BMJ Open

High-risk fertility behaviour and undernutrition among children under-five in sub-Saharan Africa: a cross-sectional study

Abdul-Aziz Seidu ,[1,2] John Elvis Hagan Jnr ,[3,4] Eugene Budu,[5] Richard Gyan Aboagye ,[6] Joshua Okyere ,[7,8] Barbara Sakyi,[7] Collins Adu ,[9,10] Bright Opoku Ahinkorah [11]

To cite: Seidu A-A, Hagan Jnr JE, Budu E, *et al.* High-risk fertility behaviour and undernutrition among children under-five in sub-Saharan Africa: a cross-sectional study. *BMJ Open* 2023;**13**:e066543. doi:10.1136/bmjopen-2022-066543

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-066543).

Received 22 July 2022
Accepted 09 March 2023

Check for updates

For numbered affiliations see end of article.

Correspondence to
Joshua Okyere;
joshuaokyere54@gmail.com

ABSTRACT

Objective The study examined high-risk fertility behaviour and its association with under-five undernutrition in sub-Saharan Africa (SSA).

Design We conducted a cross-sectional analysis of data from 32 sub-Saharan African countries' Demographic and Health Surveys. A weighted sample of 110 522 mother-child pairs was included in final analysis. Multilevel binary logistic regression was used to examine the association between high-risk fertility behaviour and undernutrition. The results were presented using adjusted odds ratio (aOR) with their respective 95% confidence intervals (CIs).

Setting Thirty-two countries in SSA.

Outcome measure Stunting, wasting, and underweight.

Results The pooled prevalence of stunting was 31.3%, ranging from 15.0% in Gabon to 51.7% in Burundi. Wasting was highest among children from Burkina Faso (19.1%) and lowest among those from South Africa (1.6%). The overall prevalence of wasting was 8.1%. The prevalence of underweight was 17.0%, with the highest among children in Niger (37.1%) and lowest in South Africa (4.8%). Mothers who gave birth at the age less than 18 years and those with short birth interval were more likely to have their children being stunted, wasted, and underweight. The odds of stunting and wasting were high among children born to women with high parity. However, maternal age at birth more than 34 was associated with lower odds of childhood underweight as against those with age at birth less than 34.

Conclusion Countries in SSA are encouraged to address the issue of maternal age at birth less than 18, high parity, and shorter birth intervals in order to meet the Global Nutrition targets, which aim to achieve a 40% reduction in the number of stunted children under the age of 5 and to reduce and maintain childhood wasting to less than 5% by 2025.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Using a nationally representative dataset allows for the generalisation of the current findings to women and under-five children in the selected sub-Saharan African countries.
⇒ Unlike previous studies that have been limited to individual countries, this study examined stunting, wasting, and underweight simultaneously from the sub-regional perspective.
⇒ Due to the cross-sectional design of the Demographic and Health Survey, causality could not be established between high-risk fertility behaviour and undernutrition in children.

INTRODUCTION

Globally, child undernutrition in the forms of wasting (weight-for height z-score<−2), stunting (height-for-age z-score<−2), and underweight (weight-for-age z-score<−2) continues to be a public health concern as closely half of all deaths in children under-five are attributable to undernutrition, especially in the low-and-middle-income countries (LMICs).[1–4] The aforementioned are all nutritional problems affecting most children in sub-Saharan Africa (SSA). Wasting occurs as a consequence of short-term response to inadequate intake or an infectious disease episode,[5] and can be reversed through adequate dietary intake in an environment that is free from infectious disease.[6] Stunting results from inadequate intake of food over a long period that may be worsened by recurrent infections.[7]

Sub-Saharan African countries continue to battle with child undernutrition despite improvement in children's health in the African continent.[8 9] Evidence from the conclusion of the Millennium Development Goals (MDG) indicated a global decline in the proportion of underweight children from 25% in 1990 to 15% in 2015.[10] Nevertheless, this decline was unevenly distributed across the regions of the world as nearly 90% of all underweight children reside in South East Asia and SSA.[11] Also, the proportion of stunted children had fallen in all regions except SSA, where the numbers increased by about one-third between 1990 and 2013.[11] In addition, according to the 2015 MDG report, SSA accounted for one-third of all undernourished children (under-five) globally with approximately 39% stunted, 10% wasted, and 25% underweight.[10] That is, between 2010 and 2016, undernourishment in SSA increased among children under-five. Although the prevalence of chronic undernutrition is decreasing, the number of stunted children under 5 years of age is increasing due to population growth in SSA. The burden of child wasting in 2017 was 13.8 million children, of whom 4 million were severely wasted.[12]

These findings clearly prove that despite the global progress that has been achieved, undernutrition remains inadmissibly high in SSA and far from being addressed. This might increase the probability of missing the Sustainable Development Goal (SDG) on child mortality if the risk factors are not dealt with.[13] The consequences of child undernutrition on children's health and resilience to disease are well established in literature to include: impaired cognitive ability and reduced educational development, death, poor economic productivity in adulthood, and social and economic challenges in disadvantaged communities.[14] Given the severity of under-five undernutrition, studies have identified the factors to include maternal age at the birth, maternal education, parity, family size, birth interval, and access to healthcare.[15–18]

Generally, fertility behaviour of women is characterised by birth order and spacing, as well as maternal age at birth.[19] Therefore, high-risk fertility behaviour (HRFB) refers to too-early (<18 years) or too-late (>34 years) maternal age at delivery, shorter birth interval (<24 months), and higher parity.[20] Although, literature has shown that women's HRFB is an important factor for the increased risk of undernutrition among children under-five,[20] it has received less attention in SSA. To the best of our knowledge, existing studies conducted in SSA to ascertain the association between HRFB and childhood undernutrition have addressed this analysis from a unidimensional approach. For example, Tamirat *et al*[21] examined the correlation between HRFB and stunting, leaving behind wasting and underweight.[22] With this dearth of empirical literature to support an association between HRFB and childhood undernutrition, this study examined HRFB and its association with under-five stunting, wasting, and underweight in SSA.

Table 1 Description of the study sample

Country	Year of survey	Weighted sample (N)	Weighted percentage (%)
Angola	2015–2016	3538	3.2
Burkina Faso	2010	4464	4.0
Benin	2017–2018	7677	6.9
Burundi	2016–2017	4178	3.8
Congo DR	2013–2014	4739	4.3
Congo	2011–2012	2589	2.3
Cote d'Ivoire	2011–2012	2107	1.9
Cameroon	2018	2863	2.6
Ethiopia	2016	6553	2.9
Gabon	2012	1932	1.7
Ghana	2014	1901	1.7
Gambia	2013	752	0.7
Guinea	2018	2212	2.0
Kenya	2014	6023	5.4
Comoros	2012	1276	1.2
Liberia	2019–2020	1959	1.8
Lesotho	2014	1011	0.9
Mali	2018	5437	4.9
Malawi	2015–2016	4007	3.6
Nigeria	2018	7323	6.6
Niger	2012	3033	2.7
Namibia	2013	892	0.8
Rwanda	2014–2015	1346	1.2
Sierra Leone	2019	2657	2.4
Senegal	2010–2011	1943	1.8
Chad	2014–2015	5889	5.3
Togo	2013–2014	2210	2.0
Tanzania	2015–2016	6038	5.5
Uganda	2016	2852	2.6
South Africa	2016	854	0.8
Zambia	2018	6249	5.6
Zimbabwe	2015	3994	3.6
All countries	2010–2020	110 522	100.0

MATERIALS AND METHODS

Data source and study design

The current study involves a cross-sectional analysis of data from 32 Demographic and Health Surveys (DHSs) in SSA. The recent DHS from the 32 countries were used for the study (table 1). We combined the dataset from the 32 countries to help quantify the burden of HRFB and undernutrition indicators and this would provide an avenue for the design and implementation of interventions aimed at reducing HRFB and undernutrition at the sub-regional level. Child's Recode (KR) files were used to create the study's data. The DHS is a nationwide survey that is conducted in over 85 LMICs.[23] Every 5 years, data on a number of health indicators, including fertility behaviours and undernutrition are collected using a standardised questionnaire.[23] A two-stage cluster sampling technique was used to select the respondents. Aliaga and Ruilin's study details the entire sampling and data collection process.[24] The inclusion criteria in this study was countries with most recent datasets published from 2010 to 2020 that had data on fertility behaviours, undernutrition and all other variables of interest in this study.

Hence, countries which had datasets published from 2010 to 2020 and did not have data on all variables of interest in this study were excluded. In the study's final analysis, 110 522 women with children under the age of 5 were included. This paper was written using Strengthening the Reporting of Observation Studies in Epidemiology guidelines.[25] Table 1 lists the study sample that was used in the analysis.

Measurements

Outcome variable

Three outcome variables were used in the study, all of which were generated from the child anthropometric indices. Stunting (height-for-age z-scores), 'wasting' (weight-for-height z-scores) and 'underweight' were the variables (weight-for-age z-scores). The indices were classified using the World Health Organization's Growth Reference for children under the age of 5 (reference standard).[26] Based on the World Health Organization's Growth Reference standard, the children who had moderate and severe forms of each undernutrition indicator were categorised as stunted, wasted, and underweight and each indicator was coded as '1=yes'. Children with normal status in each indicator were coded as '0=no'.

Key explanatory variable

HRFB was the key explanatory variable. This variable has four parameters which consist of age at birth less than 18 years, age at birth more than 34 years, short birth interval, and high parity (more than three children). These variables have been used in previous studies to examine health outcomes.[20 27 28]

Covariates

A total of 18 covariates were considered in the study. These covariates comprise child and mother characteristics, household factors and contextual factors. The covariates were selected based on their availability in the DHS dataset. Also, the variables were selected due to their significant association with undernutrition from previous literature.[29–32] The child factors consisted of sex of child (male and female), age of the child (<1, 1, 2, 3 and 4), birth order (First, second to fourth=2, and fifth or more=3), and perceived size at birth (large, average,

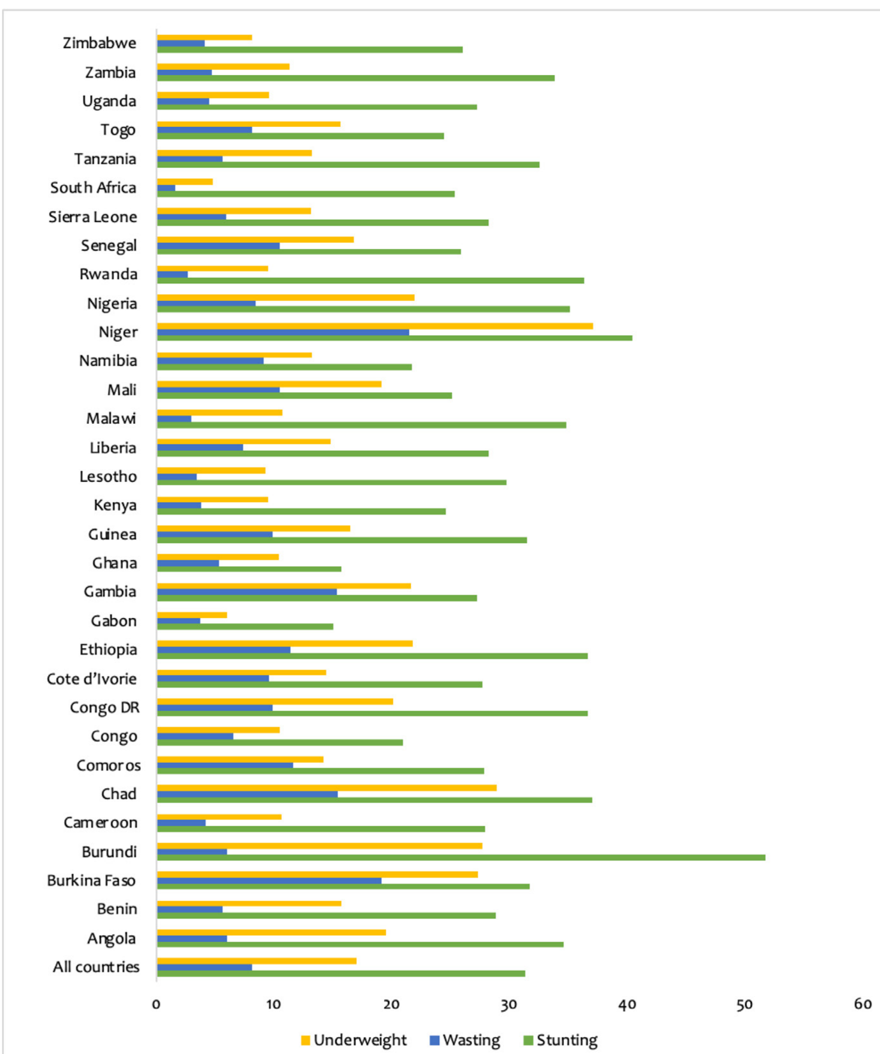

Figure 1 Prevalence of undernutrition among children under-five in sub-Saharan Africa.

Table 2 Prevalence of high-risk fertility behaviour in sub-Saharan Africa

Country	Age at birth less than 18	Age at birth more than 34	Short birth intervals	High parity
All countries	4.2	18.6	12.8	45.3
Angola	7.2	17.2	17.3	44.4
Benin	2.7	18.6	10.2	45.8
Burkina Faso	2.5	20.6	8.0	51.0
Burundi	1.2	22.9	12.9	48.9
Cameroon	5.2	16.2	16.2	45.1
Chad	6.6	16.4	20.1	57.9
Comoros	2.8	22.1	20.0	46.5
Congo	5.9	17.3	11.1	36.0
Congo DR	4.1	20.5	19.4	52.1
Cote d'Ivorie	6.4	16.2	10.4	43.0
Ethiopia	2.6	19.4	13.8	51.4
Gabon	7.9	17.9	11.4	36.8
Gambia	3.1	18.7	10.5	52.7
Ghana	2.1	23.9	8.7	40.7
Guinea	7.4	19.5	11.3	45.8
Kenya	3.0	18.2	11.6	36.6
Lesotho	3.5	13.4	6.7	20.4
Liberia	5.6	19.7	9.0	42.3
Malawi	5.1	13.3	7.4	37.5
Mali	5.4	18.7	15.4	53.1
Namibia	3.9	18.0	8.7	26.9
Niger	4.4	19.1	17.7	61.3
Nigeria	3.1	21.1	16.1	49.7
Rwanda	1.2	20.8	9.0	35.0
Senegal	3.4	20.0	11.9	46.1
Sierra Leone	4.2	18.7	8.9	40.9
South Africa	4.9	14.5	6.4	15.3
Tanzania	4.1	20.5	12.8	43.2
Togo	2.6	21.1	8.5	41.9
Uganda	3.0	18.0	17.8	47.7
Zambia	5.9	17.7	9.3	42.8
Zimbabwe	3.8	14.9	7.7	31.3

and small). Regarding the maternal characteristics, the existing coding for educational level (no formal education, primary, secondary and higher), employment status (yes and no) and postnatal checks within 2 months was maintained (yes and no). The recoding for the other maternal characteristics includes maternal age (15–19 and 20–49), antenatal care visits during pregnancy (yes and no), place of delivery (home, health facility, and other), and marital status (single [married, widowed, separated, divorved] and married). The household factors were recoded as the source of drinking water (improved and unimproved), type of toilet facility (improved and unimproved), household size (small, medium, and large), exposure to media (yes and no), and type of cooking fuel (clean and unclean). We used the already existing coding in the DHS dataset for the variables considered as contextual factors. The contextual factors were wealth status (poorest, poorer, middle, richer, and richest) and place of residence (urban and rural).

Data analyses

Stata V.16.0 was used for data extraction, cleaning, recoding, and analysis. The analysis was divided into four stages. First, a descriptive analysis was conducted to estimate the prevalence of stunting, wasting, underweight, and HRFB in each of the countries studied, with the results reported in a tabular format using frequencies and percentages. A Pearson χ^2 analysis was used to examine the association between stunting, wasting, underweight and HRFB at the second level. A multicollinearity test was further conducted to check the relationship between the key explanatory variables and covariates. From the test, the mean, minimum, and maximum variance inflation factor (VIF) were 1.56, 1.01, 4.24, respectively. Hence, there was no evidence of high collinearity among the variables. This was followed by a regression analysis which incorporated all of the significant variables from the χ^2 test. The effect of HRFBs on stunting, wasting, and underweight was then examined using a five modelled multilevel binary logistic regression. The null model (empty model) had only stunting, wasting, and underweight without any explanatory variable. Model I contained the key explanatory variable and the child characteristics. Model II had Model I and maternal factors. Model III contained Model II and household level factors. Model IV was fitted to consist of Model III and the contextual level variables. The regression analysis results were presented using the adjusted odds ratio (aOR) and its associated 95% confidence intervals (CIs). The statistical significance level was set at $p<0.05$. To accommodate for the complex sampling technique, all the analyses were weighted.

Patient and public involvement statement

Study participants or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

Prevalence of childhood undernutrition in SSA

The pooled prevalence of stunting was 31.3%, ranging from 15.0% in Gabon to 51.7% in Burundi. Wasting was highest among children from Burkina Faso (19.1%) and lowest among those from South Africa (1.6%). The overall prevalence of wasting was 8.1%. Regarding underweight, the pooled results showed that 17.0% of the children were underweight. Out of this, the prevalence was high among children from Niger (37.1%) and lowest in South Africa (4.8%) (figure 1).

Table 3 Association between high-risk fertility behaviour and stunting

Variable	Null model	Model I	Model II	Model III	Model IV
Age at birth less than 18					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		1.58*** (1.48–1.68)	1.20*** (1.10–1.31)	1.41*** (1.33–1.51)	1.19*** (1.09–1.31)
Age at birth more than 34					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		0.93*** (0.90–0.96)	0.97 (0.90–1.04)	0.95* (0.91–0.99)	0.96 (0.89–1.03)
Short birth intervals					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		1.37*** (1.32–1.42)	1.26*** (1.21–1.31)	1.34*** (1.29–1.39)	1.27*** (1.22–1.32)
High parity					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		1.29*** (1.25–132)	1.10*** (1.05–1.15)	1.14*** (1.11–1.18)	1.06* (1.01–1.11)
Random effect results					
LR test	69.91 (X=0.0000)	63.35 (X=0.0000)	36.72 (X=0.0000)	35.96 (X=0.0000)	32.19 (X=0.0000)
Wald χ^2	Reference				
Model fitness		743.34***	9038.02***	3028.57***	9782.73***
Log-likelihood		−68 403.885	−63 468.647	−67 126.925	−62 946.772
AIC	137 550.6	136 819.8	126 997.3	134 293.9	125 981.5
BIC	137 569.8	136 877.4	127 285.7	134 486.1	126 404.5
N	110 522	110 522	110 522	110 522	110 522
Number of groups	1608	1608	1608	1608	1608

Null Model had only the outcome variable with no explanatory variables or covariates.
Model I had the key explanatory variables and child factors (age of child in years, sex of child, birth order and perceived size of child at birth).
Model II contained Model I variables and maternal factors (mother's age, educational attainment, working status, antenatal visits during pregnancy, postnatal check within 2 months and place of delivery).
Model III had the variables in Model II and the household characteristics (wealth status, household size, type of toilet facility, source of drinking water, type of cooking fuel and access to media).
Model IV was fitted to contain variables in Model III and the contextual factors (place of residence and country).
*p<0.05, **p<0.01, ***p<0.001.
AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; LR, likelihood ratio.

Table 2 presents the results of the prevalence of HRFB among women of reproductive age in SSA. The pooled prevalence of age at birth less than 18 years was 4.2%, ranging from 1.2% in Rwanda and Burundi to 7.9% in Gabon. Age at birth more than 34 years was highest among women from Ghana (23.9%) and lowest in Malawi (13.3%) while the overall prevalence stood at 18.6%. With short birth intervals, the pooled prevalence was 12.8%, ranging from 6.4% in South Africa to 20.1% in Chad. The prevalence of high parity was highest in Niger (61.3%) and lowest in South Africa (15.3%) with the pooled prevalence being 45.3%.

Distribution of childhood undernutrition among HRFB and covariates

Online supplemental table 1 presents the results of the bivariate analysis of HRFB, covariates, and childhood undernutrition in SSA. Majority (95.8%) of the women gave birth at age more than 18. About 8 out of 10 women gave birth when they were aged less than 34. Most (87.2%) of the women had no short birth interval. Majority (54.7%) of the women had no high parity. At the χ^2 analysis, only age at birth less than 18 and age at birth more than 34 were not associated with wasting. With stunting, all but source of drinking water were associated. All the explanatory variables were significantly associated with underweight.

Association between HRFB and childhood undernutrition in SSA

Stunting

Table 3 shows the results of the association between HRFB and stunting. Mothers who gave birth at the age less than 18 years were more likely to have their children being stunted compared to their counterparts whose age at birth was greater than 18 years (aOR=1.19; 95% CI 1.09 to 1.31). The odds of childhood stunting was higher among mothers with short birth intervals as against those with normal birth intervals (aOR=1.27; 95% CI 1.22 to 1.32).

Table 4 Association between high-risk fertility behaviour and wasting

Variable	Null model	Model I	Model II	Model III	Model IV
Age at birth less than 18					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		1.25*** (1.13–1.39)	1.18* (1.03–1.37)	1.16*** (1.04–1.29)	1.17* (1.01–1.35)
Age at birth more than 34					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		0.93*** (0.88–0.99)	1.03 (0.91–1.16)	0.94* (0.89–1.00)	1.03 (0.91–1.16)
Short birth intervals					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		1.20*** (1.13–1.28)	1.15*** (1.08–1.23)	1.18*** (1.11–1.26)	1.16*** (1.09–1.24)
High parity					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		1.29*** (1.23–1.36)	1.10* (1.02–1.18)	1.13*** (1.07–1.19)	1.10* (1.02–1.19)
Random effect results					
LR test	15.70 (X=0.0000)	14.59 (X=0.0001)	10.97 (X=0.0005)	13.21 (X=0.0001)	11.70 (X=0.0003)
Wald χ^2	Reference	163.80***	3076.71***	1065.25***	3290.05***
Model fitness					
Log-likelihood	–31 575.797	–31 494.611	–29 958.761	–31 013.522	–29 818.049
AIC	63 155.59	63 001.22	59 977.52	62 067.04	59 724.1
BIC	63 174.82	63 058.9	60 265.91	62 259.3	60 147.07
N	110 522	110 522	110 522	110 522	110 522
Number of groups	1608	1608	1608	1608	1608

Null Model had only the outcome variable with no explanatory variables or covariates.
Model I had the key explanatory variables and child factors (age of child in years, sex of child, birth order and perceived size of child at birth).
Model II contained Model I variables and maternal factors (mother's age, educational attainment, working status, antenatal visits during pregnancy, postnatal check within 2 months and place of delivery).
Model III had the variables in Model II and the household characteristics (wealth status, household size, type of toilet facility, source of drinking water, type of cooking fuel and access to media).
Model IV was fitted to contain variables in Model III and the contextual factors (place of residence and country).
*p<0.05, **p<0.01, ***p<0.001.
AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; LR, likelihood ratio.

Also, maternal high parity was found to be associated with higher odds of childhood stunting (aOR=1.06; 95% CI 1.01 to 1.11).

Wasting

From table 4, maternal age at birth less than 18 was associated with higher odds of childhood wasting (aOR=1.17; 95% CI 1.01 to 1.35) as against those whose age at birth was more than 18 years. The likelihood of childhood wasting was higher among children born to mothers with short birth intervals (aOR=1.16; 95% CI 1.09 to 1.24) and high parity (aOR=1.10; 95% CI 1.02 to 1.19) compared to their counterparts without short birth interval and high parity, respectively.

Underweight

Table 5 shows the results of the association between HRFB and childhood underweight. The results showed that the odds of childhood underweight was higher among women whose age at birth was less than 18 years (aOR=1.27; 95% CI 1.14 to 1.41) compared to those whose age at birth was more than 18 years. Compared to mothers without short birth intervals, children born to mothers with short birth intervals were more likely to be underweight (aOR=1.30; 95% CI 1.25 to 1.37). Maternal age at birth more than 34 was associated with lower odds of childhood underweight (aOR=0.90; 95% CI 0.83 to 0.98) as against those with age at birth less than 34.

DISCUSSION

This study examined the association between HRFB (ie, age at birth less than 18 years or more than 34 years, short birth intervals, and high parity) and childhood undernutrition (ie, stunting, wasting, and underweight) among children in selected sub-Saharan African countries. Our findings indicated that HRFB was significantly associated with stunting among children. We found that the risk of stunting among children increased with mothers

Table 5 Association between high-risk fertility behaviour and underweight

Variables	Null model	Model I	Model II	Model III	Model IV
Age at birth less than 18					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		1.56*** (1.44–1.68)	1.29*** (1.16–1.42)	1.38*** (1.28–1.49)	1.27*** (1.14–1.41)
Age at birth more than 34					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		0.92*** (0.88–0.97)	0.90* (0.83–0.98)	0.93*** (0.89–0.97)	0.90* (0.83–0.98)
Short birth intervals					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		1.43*** (1.37–1.49)	1.30*** (1.24–1.36)	1.40*** (1.34–1.46)	1.30*** (1.25–1.37)
High parity					
No		Reference (1.0)	Reference (1.0)	Reference (1.0)	Reference (1.0)
Yes		1.43*** (1.38–1.48)	1.10** (1.04–1.16)	1.21*** (1.17–1.26)	1.07* (1.01–1.13)
Random effect results					
LR test	52.56 (X=0.0000)	45.89 (X=0.0000)	18.90 (X=0.0000)	36.22 (X=0.000)	23.71 (X=0.0000)
Wald χ^2	Reference	787.25***	6320.40***	2940.82***	6721.73***
Model fitness					
Log-likelihood	−51187.916	−50798.731	−47758.575	−49553.248	−47444.553
AIC	102 379.8	101 609.5	95 577.15	99 146.5	94 977.11
BIC	102 399.1	101 667.1	95 865.54	99 338.75	95 400.08
N	110 522	110 522	110 522	110 522	110 522
Number of groups	1608	1608	1608	1608	1608

Null Model had only the outcome variable with no explanatory variables or covariates.
Model I had the key explanatory variables and child factors (age of child in years, sex of child, birth order and perceived size of child at birth).
Model II contained Model I variables and maternal factors (mother’s age, educational attainment, working status, antenatal visits during pregnancy, postnatal check within 2 months and place of delivery).
Model III had the variables in Model II and the household characteristics (wealth status, household size, type of toilet facility, source of drinking water, type of cooking fuel and access to media).
Model IV was fitted to contain variables in Model III and the contextual factors (place of residence and country).
*p<0.05, **p<0.01, ***p<0.001.
AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; LR, likelihood ratio.

who gave birth at the age less than 18 years. The result is supported by a related study which found that younger maternal age significantly increased stunting among children by 30%–40%.[33] This association could be attributed to maternal inexperience and the absence of autonomy among younger mothers which results in suboptimum feeding practices, thereby exacerbating the risk of stunting among their children.[33]

The likelihood of childhood stunting was higher among mothers with short birth intervals as against those with normal birth intervals (more than 24 months apart). This finding is consistent with studies from Egypt,[34] Nigeria[35] and Peru,[36] that found a higher risk of stunting among children born into shorter birth intervals. Shorter birth interval implies that the child will have shorter period of breastfeeding as a result of weaning, thereby making them more susceptible to stunting. Aligning with earlier findings that have found a significant association between parity and stunting,[37 38] the current study shows that multiparous mothers are more probable to have stunted children.

Concerning wasting, maternal age at birth less than 18, higher parity, and shorter birth interval to significantly exacerbate the risk of wasting among children. The likelihood of a child becoming wasted was higher among mothers who gave birth at an age less than 18 aligns with a previous study from Ghana that found similar results.[39] It is important to note that birth before age 18 constitutes adolescent or teenage pregnancy. Often, teenage mothers tend to be inexperienced and also lack the empowerment ‘to guarantee children adequate dietary intake, access to safe water, and sanitary conditions’ and these could increase the propensity of their children becoming wasted.[39] These compounded socioeconomic constraints could explain why the odds of wasting was higher among this group. However, our findings are incongruent with that of Madiba *et al*,[40] that found mothers with an age of more than 35 years old to have increased odds of being wasted. Furthermore, the finding that shorter birth interval increases the risk of wasting in children is inconsistent with a study conducted in Nigeria[30] which reported no significant association between birth interval and wasting among children. The current finding on the association between shorter birth interval and wasting may be explained from the perspective that mothers might not have benefited sufficiently in terms of time to recuperate physiologically from the previous birth.[41] It is also possible that such mothers may have limited resources (ie, food, money and time), thereby limiting their capacity to meet the nutritional needs of their children. Hence, exacerbating the risk of wasting in children born to them.

The findings show that age at birth less than 18 years and short birth intervals significantly increased the risk of underweight. However, maternal age at birth more than 34 was associated with lower odds of underweight in children. The finding is congruent with a study conducted in Ethiopia that found that the risk of underweight was low among children born to this group of mothers.[42] Mothers with maternal age at birth more than 34 years are experienced with child caregiving and tend to be knowledgeable about the nutritional requirements of their child. This outcome probably justifies the lower risk of underweight among children born to mothers with maternal age at birth more than 34 years.

Using a nationally representative DHS dataset is one of the study's strengths. The sample in this dataset allows the generalisation of our findings to women and under-five children in the selected sub-Saharan African countries. Unlike previous studies that have been limited to individual countries, our study examines stunting, wasting, and underweight simultaneously from the sub-regional perspective. Nevertheless, due to the cross-sectional design of the DHS, the inferences made are limited to associations. Causality could not be established between HRFB and undernutrition in children.

Implications for policy

Based on the findings, SSA countries are encouraged to prioritise and invest in policies and interventions that would facilitate a reduction in HRFB, including shorter birth intervals, births before age 18, high parity, and births after age 34. Practically, this goal could be achieved by improving the accessibility and usage of modern contraceptives as a conduit to reduce the occurrence of shorter birth intervals, early childbirth and multiparity. Educating women about the adverse health effects of HRFB would inform their decision to refrain from such activities.

CONCLUSIONS

There is a strong association between HRFB and undernutrition. However, underweight is significantly related with maternal age at birth more than 34, but not stunting and wasting. It is critical that the SSA countries included in this study address the issue of maternal age at birth less than 18, multiparity, and shorter birth intervals in order to meet the Global Nutrition targets by 2025. The findings underscore the need for country-specific interventions that will develop programmes that meet the contextual setting of their population.

Author affiliations
[1]Centre for Gender and Advocacy, Takoradi Technical University, Takoradi, Ghana
[2]College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, Queensland, Australia
[3]Department of Health, Physical Education, and Recreation, University of Cape Coast, Cape Coast, Ghana
[4]Neurocognition and Action-Biomechanics-Research Group, Faculty of Psychology and Sport Sciences, Bielefeld University, Bielefeld, Germany
[5]Korle Bu Teaching Hospital, Accra, Ghana
[6]Department of Family and Community Health, Fred N. Binka School of Public Health, University of Health and Allied Sciences, Ho, Ghana
[7]Department of Population and Health, University of Cape Coast, Cape Coast, Ghana
[8]Department of Nursing, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[9]Department of Health Promotion, Education and Disability Studies, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[10]Center for Social Research in Health, University of New South Wales, Sydney, Sydney, New South Wales, Australia
[11]School of Public Health, Faculty of Health, University of Technology Sydney, Broadway, New South Wales, Australia

Acknowledgements We thank MEASUREDHS for giving us access to the dataset. We also acknowledge Anita Gracious Archer for assisting with proof editing of the manuscript.

Contributors A-AS developed the study concept and performed the data analysis. A-AS, JEH, EB, RGA, JO, BS, CA and BOA drafted and revised the manuscript critically for its intellectual content. All authors read and approved the final manuscript. A-AS is the guarantor for the content of the study.

Funding The authors sincerely thank Bielefeld University, Germany for providing financial support through the Institutional Open Access Publication Fund for the article processing charge (Award/grant number: Not applicable).

Competing interests None declared.

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

Patient consent for publication Not applicable.

Ethics approval There was no need for further ethical approval for this study because we used publicly available secondary data. More information regarding the DHS data usage and ethical guidelines can be found at http://goo.gl/ny8T6X. All methods were performed in accordance with the relevant guidelines and regulations.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information. The dataset is available on the following website: https://dhsprogram.com/data/available-datasets.cfm

ORCID iDs
Abdul-Aziz Seidu http://orcid.org/0000-0001-9734-9054
John Elvis Hagan Jnr http://orcid.org/0000-0003-3530-6133
Richard Gyan Aboagye http://orcid.org/0000-0002-3498-2909
Joshua Okyere http://orcid.org/0000-0003-4080-7522
Collins Adu http://orcid.org/0000-0002-1300-6327
Bright Opoku Ahinkorah http://orcid.org/0000-0001-7415-895X

REFERENCES

1 Black RE, Allen LH, Bhutta ZA, *et al*. Maternal and child Undernutrition study group. maternal and child Undernutrition: global and regional exposures and health consequences. *The Lancet* 2008;371:243–60.
2 Ward A, Guillot A, Nepomnyashchiy LE, *et al*. Seasonal malaria Chemoprevention packaged with malnutrition prevention in northern Nigeria: A pragmatic trial (SMAMP study) with nested case-control. *PLoS One* 2019;14.
3 Sundaram ME, Labrique AB, Mehra S, *et al*. Early neonatal feeding is common and associated with subsequent Breastfeeding behavior in rural Bangladesh. *J Nutr* 2013;143:1161–7.
4 Simonyan H, Sargsyan A, Balalian AA, *et al*. Short-term nutrition and growth indicators in 6-Month- to 6-year-old children are improved following implementation of a Multidisciplinary community-based programme in a chronic conflict setting. *Public Health Nutr* 2020;23:134–45.
5 WHO. *Nutrition landscape information system (NLIS) country profile indicators: interpretation guide*. Geneva, Switzerland: World Health Organization, 2010.
6 Saaka M, Iddrisu M. Patterns and determinants of essential newborn care practices in rural areas of Northern Ghana. *International Journal of Population Research* 2014;2014:1–10.
7 Mamabolo RL, Alberts M, Steyn NP, *et al*. Prevalence and determinants of Stunting and overweight in 3-year-old black South African children residing in the central region of Limpopo province, South Africa. *Public Health Nutr* 2005;8:501–8.
8 Dapi Nzefa L, Monebenimp F, Äng C. Undernutrition among children under five in the Bandja village of Cameroon, Africa. *South African Journal of Clinical Nutrition* 2019;32:46–50.
9 Bhatt S, Weiss DJ, Cameron E, *et al*. The effect of malaria control on Plasmodium Falciparum in Africa between 2000 and 2015. *Nature* 2015;526:207–11.
10 World Health Organization. *World health Statistics report*. Geneva Switzerland: World Health Organization, 2016.
11 United Nations. The millennium development goals report; United Nations. In: *New York*. NY, USA, 2015.
12 Onyango AW, Jean-Baptiste J, Samburu B, *et al*. Regional overview on the double burden of malnutrition and examples of program and policy responses: African region. *Ann Nutr Metab* 2019;75:127–30.
13 UNICEF. *Levels & Trends in Child Mortality: Report 2017- Estimates Developed by the UN Inter-Agency Group for Child Mortality Estimation*. New York City, NY, USA: United Nations Children's Fund, 2017.
14 Stewart CP, Iannotti L, Dewey KG, *et al*. Contextualising complementary feeding in a broader framework for Stunting prevention. *Matern Child Nutr* 2013;9 Suppl 2(Suppl 2):27–45. 10.1111/mcn.12088 Available: http://doi.wiley.com/10.1111/mcn.2013.9.issue-s2
15 Ayotunde T, Mary O, Melvin AO, *et al*. Maternal age at birth and Under-5 mortality in Nigeria. *East Afr J Pub Health* 2009;6:11–4.
16 Oyefara JL. *Maternal age at first birth and childhood mortality in Yoruba society: the case of Osun state*. 2013.
17 UNICEF. Levels and trends in child mortality. United Nations children's Fund. *New York City* 2012.
18 WHO. *Newborn reducing mortality". fact sheet 333*. Geneva Switzerland: World Health Organization, 2012.
19 Asghar M, Murry B, Saraswathy KN. Fertility behaviour and effect of son preference among the Muslims of Manipur, India. *Journal of Anthropology* 2014;2014:1–5.
20 Rahman M, Haque SE, Zahan S, *et al*. Maternal high-risk fertility behavior and association with chronic Undernutrition among children under age 5 Y in India, Bangladesh, and Nepal: do poor children have a higher risk? *Nutrition* 2018;49:32–40.
21 Tamirat KS, Tesema GA, Tessema ZT. Determinants of maternal high-risk fertility behaviors and its correlation with child Stunting and anemia in the East Africa region: A pooled analysis of nine East African countries. *PLoS One* 2021;16:e0253736.
22 Khan MA, Khan N, Rahman O, *et al*. Trends and projections of Under-5 mortality in Bangladesh including the effects of maternal high-risk fertility Behaviours and use of Healthcare services. *PLoS ONE* 2021;16.
23 Corsi DJ, Neuman M, Finlay JE, *et al*. Demographic and health surveys: a profile. *Int J Epidemiol* 2012;41:1602–13.
24 Aliaga A, Ruilin R. Cluster optimal sample size for demographic and health surveys. In 7th International Conference on Teaching Statistics–ICOTS 2006. 2; 2-7;
25 von Elm E, Altman DG, Egger M, *et al*. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Int J Surg* 2014;12:1495–9.
26 World Health Organization. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. World Health Organization, 2006.
27 Tessema ZT, Tamirat KS. Determinants of high-risk fertility behavior among reproductive-age women in Ethiopia using the recent Ethiopian demographic health survey: a Multilevel analysis. *Trop Med Health* 2020;48:1.:9.
28 Rahman M, Hosen A, Khan MA. Association between maternal high-risk fertility behavior and childhood morbidity in Bangladesh: a nationally representative cross-sectional survey. *Am J Trop Med Hyg* 2019;101:929–36.
29 Nshimyiryo A, Hedt-Gauthier B, Mutaganzwa C, *et al*. Risk factors for Stunting among children under five years: a cross-sectional population-based study in Rwanda using the 2015 demographic and health survey. *BMC Public Health* 2019;19:175.
30 Akombi BJ, Agho KE, Merom D, *et al*. Multilevel analysis of factors associated with wasting and Underweight among children under-five years in Nigeria. *Nutrients* 2017;9:44.
31 Poda GG, Hsu C-Y, Chao J-J. Factors associated with malnutrition among children &Amp;Amp;Lt;5 years old in Burkina Faso: evidence from the demographic and health surveys IV 2010. *Int J Qual Health Care* 2017;29:901–8.
32 Talukder A. Factors associated with malnutrition among under-five children: illustration using Bangladesh demographic and health survey, 2014 data. *Children (Basel)* 2017;4:88.
33 Fall CHD, Sachdev HS, Osmond C, *et al*. Association between maternal age at childbirth and child and adult outcomes in the offspring: a prospective study in five low-income and middle-income countries (COHORTS collaboration). *Lancet Glob Health* 2015;3:e366–77.
34 Zottarelli LK, Sunil TS, Rajaram S. Influence of parental and socioeconomic factors on Stunting in children under 5 years in Egypt. *East Mediterr Health J* 2007;13:1330–42.
35 Adekanmbi VT, Kayode GA, Uthman OA. Individual and Contextual factors associated with childhood Stunting in Nigeria: a Multilevel analysis. *Matern Child Nutr* 2013;9:244–59.
36 Sobrino M, Gutiérrez C, Alarcón J, *et al*. Birth interval and Stunting in children under five years of age in Peru (1996–2014). *Child Care Health Dev* 2017;43:97–103.
37 Faye CM, Fonn S, Levin J. Factors associated with recovery from Stunting among under-five children in two Nairobi informal settlements. *PLoS One* 2019;14.
38 Taufiqoh S, Suryantoro P, Kurniawati HF. Maternal parity and exclusive Breastfeeding history are significantly associated with stunting in children aged 12-59 months. *MOG* 2017;25:66.
39 Wemakor A, Garti H, Azongo T, *et al*. Young maternal age is a risk factor for child Undernutrition in tamale metropolis, Ghana. *BMC Res Notes* 2018;11:877.
40 Madiba S, Chelule PK, Mokgatle MM. Attending informal Preschools and Daycare centers is a risk factor for Underweight, Stunting and wasting in children under the age of five years in underprivileged communities in South Africa. *Int J Environ Res Public Health* 2019;16:2589.
41 Kozuki N, Walker N. Exploring the association between short/long preceding birth intervals and child mortality: using reference birth interval children of the same mother as comparison. *BMC Public Health* 2013;13 Suppl 3.
42 Nigatu G, Assefa Woreta S, Akalu TY, *et al*. Prevalence and associated factors of Underweight among children 6-59 months of age in Takusa district, Northwest Ethiopia. *Int J Equity Health* 2018;17:106.