Severe acute malnutrition among under-five children in low- and middle-income countries: A hierarchical analysis of associated risk factors.

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Abstract

Introduction: Malnutrition is one of the top killer diseases among under-five children in Low- and Middle-Income Countries (LMIC). It accounts for about a third of preventable deaths among children. Reduction of malnutrition, especially severe acute malnutrition (SAM) is very crucial, directly, or indirectly, to a targeted decrease in child mortality and improvement in maternal health and would help achieve the sustainable development goal (SDG) 2 on the improvement of nutrition across board and SDG 3 on ensuring healthy lives and well-being promotion for all at all ages. We aim to develop and test a model of risk factors associated with SAM among under-five children in LMIC.

Methods: We used 51 recent Demographic and Health Survey (DHS) cross-sectional nationally representative data collected between 2010 and 2018 in LMIC. We used multivariable Bayesian logistic multilevel regression models to analyse the association between individual compositional and contextual risk factors associated with SAM.

Results: We analysed information on 532,680 under-five children (Level 1) nested within 55,823 communities (Level 2) from 51 LMIC (Level 3). The prevalence of SAM ranged from 0·1% in Guatemala to 9·9% in Timor-Leste. Children who are males, infants, low birth weight, whose mothers had no formal education, from the poorer household, who has no access to any media were more likely to have SAM. In addition, children from rural areas, neighbourhoods with high illiteracy and high unemployment rates and those from countries with high intensity of deprivation and high rural population percentage were more likely to have SAM.

Conclusion: Individual compositional and contextual factors were significantly associated with SAM. Attainment of SDG 1, 4, and 10 will automatically aid eradication SAM which in turn leads to the attainment of SDG 2 and 3. These findings underscore the need to revitalize existing policies and implement interventions to rescue and prevent children from having SAM at the individual-, community- and societal-levels.

Keywords: severe acute malnutrition, low and middle-income countries, Bayesian, Under-five children

Research in context

Evidence before this study

The authors searched PubMed, Hinari, Science direct, and Africa Journal online (Between March and August 2019) using the terms “malnutrition”, “severe acute malnutrition”, “burden”, “prevalence”, “mortality”, “morbidity”, “low and middle income countries”, “African”, “Asia”, and “sub-Saharan” for the most articles published in English. The burden of malnutrition, especially the severe acute malnutrition (SAM) and its associated has been studied in in sone countries across the low and middle-income countries (LMIC). The studies found that severe acute malnutrition is high in LMIC relative to other regions. To the best our knowledge, these studies are increasingly being generated for some countries in LMIC but no efforts were made to carry out a comprehensive assessment of the prevalence and risk factors and as well as consider the multi-level structure of factors that are associated with SAM across the entire the LMIC. This information is needed to allow informed health-system and policy development across the LMIC if SAM is to be drastically reduced. While the burden of malnutrition in most LMIC has been estimated by the Global Burden of Disease Study the study of who the children are and where the children live as well as hierarchical analysis of factors associated with SAM has not been comprehensively assessed to the best of our knowledge.

Added value of this study

We used 51 recent Demographic and Health Survey (DHS) cross-sectional nationally representative data collected between 2010 and 2018 in LMIC. We used multivariable Bayesian logistic multilevel regression models to analyse the association between individual compositional and contextual risk factors associated with SAM. We analysed information on 532,680 under-five children (Level 1) nested within 55,823 communities (Level 2) from 51 LMIC (Level 3). We developed and tested a model of risk factors associated with SAM among under-five children in LMIC. We found that children who are males, infants, with low birth weight, whose mothers had no formal education, from the poorer household, who has no access to any media were more likely to have SAM. In addition, children from rural areas, neighbourhoods with high illiteracy, and high unemployment rates and those from countries with high intensity of deprivation and high rural population percentage were more likely to have SAM.

Implications of all the available evidence

There are individual compositional and contextual factors that are significantly associated with SAM. Attainment of SDG 1, 4, and 10 will automatically aid eradication SAM which in turn leads to the attainment of SDG 2 and 3. These findings underscore the need to revitalize existing policies and implement interventions to rescue and prevent children from having SAM at the individual-, community-, and societal-levels. The findings of this study will help countries to identify priority areas for interventions and will also be used as a yardstick and serve as a baseline for measuring the effectiveness of programmes and policies over time.

Introduction

Malnutrition is one of the top killer diseases among under-five children in Low- and Middle-Income Countries (LMIC) and it accounts for about a third of preventable deaths among children (1–3). Reduction of malnutrition, especially Severe Acute Malnutrition (SAM) is very crucial, directly, or indirectly, to a targeted decrease in child mortality and improvement in maternal health (3,4).

According to the World Health Organization (WHO), SAM is "a very low weight for height score (WHZ) below -3 z-scores of the median WHO growth standards, by visible severe wasting, or by the presence of nutritional oedema"(3). In earlier definition, SAM was said to include the mid-upper arm circumference (MUAC) < 115 millimetres, or the presence of bilateral pitting oedema, or both (5,6).

While the burden of SAM is higher among the LMIC than in other countries, inequalities exist in its distribution within these countries. The particular people affected by SAM within the LMIC and where they live in the LMIC have not been exploited. Rather than using "one cap fits all approach" in the implementation of an intervention aimed at reducing the burden of SAM in these countries, the identification of the most affected sub-population-group and where they live will enable the adoption of appropriate approaches that can substantially reduce the burden. The knowledge of this information and its adoption could further reduce the case-fatality rate of SAM beyond the current 55% in hospital settings as stipulated by WHO (3). The WHO had reported that the management of severe acute malnutrition according to WHO guidelines in hospital settings use of ready-to-use therapeutic foods reduce the fatality of SAM.

The UNICEF framework also identified the short-term consequences of malnutrition to include mortality, morbidity, and disability. The identified long term and intergenerational consequences include adult height, cognitive ability, economic productivity, reproductive performance, metabolic as well as cardiovascular diseases (7) as shown in Figure 1. A child with SAM and other medical issues are more difficult to manage. The medical complications with SAM are enormous. They include severe pneumonia, shock, dehydration, convulsions, blinding eye signs, congestive heart failures, severe anaemia, hypoglycaemia, hypothermia, anorexia, poor appetite, intractable vomiting. Hypothermia, high fever etc(6,8).

Conceptual Framework

We adopted the UNICEF conceptual framework for undernutrition to conceptualize and understand the risk factors and cause of malnutrition among under-five children across the world (7) as shown in Figure 1. The framework identified basic, underlying, and immediate causes of undernutrition and depicted interconnectedness among these (6). The framework stated that household food insecurity, inadequate care, and feeding, unhealthy environment, poor access to education, employment, income among others are risk factors of undernutrition among children. Similar factors have been reported in the literature(9–12).

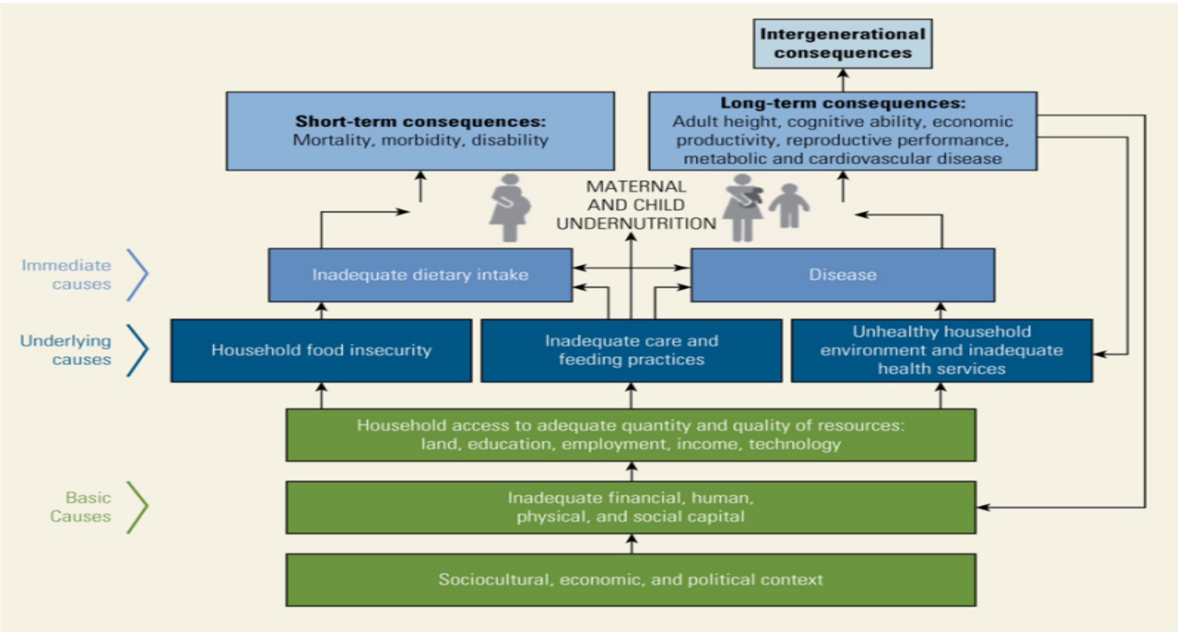

Figure 1: Conceptual Framework of Determinants of Undernutrition (7).

While a number of studies(9–16) have addressed local and regional level, distribution, and risk factors of malnutrition in literature, we found no published studies that had examined multilevel inter-connected contextual factors associated with SAM globally especially among LMIC. In this study, we considered the central role of neighbourhoods in shaping tendencies of children to develop SAM. The goal of this study was to develop and test a model of risk factors associated with SAM among U5C in LMICs using individual-level, neighbourhood-level, and country-level socio-economic factors in a united framework.

Methods

Study design and data

We used sets of successive cross-sectional data obtained from Demographic and Health Surveys (DHS) for this study. The DHS data are nationally representative household surveys and are conducted in LMIC. This study used data from 51 recent DHS surveys conducted between 2010 and 2018 and available as of March 2019 and that included under-five children (U5C) anthropometry data. The sample ranged from 1082 number of children in South Africa to 225,002 children in India, comprising of 532,680 total number of children. Typically, the DHS uses a multi-stage, stratified sampling design with households as the sampling unit (17,18). Country-specific sampling methodologies are also available at dhsprogram.com and also available in report forms (19–21). Within each sampled household, all women and men meeting the eligibility criteria are interviewed. Sampling weights are calculated to account for unequal selection probabilities including non-response whose application makes survey findings represent the full target populations. All the DHS questionnaires are standardized and implemented across countries with similar interviewer training, supervision, and implementation protocols. In this study, we used the DHS children recode data. The data covered the health experiences of under-five children born to sampled women within five years preceding the survey date. The anthropometry measurements were taken using standard procedures.

Dependent variable

Our dependent variable is SAM. SAM is a composite score of children weight and height. The DHS data consist of z-scores generated using WHO-approved methodologies (22). We then categorized children with z-scores <-3 standard deviation as having SAM. A child with <-3 weight for height score (WHZ) z-scores of the median WHO growth standards are classified as having SAM.

Independent variables

There are three categories of explanatory variables

Individual-level factors: sex of the children (male versus female), children age in years (under 1 and 1-5 year), maternal age (15 to 24, 25 to 34, and 35 to 49), maternal educational attainment (no education, primary, secondary or higher); occupation (working or not working), access to media, sources of drinking water (improved or unimproved), toilet type (improved or unimproved), weight at birth (average+, small, and very small) birth interval (firstborn, <36 months and >36 months) and birth order (1, 2, 3, and 4+). We used the DHS wealth index as a proxy indicator for socioeconomic status. The methods used in computing DHS wealth index have been described previously(23) as depicted in Figure 2.

Neighbourhood-level factors

In this study, the term "neighbourhood" was used to describe clustering within the same geographical living environment. Neighbourhoods were based on sharing a common primary sample unit (PSU) within the DHS data. The PSUs were identified using the most recent census in each country where DHS was carried out. The neighbourhood-level factors included in the models are the place of residence (rural or urban), neighbourhood poverty-, illiteracy-, and unemployment rates. The neighbourhood factors were categorized into two (low and high) each, to allow for non-linear effects and offer useful results for policy decisions. The median values were used as the reference category for comparison as illustrated in Figure 2.

Country-level factors

Country-level data were retrieved from the human index reports published by the United Nations database (24,25). In particular, we included countries' percentage rural population(25) and the intensity of deprivation (24) in the models. Both indicators belong to the body of the human development index (HDI). The HDI was created by the United Nations to emphasize "that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone" (26). The HDI summarizes average achievement in long and healthy life, being knowledgeable and have a decent standard of living dimensions of human development(26). The intensity of deprivation is a measure of the average percentage of deprivation experienced by people in multidimensional poverty while percentage rural population is a measure of the proportion of a countries population that resides in rural areas. The two factors were categorized into two (low and high) levels as shown in Figure 2.

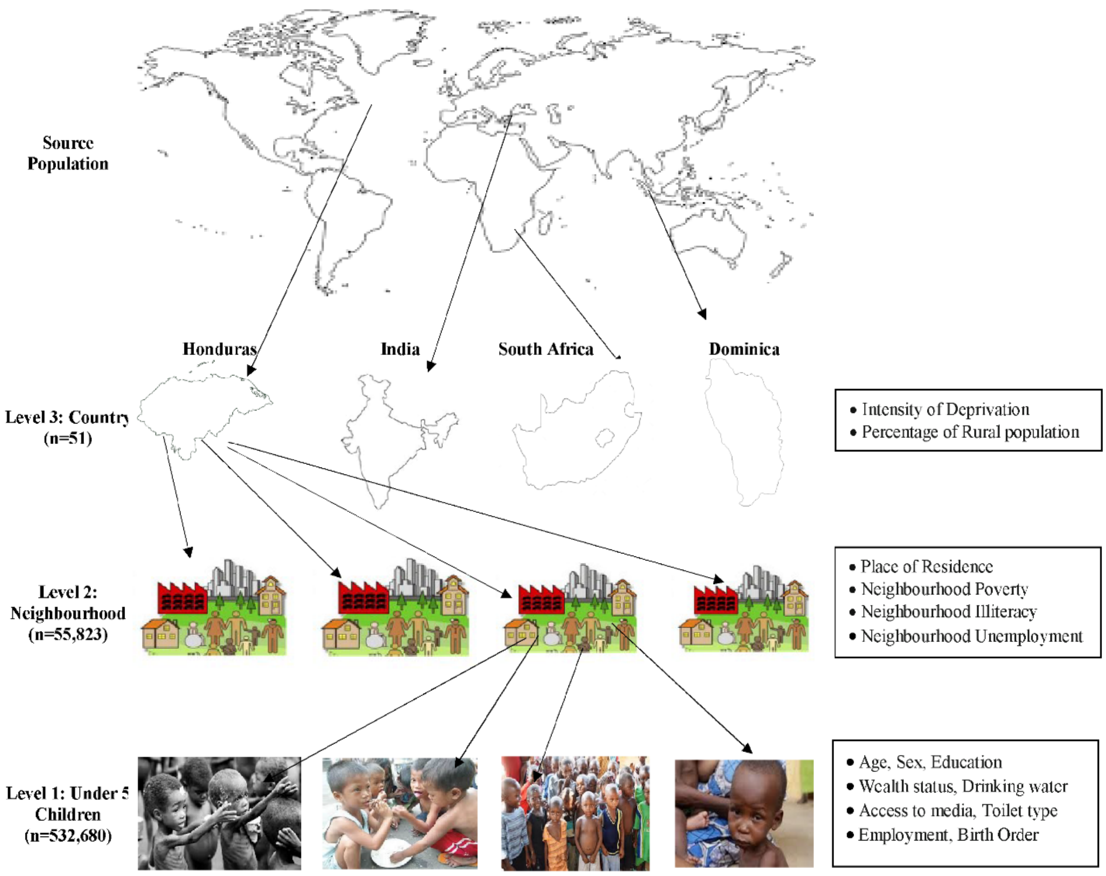

Figure 2: The hierarchical structure of the source data: authors drawings

Statistical analyses

Descriptive statistics were used to show the distribution of respondents by country, dependent and independent variables in percentages. Chi-square test of association was used to determine the significance of the association between the independent variables and SAM (Table 1).

Due to the hierarchical nature of the data as shown in Figure 2 and the dichotomous responses of the outcome variable, we used multivariable logistic multilevel regression models to analyse the association between individual compositional and contextual risk factors associated with SAM. Using the 3-level model for binary response specified above, with children who had SAM (at level 1), in a neighbourhood (at level 2) living in a country (at level 3) (see Fig. 2). To arrive at a robust model that will help identify risk factors of SAM bearing in mind the hierarchical structure of the data, we constructed five models. The first model, (Model 1- an empty model) without any explanatory variables, was specified to decompose the magnitude of variance that existed between country and neighbourhood levels. The Model II contained only individual-level factors, Model III has only neighbourhood-level factors, Model IV contained only the country-level factors while Model V ((Full Model) which jointly controlled for all the individual-, neighbourhood-, and country-level factors. The multilevel regression model was executed in the MLwinN software, version 3.03(27). Parameters were estimated using the Bayesian Markov Chain Monte Carlo (MCMC) procedures (28) with the following specifications: Distribution: binomial; link: logit, burning: 5000, chain: 50000 and refresh: 500.

The results (measures of association) were reported as odds ratios (ORs) with their 95% credible intervals (CrIs). The Bayesian statistical inference provides an opportunity to summarize probability distributions for measures of association alongside the 95 % credible intervals (95 % CrI), rather than 95 % confidence intervals (95 % CI) obtained in the frequentist approach. A 95 % credible interval is easily interpreted as the 95 % probability that the parameter takes a value in a particular range.

We also measured the likely contextual effects of the factors considered in the different levels using the intraclass correlation (ICC) and median odds ratio (MOR). The ICC was used to measure the similarity between respondents in the same neighbourhood and within the same country. It estimates the percentage of the total variance in the probability of a child having SAM that is related to the neighbourhood and country-level, i.e. measure of clustering of odds of developing SAM in the same neighbourhood and country. The ICC was calculated by the linear threshold (latent variable method)(29). Adopting the methods recommended by Larsen et. al. on neighbourhood effects(30), we reported the random effects in terms of the odds. The MORs are the measures of the variance of the odds ratio in higher levels (neighbourhood or country) and it estimates the probability of having SAM that can be attributed to any of the neighbourhood and country factors. If MOR=1, there is no neighbourhood or country variance. Conversely, the higher the MOR, the more significant are the contextual effects for understanding the probability of having SAM. A similar approach has been used in a similar setting in the literature (31,32).

Multicollinearity among explanatory variables was checked by examining the variance inflation factor (VIF) (33). All diagonal elements in the variance-covariance (τ) matrix for correlation between −1 and +1, and diagonal elements for any elements close to zero. None of the results of the tests provided reasons for concern. Thus, the models provide robust and valid results. The Bayesian Deviance Information Criterion (DIC) was used to evaluate how well the different models considered in this study fitted the data. A lower value on DIC indicates a better fit of the model.

Results

The regions of the world, countries, year of data collection, numbers of neighbourhoods, number of under-five children and the weighted prevalence of SAM are listed in Table 1. A total of 51 LMIC were sampled with the surveys conducted between 2010 and 2018. For this analysis, we analysed information on 532,680 under-five children (Level 1) nested within 55,823 neighbourhoods (Level 2) from 51 LMIC (Level 3). The median number of neighbourhoods per country sampled was 491, ranging from 251 in Comoros to 28,164 in India. The overall SAM prevalence was 4.7% with a median prevalence of 1.8% ranging from 0.1% in Guatemala to 9.9% in Timor-Leste as shown in Table 2 and Figure 3.

Table 1: Description of Demographic and Health Surveys data by countries and SAM prevalence among under-five children in LMIC, 2010-2018

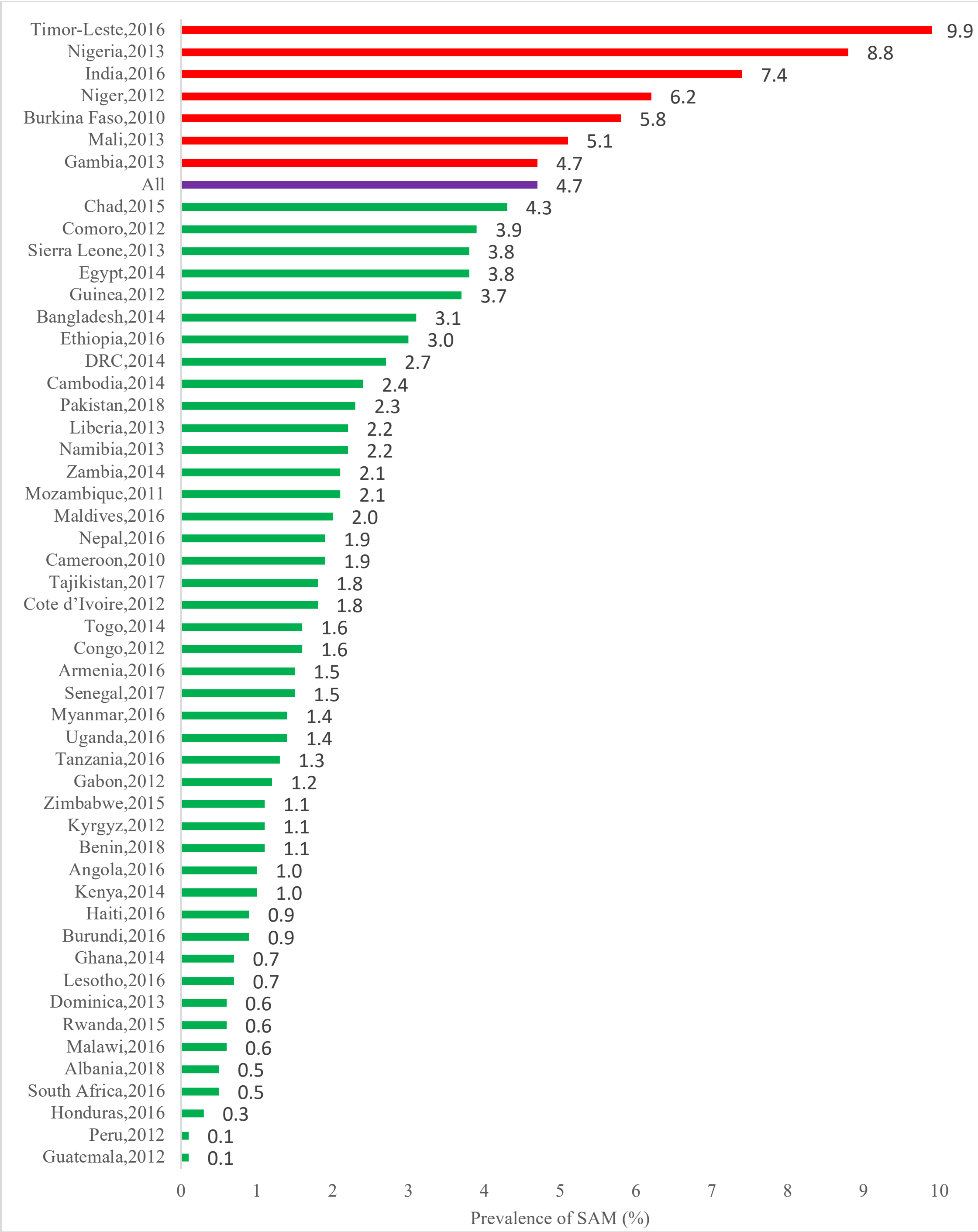

Figure 3: Prevalence of SAM by countries (DHS 2010-2018)

In Table 2, we present the descriptive statistics for the pooled sample. One-fifth of the children were infants, more than half of the respondents were male (51 %) and the majority of their mothers were between the 25 and 34 years of age (53 %). Nearly a third (31 %) of their mothers had no formal education while only 16 % belong to households in the richest wealth quintiles. Most of their mothers were currently employed (71 %) and currently married (9481 %). Most (81 %) of the children had drinking water from improved sources but only 50 % had improved toilet types. Most of the children were living in rural areas (69 %), high poverty rate (21 %), high illiteracy rate (29 %), and high unemployment rate (27 %) neighbourhoods. At the country level, 27% lived in countries with a high level of intensity of deprivation and 81% in high per cent rural population. All the variables considered at the different levels were significantly associated with SAM at 5% chi-square test. Also, the bivariate logistics regression models between each of the explanatory variables and SAM showed that all the variables significantly predicted SAM at p=0.05. Hence, they are all suitable for inclusion in the multivariable models.

Table 2: Description of Demographic and Health Surveys data by background characteristics and SAM prevalence among under-five children in LMIC, 2010-2018

Table 3 presents the results of all the different models exploited in this study. In the fully adjusted model controlling for the effects of individual-, neighbourhood-, and country-level factors, children age, sex, mothers education, mothers age, place of residence (rural or urban), neighbourhood poverty-, illiteracy- and unemployment rates, intensity of deprivation, percentage rural population were significantly associated with odds of SAM. In particular,

The odds of SAM doubled among infants than those aged 12-59 months (OR = 1·99, 95 % CrI 1·92 to 2·05). Male children were more likely to have SAM (OR = 1·24, 95 % CrI 1·20 to 1·28). The odds of SAM was also higher among children of younger mothers compared with children whose mothers were aged 35-49 years (15-24: OR = 1·16; 95 % CrI 1·10 to 1·24) & 25-34: OR = 1·05; 95 % CrI 1·01 to 1·10). Children whose mothers had no formal education were significantly more likely to have SAM than those with secondary or higher education (OR = 1·11; 95 % CrI 1·06 to 1·16). Children from the poorest households were 39 % more likely to have SAM than those from the richest households (OR = 1·39, 95 % CrI 1·28 to 1·49). Also, children whose mothers did not have access to media had higher odds of SAM (OR = 1·08; 95 % CrI 1·04 to 1·12). The odds of SAM was higher among children who had very small (OR = 1·62; 95 % CrI 1·52 to 1·74) and small (OR = 1·21; 95 % CrI 1·15 to 1·26) than those with average or bigger birth weights. Children from rural areas were more likely to have SAM than those from urban areas (OR 1·11; 95 % CrI 1·06 to 1·17). Children from neighbourhoods with high unemployment (OR = 1·15, 95 % CrI 1·08 to 1·22) rates were more likely to have SAM than those from neighbourhoods with the respective low rates. At the country-level, respondents from countries with high rates of the intensity of deprivation were 77 % times more likely to have SAM than those from countries with low rates (OR = 1·95, 95 CrI 1·08 to 3·85). Similarly, children living in countries with high percentages of rural population were

134% more likely to have SAM than those living in countries with low percentages (OR = 2·34, 95% CrI 1·51 to 3·45).

As shown in Table 3, in Model I (the null model), there was a significant variation in the odds of developing SAM across the countries (σ^2 = 0·93, 95 % CrI 0·62 to 1·40) and across the neighbourhoods (σ2 = 0·92, 95 % CrI 0·87 to 0·96). On the assessment of the intra-country and intra-neighbourhood correlation coefficient, 18·1 % and 36·0 % of the variance in odds of having SAM could be attributed to the country- and neighbourhood-level factors, respectively. Results from the median odds ratio (MOR) also confirmed evidence of neighbourhood and societal contextual phenomena shaping the distribution of SAM among the children. The full model (Model V) showed a variation in the odds of developing SAM across the countries (σ^2 = 0·69, 95 % CrI 0·45 to 1·06) and across the neighbourhoods (σ^2 = 0·97, 95 % CrI 0·92 to 1·03). If a child is moved to another neighbourhood or another country with a higher probability of having SAM, the median increase in their odds of having SAM would be 2·2 (95 % CrI 1·9 to 2·7) and 2·57 (95 % CrI 2·51 to 2·64) respectively.

Table 3: Individual compositional and contextual factors associated with the SAM identified by multivariable multilevel logistic regression models, DHS data, 2010–2018

Discussion

Since the WHO declared war against SAM, there is a paucity of information on the relationship between contextual and societal factors in the distribution of SAM among under-five children. The current study appeared to have been the first multilevel examination of factors associated with SAM across the globe wherein we considered 51 LMIC using national representative data consisting of 532,680 children found in 55823 neighbourhoods.

There are significant relationships between SAM and characteristics considered at the individual-level with male infants, low birth weight, children whose mothers had no education (vs those with secondary or higher), younger mothers, from poorer households, who had no access to media, used unimproved toilet type were significantly more likely to have SAM. Sex of the children appeared to be a very important risk factor, male children were significantly more likely to have SAM. The findings corroborate those of previous studies that examined the association between sex of children and nutritional status (14,15,34–37). Literature agreed that poor nutritional outcomes are commoner among male children than female children. We found that the older a child is, the less the likelihood of having SAM. There were higher odds among infants than the older children as reported in earlier studies (9,14,15,34,36,38). Maternal age also played a key role in an under-five child having a SAM. Children of younger mothers aged 15 to 24 years as well as those aged 25 to 34 years had higher odds of being SAM than children of those aged 34-49 years. Our finding is in consonance with previous studies in child nutrition which found a significant association between mothers' age and nutritional outcomes (12,15).

Children whose mothers had no education or only primary education were at higher odds of developing SAM. The same relationship has been established in the literature (10,14,16,34,35,38,39). Poor educational attainment could restrict mothers' knowledge on best feeding practices and therefore predispose children to poor nutrition. This is also linked to the wealth status of the family as education alone is not sufficient to make good decisions, availability of income to execute such decisions is also vital. Fagbamigbe et al had already established a linkage between wealth and education in Nigeria setting (40). This is evident in our finding as children from households in the poorest wealth quintiles had higher odds of SAM compared from households in the richest wealth quintiles. Similar findings have been reported earlier (9,10,16,35,38). Other important findings were the relationships between weight at birth and SAM, U5C with low birth weight are at higher odds of developing SAM as reported in earlier studies(9,12,15,34). It is not unlikely that efforts to control low-birth weight are not yielding the expected results.

In addition, our findings found evidence that showed that neighbourhood- and country-level factors influence the development of SAM among U5C besides the individual-level factors. The estimates of the only neighbourhood-level factor model (Model III) showed that U5C who reside in a neighbourhood with low rates of socioeconomic factors had higher odds of developing SAM. The same pattern of the significance of the neighbourhood-level factors was found in the only country-level model (Model IV) where children in high rural percentage and high intensity of deprivation are at higher odds of developing SAM.

However, in the full model, when individual-, neighbourhood-, and country-level factors were adjusted for at the same time. We found evidence that besides the individual-level factors, living in a neighbourhood with low rates of the socioeconomic position increases the odds of developing SAM. The findings are supported by the reports from previous studies (15,16,38). It is evident in the current study that geographical clustering affects the odds of developing SAM as corroborated in the literature (9,14). About 18.1 % and 35.9 % of the variation in developing SAM is conditioned by differences between neighbourhoods and countries, respectively. The odds of an under-five child moved to another neighbourhood or another country with a higher probability of developing SAM, to develop SAM may increase by about 157 % and 122 %, respectively. This finding demonstrated that SAM is clustered among neighbourhoods and countries. A clear demonstration of this is shown in Table 1 and Figure 3 where we reported wide differences in the prevalence of SAM among countries. Under-five children living in the same neighbourhood tends to have similar tendencies in developing SAM. It is, therefore, possible that there is some evidence of possible neighbourhood and country contextual phenomenon affecting tendencies of children at developing SAM. Literature is replete with the fact that odds of poor nutrition are higher among under-five children residing in communities with low levels of urbanization and low-level index (12,35,36).

Our findings showed the need to strengthen existing policies on child' nutrition and implement public health prevention strategies targeted at all children in most-at-risk, high-risk, and low-risk neighbourhoods and countries. There is a need for further decomposition analyses to explore how the significant factors identified in the current study could help explain the disparities in SAM among high-risk children residing in high-risk places. However, our study has some limitations. We are unable to identify any causal factors of developing SAM due to the cross-sectional nature of the data. We are limited to establish only associations. Longitudinal studies may help in this regard. Also, the secondary nature of the data prevented us from including some variables of interest. For instance, the length of time that children had spent in their neighbourhoods and the extent of their exposure to the neighbourhood environment. In addition, we only used wealth index computed from the household asset as a proxy for household income because DHS does not collect data on household income or expenditure, the traditional indicators used to measure wealth.

Despite the highlighted study limitations, the study has significant strengths. Our study is a multi-country study with large, population-based spanning 51 countries. Over 500 under-five children were included in this study. The DHS has a unique advantage of been nationally representative, with a proven sampling methodology. Also, variables used in DHS were operationalized in the same way and making it possible for the comparison of numerical values across countries. The use of a multilevel approach in studying the distribution of SAM among under-five children is advantageous over non-recognition of the hierarchical nature of the data. We are therefore able to provide more robust evidence about under-five children compositional and contextual measures of socioeconomic position associated with the development of SAM. In addition, the Bayesian approach we adopted has the advantage of being able to produce a far more robust estimate with better properties and yields unbiased estimates (28,41).

Conclusions

In conclusion, at 4.7 % prevalence, over twelve million under-five children in the LMIC have SAM. Individual compositional and contextual measures of socioeconomic position were independently associated with the having SAM across the 51 LMIC. The odds of SAM is generally among children aged <1 year, with small birth weight, whose mothers had no formal education, of mothers aged 15-24 years, from households in poorest wealth quintiles, who had no access to media and who used unimproved toilet types. Our findings impacted on several SDGs and therefore have several policy implications: For instance on the SDG 1: Ending poverty and all its forms everywhere will definitely reduce the chances of a child developing SAM. In addition, our study is connected to attainment of the SDG 2 on the improvement of nutrition everywhere, SDG 3 on ensuring healthy lives and well-being promotion for all at all ages and SDG 4 on provision of quality education for all. In addition, our findings inter-country variabilities suggest a need for renewed efforts to achieve the SDG 10 on reduction of inequality within and among countries. These findings underscore the need to revitalize existing policies and implement interventions to rescue and prevent children from having SAM at the individual-, community-, and societal-levels.

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Availability of data and materials

The data supporting this article is available at http://dhsprogram.com.

Authors Contributions

OU conceived the study, AFF and OU designed the study and analysed the data; AFF retrieved and merged the data and drew the Figures; AFF, OU, and NBK carried out literature search, data interpretation, and writing of the manuscript. All authors read and consented to the final version of the manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Ethics approval and consent to participate

This study was based on an analysis of existing survey data with all identifier information removed. The survey was approved by the Ethics Committee of the ICF Macro at Fairfax, Virginia in the USA and by the National Ethics Committees in their respective countries. All study participants gave informed consent before participation and all information was collected confidentially. The full details can be found at http://dhsprogram.com.

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