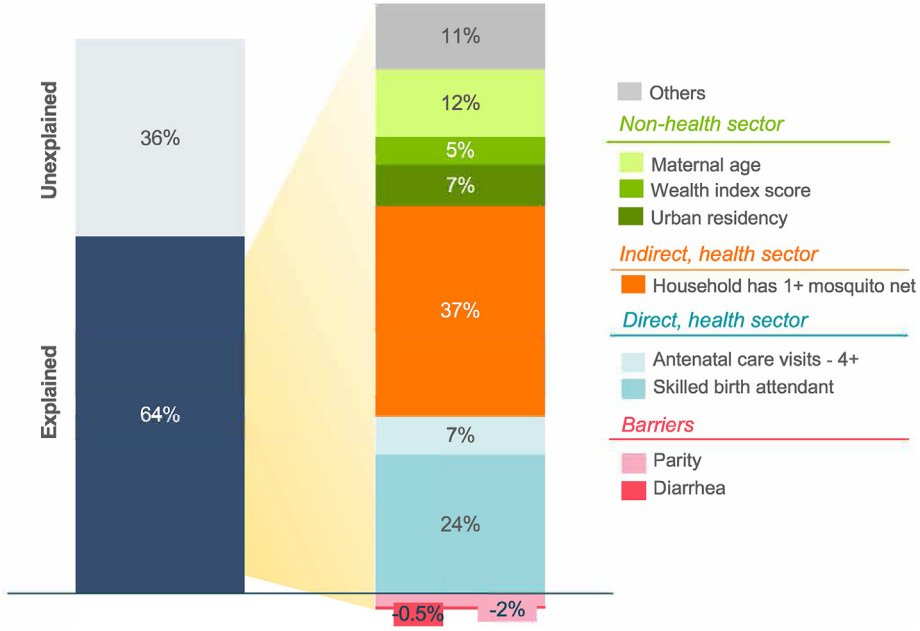

FIGURE 6. Decomposition of the observed 0.43 height-for-age *z*-score increase in Ghana from 2003 to 2017 into the relative contribution of each associated factor.

education among mothers suggests policy and advocacy efforts to delay marriage and improve girls' educational attainment may also be promoting child growth. Stunting reduction has been fastest in the higher burden northern regions, where coverage of maternal and newborn health interventions has improved, but where non-health sector drivers of progress such as improved maternal education and access to water, sanitation, and hygiene are also evident. The importance of non-health sector factors in the high-burden north as well as in the country as a whole reflects that they are closely intertwined with child nutrition and that limited access or uptake may pose major constraints to child growth.

Several limitations of our work should be noted. Our decomposition analyses included a range of potential distal, intermediate, and proximal explanatory factors but were still constrained by the limited availability over time of valid and reliable data on these and other likely important indicators, including, for example, robust measures of social safety nets and food security at the household level and individual dietary intake. Fortunately, findings from our qualitative analyses largely provide insights into the potential importance of some of the factors that could not be included in our quantitative models due to lack of available household-level data. Household surveys also do not reliably capture measures of intrauterine growth such as birth weight and length or gestational age, and only some household surveys routinely collect maternal anthropometry data. We were also not able to quantitatively examine the relative contributions of contextual factors or policies and programs due to the challenges posed in measuring such phenomena (e.g., political will, changes in governance structures, and political instability or conflict) and the limited availability of policy or program evaluation data. In our qualitative work, we aimed to sample regions and stakeholders to be as representative as possible, but our primary data collection was necessarily limited to only 2 regions in Ghana; additional perspectives from stakeholders based elsewhere in the country may have yielded different insights.

Consistent with findings from similar analyses in other malaria-endemic sub-Saharan African countries [23,24] and from other recent work in Ghana [25], our analyses suggest that the rapid scale-up of malaria prevention initiatives may have had a strong positive effect on child growth in Ghana. Other stunting Exemplar studies in Uganda [24] and Nigeria [26] estimated that increased malaria prevention intervention coverage accounted for 35% and 29% of the predicted improvement in national mean HAZ over their respective study periods.

Previous decomposition analysis in Ghana estimated that increased coverage of household bed net ownership accounted for 17% of the observed reduction in under-5 stunting during the 2003–2014 study period and 25% of the observed improvement in mean HAZ [25]. There are several pathways by which malaria prevention might affect child linear growth. The avoidance of malaria in pregnancy may reduce risk of intrauterine growth restriction and thus the infant's subsequent risk for low HAZ at birth [27–29]; our analysis of the trend in mean HAZ at around the time of birth over time in Ghana showed little change across survey periods, but relatively few children are sampled and measured in national household surveys within the first weeks of life. Although previous studies have found mixed evidence for an effect of malaria on stunting [30], the avoidance of malaria, and indeed any infectious disease, in early childhood may reduce risk of stunting by avoiding periods of reduced dietary intake and micronutrient insufficiency that often occur during (often repeated) bouts of childhood illness.

Although malaria prevention as a correlate of stunting reduction was not a key theme emanating from our qualitative work, both national and regional stakeholders explicitly posited malaria as a risk factor for stunting, and several flagged specific malaria-related policy initiatives as having likely contributed importantly to malaria prevention over the study period and thus to improved child growth. Implementation of the USAID-funded United States President's Malaria Initiative began in Ghana in 2007, following on from the Roll Back Malaria Initiative that had been operating since 1998, and aiming to scale up bednet use, indoor residual spraying, intermittent preventive treatment in pregnancy, and accurate diagnosis and prompt treatment with artemisinin-based combination therapies. Although the 2010–2013 Health Sector Medium Term Development Plan did not deliver on all of its priorities [31], its most significant achievements included increasing access to family planning, maternal and child health services, and malaria, tuberculosis,

and HIV/AIDS interventions and services. Multiple national and regional key informants in our study referred to the importance of investments in infrastructure and personnel and emphasized the CHPS program in ensuring wider access to both public health and clinical services, including malaria services. The national prevalence of microscopy-diagnosed malaria among children aged 6–59 mo declined from 26.5% in 2014 [32] to 13.8% in 2019 [33].

These and other policy initiatives seem likely to also have improved maternal and newborn care nationally during the 2003–2017 study period, with coverage of SBA increasing by 31% and 4 or more ANC visits by 16%; combined, these factors are estimated to account for ~30% of the predicted improvement in HAZ over the same period. National key informants and community mothers in Greater Accra also narrated that births attended by a skilled professional have increased in Ghana, and regional key informants in the Northern Region highlighted an increase in the number of women accessing ANC there. Improved ANC coverage could be expected to promote child growth in utero through nutritional counseling to improve maternal diet, provision of iron–folic acid supplementation to prevent maternal anemia, and screening, detection, and treatment of adverse maternal conditions such as pre-eclampsia and infectious diseases to prevent preterm birth, in addition to affecting postnatal outcomes through antenatal education on optimal infant feeding practices and family planning for optimal future birth spacing. SBA may affect mean HAZ directly by ensuring the safe delivery of larger infants and through promotion of early and exclusive breastfeeding and uptake of postnatal care, including family planning. In our analysis, the magnitude of the importance of SBA in particular suggests that it is likely a marker of improved access to maternal and newborn care more broadly and perhaps even of improved individual and household-level care-seeking behavior more generally, all of which would promote improved child growth throughout the childhood period.

Several of the key informants that we interviewed and several mothers attending our FGDs narrated that there has been little improvement in the incidence of teenage pregnancy over the past 2 decades in Ghana. Indeed, the estimated proportion of infants born to adolescent mothers in the 2017 MICS survey (4.8%) was the same as in 2003 DHS survey. However, the UN Population Division estimates the adolescent fertility rate in Ghana to have declined from 83.6 births per 1000 women aged 15–19 y in 2000 to 65.2 in 2022 [34]. Multiple study participants referred to an increase in advocacy efforts in Ghana to delay marriage to ensure better education and employment outcomes, and our policy and program review assessed the 2003–2015 Education Strategic Plan as important for stunting reduction, which included as one of its 10 policy goals the provision of equal opportunities to girls access the full cycle of education [35,36]. The proportion of mothers with no formal education in Ghana fell from 40% in 2003 to 27% by 2017, and mean maternal age increased from 30.5 to 31.2 y over the same period. The observed 0.7 y increase in mean maternal age emerged as strong predictor of improved linear child growth over time in our quantitative analyses. Policy and advocacy efforts to delay marriage and pregnancy and improve girls' educational attainment thus also appear to be promoting child growth in Ghana.

In conclusion, Ghana has made exemplary progress in reducing stunting prevalence and stunting inequities in recent decades, including in the northern parts of the country where the burden of stunting has been greatest but where progress has been most rapid due to improved intervention coverage and outcomes both within and outside of the health sector. Further improvement in child growth in Ghana could be accelerated through increased coverage of high-quality nutrition-specific interventions and greater health and non-health sector investments.

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Author contributions

The authors; responsibilities were as follows – GEO, ECK, AA, ZAB, SA-A: designed the research; GEO, MFG, EC, AS, FK-A, ECK, AA, ZAB, SA-A: conducted the research; GEO, MFG, EC, AS, FK-A, ECK: analyzed the data; GEO, MFG, EC, AS, FK-A, ECK, AA, ZAB, SA-A: contextualized and interpreted results; GEO, MFG, EC, ZAB, SA-A: wrote the paper; ZAB: had primary responsibility for final content; and all authors: read and approved the final manuscript.

Conflict of interest

ZB reports financial support and article publishing charges were provided by the Gates Foundation and financial support was provided by Gates Ventures. All other authors report no conflicts of interest.

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Data availability

Quantitative data described in the article are publicly available from the Demographic and Health Survey program (https://dhsprogram.com/Data/) and the Multiple Indicator Cluster survey program (https://mics.unicef.org/surveys), and the authors' analytical code will be made available upon request. Qualitative data described in the article will not be made available because participating key informants and focus group discussants did not provide consent to share their data.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajcnut.2025.02.011.

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