



Household structure, maternal characteristics and children's stunting in sub-Saharan Africa: evidence from 35 countries

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Background: Adequate nutrition in early childhood is a necessity to achieve healthy growth and development, as well as a strong immune system and good cognitive development. The period from conception to infancy is especially vital for optimal physical growth, health and development. In this study we examined the influence of household structure on stunting in children <5 yrs of age in sub-Saharan Africa (SSA) countries.

Methods: Demographic and Health Survey data from birth histories in 35 SSA countries were used in this study. The total sample of children born within the 5 yrs before the surveys (2008 and 2018) was 384 928. Children whose height-for-age z-score throughout was <−2 SDs from the median of the WHO reference population were considered stunted. Percentages and χ^2 tests were used to explore prevalence and bivariate associations of stunting. In addition, a multivariable logistic regression model was fitted to stunted children. All statistical tests were conducted at a $p < 0.05$ level of significance.

Results: More than one-third of children in SSA countries were reportedly stunted. The leading countries include Burundi (55.9%), Madagascar (50.1%), Niger (43.9%) and the Democratic Republic of the Congo (42.7%). The percentage of stunted children was higher among males than females and among rural children than their urban counterparts in SSA countries. Children from polygamous families and from mothers who had been in multiple unions had a 5% increase in stunting compared with children from monogamous families and mothers who had only one union (AOR 1.05 [95% CI 1.02 to 1.09]). Furthermore, rural children were 1.23 times as likely to be stunted compared with urban children (AOR 1.23 [95% CI 1.16 to 1.29]). Children having a <24-mo preceding birth interval were 1.32 times as likely to be stunted compared with first births (AOR 1.32 [95% CI 1.26 to 1.38]). In addition, there was a 2% increase in stunted children for every unit increase in the age (mo) of children (AOR 1.02 [95% CI 1.01 to 1.02]). Multiple-birth children were 2.09 times as likely to be stunted compared with a singleton (AOR 2.09 [95% CI 1.91 to 2.28]).

Conclusions: The study revealed that more than one-third of children were stunted in SSA countries. Risk factors for childhood stunting were also identified. Effective interventions targeting factors associated with childhood stunting, such as maternal education, advanced maternal age, male sex, child's age, longer birth interval, multiple-birth polygamy, improved household wealth and history of mothers' involvement in multiple unions, are required to reduce childhood stunting in the region.

Keywords: global health, low birthweight, nutrition, sub-Saharan Africa, underweight

Introduction

Proper nutrition in early childhood is necessary to achieve healthy growth, a strong immune system, appropriate organ formation and function, and cognitive and neurological development.^{1,2}

The period from conception to infancy is especially vital for optimal physical, mental and cognitive growth, health and development. It is estimated that about one-third of childhood mortalities are attributable to malnutrition.³ Over time, nutrition has been recognised as an essential factor in human, economic and

social development,⁴ especially as food systems interact with aspects of their environmental, societal, political and economic contexts.⁵ Therefore poor nutrition in the first 1000 d of a child's life can lead to stunted growth.² Childhood stunting remains among the foremost factors that hamper human development. In 2016, an estimated 155 million children were stunted globally (23%), and more than one-third of them came from Africa.⁶ In 2011, approximately 165 million (26%) children <5 y of age were stunted.² Stunting in children is usually not detected in a timely manner in early life, leading to decreased physical growth and increased child morbidity and mortality. Later consequences include adverse functional consequences, including lower cognition and educational performance, low adult wages and lost productivity.^{7,8} More than 90% of the global burden of malnutrition is in Africa and Asia, with African children being disproportionately affected. Thus the high prevalence of childhood stunting in Africa remains a major public health problem.^{2,9}

Adequate nutrition is required for national development and for the well-being of individuals, especially children. Malnutrition affects the entire population, but children are particularly vulnerable due to their physiological characteristics. To achieve the Sustainable Development Goals (SDGs), childhood malnutrition needs to be addressed and reduced significantly, especially those goals targeted to end poverty in all its forms (SDG 1); end hunger, achieve food security and enhanced nutrition and advance sustainable agriculture (SDG 2); and ensure healthy lives and promote well-being for all ages (SDG 3).^{10,11} Proper nutrition is required to prevent childhood morbidity and mortality, which are prevalent in sub-Saharan Africa (SSA).

In 2012, World Health Assembly Resolution 65.6 endorsed a comprehensive implementation plan on maternal, infant and young child nutrition,¹² specifying six global nutrition targets for 2025.¹³ The key target is a relative reduction of 40% in the number of stunted children by 2025 compared with the baseline of 2010. The purpose of the plan is to increase attention to, investment in and action on a set of cost-effective interventions and policies that can help member states and their partners reduce stunting rates among children <5 y of age. This would translate into a 3.9% relative reduction per year between 2012 and 2025, reducing the number of stunted children from 171 million to approximately 100 million. An analysis of 110 countries for which stunting prevalence is available revealed at least twice in the 1995–2010 period that global stunting is decreasing at a rate of 1.8% per year (2.6% in countries with a prevalence >30%). During this period, about one-fifth of the countries have reduced stunting at a minimum rate of 3.9%.¹³

Evidence-based studies have reported a large number of risk factors for poor childhood growth.^{14–16} Several factors that contribute to stunted growth and development include poor maternal health and nutrition, inadequate infant and young child feeding practices and infections, among others. Specifically, maternal nutritional status and health status determine a child's early growth and development, and begin during pregnancy.¹⁷ Intrauterine growth restriction due to maternal malnutrition, usually estimated by rates of low birthweight, accounts for approximately one-fifth of childhood stunting.¹⁵ Maternal determinants of childhood stunting include adolescent pregnancy and short birth spacing, which interferes with nutrient availability to the foetus. Furthermore, childhood feeding practices such

as suboptimal breastfeeding or non-exclusive breastfeeding and complementary feeding that is inadequate in quantity and quality contribute to childhood stunting.¹⁸ Also, severe infectious diseases lead to stunting, which could have long-term effects on growth, particularly based on the duration and whether there is inadequate nourishment to support recovery.¹⁸ In addition, subclinical infections resulting from exposure to poor hygiene and contaminated environments are associated with stunting, due to nutrient malabsorption and limited ability of the gut to act as a barrier against disease-causing organisms.^{18,19} Household poverty, non-responsive feeding practices, caregiver neglect and food insecurity can all interact to hamper childhood growth and development.¹⁸

Child morbidity and mortality in resource-constrained settings are mostly due to preventable causes. Studies on stunting are usually country specific. Achieving the global stunting target of 2025¹³ will depend on reducing the main risk factors for stunting in various countries and regions. It is important to undertake regional situation analysis to estimate the prevalence of children <5 y of age who are stunted, as well as assess the determinants of stunting. As there are disparities among risk factors of stunting in different countries, a regional approach would provide regional data (most especially in SSA, with its high level of childhood malnutrition) and could help in formulating regional interventions on the key risk factors to reduce the prevalence of malnutrition. An equity-driven policy targeting the key population is an effective approach for reducing stunting, and is the focus of several evidence-based research and public health interventions. In addition, evidence-based results to determine methods to alleviate childhood stunting are crucial. Also, it is important to understand the prevalence and determinants of childhood stunting and their relative effect to help set priorities in designing interventions and policies to improve childhood growth.

Methods

Data source

The study used nationally representative Demographic and Health Survey (DHS) data from birth histories in 35 SSA countries. A total of 384 928 births occurred within the 5 y before the surveys were conducted (2008 and 2018). The DHSs are routinely conducted usually every 5 y using structured methodologies and pretested validated quantitative tools. The consistency of the survey method over time and across countries makes multicountry analysis possible. Household samples are drawn using a stratified multistage cluster sampling design. Clusters are usually census enumeration areas and are also treated as primary sampling units. Data are collected on vital reproductive health issues. A major component of data collection is maternity history, while stunting data are part of the child history, where women are asked about their birth histories, the number of daughters and sons they have, their living conditions (elsewhere or with their mother), the number of children who have died, the number of births, sex, year, month and date of births, births in the last 3 or 5 y, in the past year or in the month of the interview, the preferred waiting time for another child, live births, size, length and weight at birth, survivorship status and current age or age at death, among other indicators. Data from the birth history have

been recoded into separate records for individual children listed by the mothers, with data on the study variables extracted for analyses. The data are in the public domain and were accessed at <http://dhsprogram.com/data/available-datasets.cfm>. More information about DHS data has been reported previously.²⁰

Variables selection and measurement

Outcome variable

Stunting. Children whose height-for-age Z-score (HAZ) is <-2 SDs from the median of the WHO reference population were considered stunted. Stunting, an indicator of chronic malnutrition, refers to linear growth retardation and cumulative growth deficits in children. It reflects a failure to grow in stature, which occurs as a result of inadequate nutrition over a long period. For this reason, stunting, and especially stunting of children <5 y of age, is a strong indicator of hunger and endemic poverty.

Independent variables. The explanatory variables in this study include sex of household head (male/female), family type (monogamy/polygamy), marital status of the mother (never in union, currently in union or living with a partner, formerly in union or lived with a partner), number of unions of the mothers (once, more than once), current residence of the mother (with husband/partner, staying elsewhere), education level of the mothers (none, primary, secondary, tertiary), place of residence (urban, rural), age of the mother (15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49 y), sex of the child (male, female), birth interval (first birth, <24 mo, 24–47 mo, ≥ 48 mo), child lives with whom (respondent [mother], lives elsewhere), birth order (first, second, third, fourth, fifth, sixth and above), age of the child (mo), total children ever born (1–2, 3–4, ≥ 5), birth type (singleton, multiple births) and household wealth quintile. For computation of the wealth index, principal components analysis was used to assign the wealth indicator weights. This procedure assigned scores and standardised the wealth indicator variables such as floor type, walls, roof, water source, sanitation facilities, radio, electricity, television, refrigerator, cooking fuel, furniture and number of persons per room. Then the factor coefficient scores (factor loadings) and Z-scores were calculated. Finally, for each household, the indicator values were multiplied by the loadings and summed to produce the household's wealth index value. The standardised Z-score was used to assign the overall assigned scores to poorest, poorer, middle, richer or richest.²¹

Ethical considerations. Publicly available data were used in this study. The ethical procedures for data collection were the responsibility of the institutions that commissioned, funded or coordinated the surveys. All DHSs are approved by ICF International and an institutional review board to ensure that the protocols follow the US Department of Health and Human Services regulations for the protection of human subjects. Original DHS data for all countries were retrieved from the Measure DHS online data archive after necessary approval for data use.

Data management plan. Multicollinearity is a major issue for interdependent variables in multiple regression models. A correlation matrix was used to examine interdependence between variables.

A cut-off of 0.7 was set to determine multicollinearity.²² Based on the results, birth order and total children ever born were excluded from the model, while retaining maternal age, which had significant interdependence with the two other variables. Furthermore, we used a complex survey module ('svy') to adjust for clustering, stratification and sampling weights. Percentages and χ^2 tests were used to explore prevalence and bivariate association of stunting. In addition, a multivariable logistic regression model was fitted to stunted children. Measures of association of the adjusted regression model with 95% CI were used to examine factors of childhood stunting. All statistical tests were conducted at a $p < 0.05$ level of significance. Data was analysed using Stata version 14.0 (StataCorp, College Station, TX, USA).

Results

Table 1 presents the percentages of stunted children in SSA countries stratified by sex, place of residence and birth intervals. More than one-third of children in SSA countries were reportedly stunted. The leading countries include Burundi (55.9%), Madagascar (50.1%), Niger (43.9%), Democratic Republic of the Congo (42.7%), Mozambique (42.6%) and Zambia (40.1%). The percentage of stunted children was higher among male than female children, except in São Tomé and Príncipe, and among rural than urban children in SSA countries. Also, there were differences in the percentages of children stunted by birth interval. Children having a birth interval of <24 mo had a higher percentage of stunting in SSA countries. Conversely, children with a birth interval ≥ 48 mo were the least stunted.

Table 2 shows that a total of 216 175 children were included in the study, with almost equal representation of males and females (50.3% vs 49.7%); 69.5% were rural residents, 97% were singleton birth type, 99.9% lived with their mothers, 76.0% were from a monogamous family type, 15.1% were classified as richest while up to 25.7% were classified as poorest. Furthermore, the table also reveals that about 26.2% of stunted children were from polygamous homes, whereas 73.8% were from monogamous homes. The bivariate analysis between stunted children and maternal, household and child characteristics showed significant associations. The percentage of stunted children among women currently in a union or living with a partner was highest (88.9%), while for women formerly in a union or living with a partner it was 6.7% and those never in union were reported were 4.4%. The percentages of stunted children was least among higher household wealth index, maternal education, urban residence, female child, birth interval ≥ 48 mo, fewer number of children ever born and singleton birth.

Results from multivariable logistic regression in **Table 3** show that children from a polygamous family and from mothers who had been in multiple unions had a 5% increase in stunting compared with children from monogamous families and mothers who had only one union (AOR 1.05 [95% CI 1.02 to 1.09]). Among mothers who were currently living elsewhere from their husband/partner, there was a 19% reduction in stunting compared with women who were currently residing with a partner (AOR 0.81 [95% CI 0.77 to 0.86]). Higher household wealth quintile, advanced maternal age and educated mothers had a significant reduction in stunted children compared with children from a low

Table 1. Distribution of children stunted in SSA countries; DHS 2008–2018

Country	Survey year	Sample size	Children stunted								
			Total (%)	Sex (%)		Residence (%)		Birth interval (%)			
				Male	Female	Urban	Rural	First birth	<24 mo	24–47 mo	≥48 mo
Angola	2015/16	14 322	37.6	41.0	34.1	31.8	45.7	35.0	46.4	37.8	27.5
Benin	2017/18	13 589	32.2	35.1	29.1	27.5	35.5	31.8	35.6	32.9	24.3
Burkina-Faso	2010	15 044	34.6	36.8	32.3	21.3	37.3	35.3	40.2	35.8	27.1
Burundi	2016/17	13 192	55.9	59.4	52.4	27.8	58.8	55.0	55.9	58.1	49.3
Cameroon	2011	11 732	32.5	35.1	30.0	21.9	40.5	25.5	39.2	34.7	26.5
Chad	2014/15	18 623	39.9	41.0	38.8	32.4	41.6	36.2	47.7	38.2	34.3
Comoros	2012	3149	30.1	32.0	28.3	24.9	32.1	29.7	38.0	27.8	23.0
Congo	2011/12	9329	24.4	25.1	23.7	20.3	30.4	22.5	32.9	25.6	16.3
Côte d'Ivoire	2011/12	7776	29.8	32.7	26.9	20.5	34.9	32.6	32.1	30.6	25.0
Democratic Republic of the Congo	2013/14	18 716	42.7	45.2	40.2	32.5	47.1	41.2	48.4	42.4	34.7
Ethiopia	2016	10 641	38.4	41.3	35.3	25.4	39.9	36.3	45.3	38.7	35.4
Gambia	2013	8088	24.5	26.2	22.7	19.2	28.5	24.4	26.1	25.1	20.6
Gabon	2012	6067	16.5	19.0	13.9	14.1	28.5	14.8	18.0	20.0	11.3
Ghana	2014	5884	18.8	20.4	17.0	14.8	22.1	16.9	28.7	18.9	14.3
Guinea	2012	7039	31.2	32.7	29.6	17.5	35.9	29.2	42.0	32.4	25.5
Kenya	2014	20 964	26.0	29.7	22.3	19.8	29.1	21.8	32.6	29.6	21.0
Lesotho	2014	3138	33.2	38.8	28.1	27.3	35.1	30.9	46.9	39.0	25.4
Liberia	2013	7606	31.6	34.0	28.8	30.0	33.3	28.4	39.5	32.7	23.4
Madagascar	2008/09	12 448	50.1	52.9	47.3	43.4	50.9	47.6	59.7	50.4	44.7
Malawi	2015/16	17 286	37.1	39.0	35.4	25.0	38.9	36.5	44.4	36.8	34.1
Mali	2012/13	10 326	38.3	39.8	36.6	23.2	41.9	35.7	50.1	37.4	32.9
Mozambique	2011	11 102	42.6	44.7	40.5	35.0	45.5	46.3	45.5	43.6	36.0
Namibia	2013	5,046	23.7	26.5	20.9	16.7	27.8	21.7	22.8	25.9	19.0
Niger	2012	12 558	43.9	45.8	41.9	29.6	45.9	44.6	51.1	41.7	35.6
Nigeria	2013	31 482	36.8	38.6	35.0	26.0	43.2	33.3	41.4	38.0	31.8
Rwanda	2014/15	7856	37.9	42.7	32.9	23.7	40.6	34.7	38.7	40.3	36.8
São Tomé and Príncipe	2008/09	1931	29.3	29.1	29.5	29.3	29.3	27.5	38.0	32.0	25.7
Senegal	2017	12 185	16.5	18.0	15.0	10.2	20.2	14.1	22.2	17.9	12.0
Sierra Leone	2013	11 938	37.9	38.9	36.9	29.6	40.3	33.8	45.6	39.7	34.1
South Africa	2016	3548	27.4	29.8	25.0	25.7	29.2	24.0	27.1	31.0	26.6
Tanzania	2015/16	10 233	34.4	36.7	32.2	24.7	37.8	33.7	35.5	36.8	28.9
Togo	2013/14	6979	27.5	28.1	26.9	16.0	33.3	24.8	35.6	28.4	21.5
Uganda	2016	15 522	28.9	30.9	26.9	23.5	30.2	28.0	32.5	28.8	21.5
Zambia	2013/14	13 457	40.1	42.4	37.6	36.0	42.1	40.0	46.1	40.5	34.4
Zimbabwe	2015	6132	26.8	29.6	24.0	22.1	28.5	24.3	27.3	31.9	21.3

household wealth quintile, low maternal age and mothers with no formal education. Furthermore, rural children were 1.23 times as likely to be stunted compared with urban children (OR 1.23 [95% CI 1.16 to 1.29]). Female children had an 18% reduction in stunting compared with their male counterparts (OR 0.82 [95% CI 0.80 to 0.84]). Although first babies were generally smaller than other babies, this study also revealed that children with a <24-mo birth interval were 1.32 times as likely to be stunted com-

pared with first births (OR 1.32 [95% CI 1.26 to 1.38]); conversely, children with a ≥48-mo birth interval had a 12% reduction in stunting compared with first births (OR 0.88 [95% CI 0.84 to 0.93]). In addition, an increasing positive significant association of 2% in stunted children was observed with every unit increase in the child's age (mo) (OR 1.02 [95% CI 1.01 to 1.02]). Multiple-birth children were 2.09 times as likely to be stunted compared with a singleton (OR 2.09 [95% CI 1.91 to 2.28]).

Table 2. Association between sociodemographic characteristics and stunted children

Variable	Total, n (%)	Children stunted, n (%)		p-Value
		Yes	No	
Household headship				<0.001*
Male	171 324 (79.3)	59 194 (80.3)	112 130 (78.7)	
Female	44 851 (20.7)	14 557 (19.7)	30 294 (21.3)	
Family type				<0.001*
Monogamous	137 528 (76.0)	46 174 (73.8)	91 354 (77.1)	
Polygamous	43 473 (24.0)	16 363 (26.2)	27 110 (22.9)	
Marital status of mothers				<0.001*
Never in union	10 923 (5.1)	3267 (4.4)	7656 (5.4)	
Currently in union/living with a man	191 872 (88.8)	65 547 (88.9)	126 325 (88.7)	
Formerly in union/living with a man	13 378 (6.2)	4936 (6.7)	8442 (5.9)	
Number of unions				<0.001*
One	177 297 (86.7)	60 547 (86.3)	116 750 (87.0)	
More than one	27 095 (13.3)	9 592 (13.7)	17 503 (13.0)	
Currently residing with husband/partner				<0.001*
Living with her	156 750 (85.6)	55 055 (87.3)	101 695 (84.8)	
Staying elsewhere	26 291 (14.4)	8 031 (12.7)	18 260 (15.2)	
Household wealth quintiles				<0.001*
Poorest	55 577 (25.7)	22 749 (30.9)	32 828 (23.1)	
Poorer	47 245 (21.9)	18 172 (24.6)	29 073 (20.4)	
Middle	42 207 (19.5)	14 676 (19.9)	27 531 (19.3)	
Richer	38 413 (17.8)	11 461 (15.5)	26 952 (18.9)	
Richest	32 733 (15.1)	6693 (9.1)	26 040 (18.3)	
Mother's education level				<0.001*
No formal education	87 956 (40.7)	34 707 (47.1)	53 249 (37.4)	
Primary	76 143 (35.2)	26 982 (36.6)	49 161 (34.5)	
Secondary	45 949 (21.3)	11 310 (15.3)	34 639 (24.3)	
Higher	6101 (2.8)	744 (1.0)	5357 (3.8)	
Place of residence				<0.001*
Urban	65 896 (30.5)	16 814 (22.8)	49 082 (34.5)	
Rural	150 279 (69.5)	56 937 (77.2)	93 342 (65.5)	
Maternal age (y)				<0.001*
15–19	12 851 (5.9)	4409 (6.0)	8442 (5.9)	
20–24	47 131 (21.8)	16 556 (22.5)	30 575 (21.5)	
25–29	59 371 (27.5)	20 016 (27.1)	39 355 (27.6)	
30–34	45 763 (21.2)	15 161 (20.6)	30 602 (21.5)	
35–39	31 568 (14.6)	10 621 (14.4)	20 947 (14.7)	
40–44	14 910 (6.9)	5322 (7.2)	9588 (6.7)	
45–49	4581 (2.1)	1666 (2.3)	2915 (2.1)	
Sex of child				<0.001*
Male	108 729 (50.3)	39 501 (53.6)	69 228 (48.6)	
Female	107 446 (49.7)	34 250 (46.4)	73 196 (51.4)	
Birth interval (mo)				<0.001*
First birth	44 804 (20.7)	14 344 (19.5)	30 460 (21.4)	
<24	31 074 (14.4)	12 869 (17.5)	18 205 (12.8)	
24–47	98 521 (45.6)	34 948 (47.4)	63 573 (44.64)	
≥48	41 776 (19.3)	11 590 (15.7)	30 186 (21.2)	
Child lives with whom				0.001*
Mother	215 944 (99.9)	73 696 (99.9)	142 248 (99.9)	
Lives elsewhere	231 (0.1)	55 (0.1)	176 (0.1)	

Continued

Table 2. Continued

Variable	Total, n (%)	Children stunted, n (%)		p-Value
		Yes	No	
Birth order				<0.001*
First	44 409 (20.5)	14 159 (19.2)	30 250 (21.2)	
Second	40 520 (18.7)	12 923 (17.5)	27 597 (19.4)	
Third	34 599 (16.0)	11 441 (15.5)	23 158 (16.3)	
Fourth	28 346 (13.1)	9848 (13.4)	18 498 (13.0)	
Fifth	22 206 (10.3)	8106 (11.0)	14 100 (9.9)	
Sixth and above	17 274 (23.4)	17 274 (23.4)	28 821 (20.2)	
Age of child (mo), mean \pm SD	216 175	31.5 \pm 15.4 ^a	27.1 \pm 17.9 ^b	<0.001*
Total children ever born				<0.001*
1–2	70 786 (32.7)	21 829 (29.6)	48 957 (34.4)	
3–4	67 286 (31.1)	22 566 (30.6)	44 720 (31.4)	
\geq 5	78 103 (36.1)	29 356 (39.8)	48 747 (34.2)	
Birth type				<0.001*
Singleton	209 606 (97.0)	70 537 (95.6)	139 069 (97.4)	
Multiple	6569 (3.0)	3214 (4.4)	3355 (2.4)	

*Significant at $p < 0.05$.

^a73 751 observations.

^b142 424 observations.

Discussion

This study explored the prevalence and determinants of childhood stunting in SSA countries. The study used secondary data involving birth histories from the DHS conducted between 2008 and 2018 across 35 SSA countries. While the time lag in the years data were collected in different countries might cause some issues with the risk factors, the major strength of the study is the use of multicountry nationally representative data, which permits generalisation of the findings in the SSA region. In total, 384 928 children were born within the 5 y before the surveys were collected. Stunting is a key indicator of a chronic type of undernutrition among children.^{23,24} The findings have provided insights into the large disparities of stunted children across SSA countries, with a minimum prevalence for Gabon and Senegal of slightly less than one-fifth and a maximum from Burundi, followed by Madagascar, where approximately half of the children were stunted. This is consistent with reports from previous studies on the prevalence of childhood stunting in SSA countries.^{25–28} In some countries these prevalences are higher than the WHO cut-off point of 40% set for stunting.¹³ The high prevalence of stunted children could be because children in poor-resource settings are highly vulnerable to impaired physical growth because of repeated infections, a lack of appropriate care and, most importantly, poor dietary intake.²⁸ The high level of poverty in the SSA region prevents children from getting adequate nutrition, hence the high prevalence of stunting.

The determinants of childhood stunting identified in this study were male sex, older age of the child and multiple births (such as twins, triplets, quadruplets and so forth). In this study, children

from multiple births had a higher risk of stunting compared to a singleton. In line with reports from previous studies, children from multiple births have challenges including growth and development.^{29,30} The effects of intrauterine growth retardation and discordancy at birth on the incidence and severity of stunting can cause discordancy in the height and weight of children from multiple births. Multiple births are well known to be associated with birth defects, low birthweight, premature birth and cerebral palsy,^{31–33} which can hinder the growth of a child. In line with reports from previous studies, male sex was positively associated with stunting.^{30,34,35} Also, stunting reportedly increased with the age of children.^{28,36} This could be a result of the nutritional status of mothers or caregivers through poor weaning and dietary practices, lower and inappropriate breast and complementary feeding practices, and food insecurity and poverty. Other probable explanations for increased risk of stunting in older children could be poor access to safe drinking water and unhygienic preparation of foods that may expose children to different kinds of infections and diarrhoeal diseases, which can increase the occurrence of chronic malnutrition.³⁷

Notably, the study identified polygamy (father having multiple wives) and the mother's involvement in multiple unions as risk factors of childhood stunting. Generally, involvement in multiple unions can lead to an increase in family size.³⁸ Large family size can increase the odds of stunting, especially in disadvantaged households, which are common in rural settings.^{39,40} This is confirmed by our finding that rural residence is a significant factor in childhood stunting. For example, children from families with more members will have a higher risk of being stunted compared with children from smaller families, due to food insecurity. In a

Table 3. Multivariate analysis of factors associated with stunted children

Variable	Adjusted OR	p-Value	95% CI
Household headship			
Male	1.00		
Female	1.02	0.535	0.97 to 1.07
Family type			
Monogamous	1.00		
Polygamous	1.05	0.005	1.02 to 1.09*
Marital status for mothers			
Never in union	1.00		
Currently in union/living with a man	NA		
Formerly in union/living with a man			
Number of unions			
One	1.00		
More than one	1.05	0.024	1.01 to 1.09*
Currently residing with husband/partner			
Living with her	1.00		
Staying elsewhere	0.81	<0.001	0.77 to 0.86*
Household wealth quintiles			
Poorest	1.00		
Poorer	0.90	<0.001	0.86 to 0.94*
Middle	0.80	<0.001	0.76 to 0.83*
Richer	0.69	<0.001	0.65 to 0.73*
Richest	0.51	<0.001	0.47 to 0.54*
Mother's education level			
No formal education	1.00		
Primary	0.91	<0.001	0.88 to 0.94*
Secondary	0.67	<0.001	0.64 to 0.71*
Higher	0.39	<0.001	0.34 to 0.45*
Place of residence			
Urban	1.00		
Rural	1.23	<0.001	1.16 to 1.29*
Maternal age (y)			
15–19	1.00		
20–24	0.89	<0.001	0.83 to 0.95*
25–29	0.75	<0.001	0.70 to 0.80*
30–34	0.72	<0.001	0.67 to 0.77*
35–39	0.71	<0.001	0.66 to 0.76*
40–44	0.72	<0.001	0.66 to 0.78*
45–49	0.66	<0.001	0.59 to 0.74*
Sex of child			
Male	1.00		
Female	0.82	<0.001	0.80 to 0.84*
Birth interval (mo)			
First birth	1.00		
<24	1.32	<0.001	1.26 to 1.38*
24–47	1.09	<0.001	1.05 to 1.14*
≥48	0.88	<0.001	0.84 to 0.93*
Child lives with whom			
Mother	1.00		
Elsewhere	0.48	0.003	0.30 to 0.78*
Age of child (mo)	1.02	<0.001	1.01 to 1.02*
Birth type			
Singleton	1.00		
Multiple	2.09	<0.001	1.91 to 2.28*

NA: not estimated.

*Significant at 0.05.

previous study, children whose mothers gave birth to more than four children had a higher risk of been stunted compared with children whose mothers gave birth to one child.⁴¹ Families with more children have a higher economic demand in providing the daily nutrition requirements for proper child growth and physical development. The implication is that as the size of a family increases, there is a scarcity of resources for household consumption, particularly food, that could lead to stunted growth. Worse still, parents with many children commonly lack sufficient time to pay proper attention to the needs of each child. This can also be the case for single mothers or mothers who are not currently living with their partners. Being the only parent, they have to provide for the needs of all the children. An inability to do this may have adverse effects on the children and also increase the odds of stunting.

Based on our findings, maternal education and improved household wealth are key factors that enabled women to provide appropriate childcare with regard to growth and child feeding practices. Attainment of primary, secondary and tertiary education of the mother as well as a higher household wealth quintile were observed to ameliorate the effect of stunting among SSA children. This is consistent with reports from a previous study.^{28,42} Improved socio-economic status has an influence on providing adequate nutrition and quality healthcare for children. When mothers are educated, they are more likely to be knowledgeable in childcare and appropriate nutritional requirements. In addition, long interpregnancy birth interval and advanced maternal age were identified as protective factors of stunting. A study on child nutrition outcomes reported that a longer birth interval was associated with a lower risk of malnutrition.⁴³ Also, the positive impact of advanced maternal age is certainly notable in childcare. Older mothers could have more experience in ways to nurture children in a healthy manner. A previous study reported the adverse effect of young maternal age on child growth.⁴⁴ Young maternal age has numerous negative effects, including poor growth outcomes among children.

Strengths and limitations

This study has a huge strength in the DHS sampling method and the study was conducted among children in an age group that has the potential for catch-up growth and therefore could benefit from targeted interventions. The assessment of diverse factors such as individual, family and community correlates that influence stunting is an added advantage. However, estimating the effect of stunting attributable to various factors does not in itself establish causality. Nonetheless, because factors were added for which there is evidence of association with stunting, the relationships determined can be interpreted as our current best estimates of their causal effect. The use of a cross-sectional design makes it difficult to examine any potential temporal relationships. Also, the study was based on DHS data, and more variables could have been included in the analysis, such as the quality, quantity and frequency of food intake. Again, most children's data in DHS are self-reported by primary caregivers, and this could be subject to recall bias. In addition, DHS surveys were conducted over a period of about 10 y in different countries (i.e. 2008–2018), so comparison of findings from different surveys should be done with caution.

Conclusions

In conclusion, the prevalence and determinants of childhood stunting have been examined extensively in this study, using nationally representative survey data from several SSA countries. Based on the findings from this study, preventing childhood stunting should have priority in policy, programme and advocacy interventions in the region. In addition, there should be coordinated attention given to the implementation of evidence-based policies and programmes designed to improve the nutrition plan for children. The analyses have provided a holistic view of the prevalence and determinants of childhood stunting in SSA for policymakers to target populations with relevant intervention programmes. More than one-third of children in SSA countries were stunted, with Burundi (55.9%) and Madagascar (50.1%) taking the lead. The percentage of stunted children was higher among male children than female children, except in São Tomé and Príncipe, and also among rural children compared with their urban counterparts. Also, variations in stunting by birth intervals were also noted. The determinants of childhood stunting to be targeted for appropriate intervention programmes include male sex, increasing child age, maternal education, improved household wealth, longer birth interval, advanced maternal age, multiple births (twins, triplets, quadruplets and so forth) and history of mother's involvement in multiple unions. The existing policies regarding childhood stunting control should be strengthened, with a particular focus on these factors. Effective intervention policies and programmes are required to reduce childhood malnutrition and mitigate childhood malnutrition risk factors.

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