Original Article

Birth Spacing and Undernutrition among Children Under Five Years in Rwanda: A Secondary Data Analysis of RDHS 2019/2020

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Abstract

Background
Short birth intervals have been linked with increased childhood undernutrition, yet evidence in Rwanda remains limited. Using data from the 2019/2020 Rwanda Demographic and Health Survey (RDHS), this study assessed the association between birth spacing and undernutrition among children under five years.

Methods
This cross-sectional study utilized weighted data from 3,815 children under five from the 2019/2020 RDHS. Undernutrition was defined as either stunting, underweight, or wasting. Birth spacing was categorized as short (<24 months), intermediate (24 – 35 months), and optimal (≥36 months) and multivariable model was used to examine the association.

Results
The prevalence of undernutrition was 34.1%, and most (69.1%) had a birth interval ≥ 36 months. After adjusting for confounders, optimal birth spacing was associated with lower odds of undernutrition (AOR: 0.8; 95% CI: 0.6–0.9, p = 0.034). In addition, undernutrition was significantly associated with children from poor households, children of mothers with no education or primary education, and male children, while children of married or cohabiting mothers had lower odds of undernutrition.

Conclusion
Optimal birth spacing is associated with lower odds of child undernutrition. Public health policies should strengthen access and utilization of family planning services, maternal education, and socioeconomic support to enhance child nutrition outcomes.

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Keywords: Birth spacing, Undernutrition, Children under five years, Rwanda

Background

Child undernutrition remains a major global public health challenge and a leading cause of morbidity and mortality among children under five years of age.[1] Undernutrition is a condition resulting from insufficient intake of energy and essential nutrients, including quality proteins, vitamins, and minerals, preventing the body from meeting its needs for growth, maintenance, and normal functioning.[2]

Globally, approximately 148 million children under five years are stunted, 45 million are wasted, and 37 million are overweight.[3] In Sub-Saharan Africa, nearly one-third of children under five suffer from chronic undernutrition, making the region one of the most affected globally.[4] Undernutrition that manifests as stunting, wasting, and underweight remains the most common form in low- and middle-income countries.[5] This childhood undernutrition contributes to impaired growth, poor cognitive and educational outcomes, weakened immunity, and increased mortality risk.[1] Several factors contribute to childhood undernutrition, including household poverty, low maternal education, inadequate infant feeding practices, recurrent infections, poor sanitation, food insecurity, and poor maternal nutritional status.[6,7] Besides, birth spacing has increasingly emerged as an important reproductive health factor influencing child nutritional outcomes.[8,9]

Birth spacing, also referred to as the interbirth interval, is the duration between two consecutive live births.[10] Adequate birth spacing of three to five years is recognized as a key intervention for improving maternal and child health outcomes compared to intervals of 2 years or less.[11,12] The World Health Organization (WHO) recommends waiting at least 24 months after a live birth before attempting another pregnancy, or 33 months before the next delivery, to reduce adverse maternal, perinatal, and child health outcomes.[13,14] In addition, optimal birth intervals, defined as 36 months and above, have been associated with reduced risks of undernutrition among children under five.[13,15]

The relationship between birth spacing and child undernutrition is biologically and socially plausible.[16] Short birth intervals (<24 months) may limit maternal nutritional recovery, resulting in maternal depletion, poor fetal growth, low birth weight, and inadequate breastfeeding practices.[17] Short intervals between births can increase competition for food, healthcare, caregiver attention, and financial resources, negatively affecting child growth and nutrition.[18] Children born after short birth intervals are at higher risk of infections, low birth weight, growth failure, and poor nutritional outcomes.[19]

Existing research indicates that spacing births by at least 36 months can lower the risk of stunting by 10% to 50%, while intervals shorter than 24 months are associated with a heightened risk.[8,20] Similarly, birth intervals under 36 months substantially increase stunting vulnerability compared to a 36-to-59-month gap.[24] Furthermore, closely spaced pregnancies can deplete maternal nutrient stores, potentially leading to intrauterine growth restriction and diminished nutrient availability and reserves for the newborn.[8]

In Rwanda, childhood undernutrition remains a significant public health concern, with the 2019/2020 RDHS reporting that 33% of children under five are stunted, 8% are underweight, and 1% are wasted.[21] Despite ongoing interventions, these levels remain high, and short birth intervals have been suggested as a factor in poor child nutritional outcomes.[22] However, limited context-specific evidence exists on the independent association between birth spacing and child nutritional outcomes in Rwanda. This gap in evidence limits the capacity of policymakers and health practitioners in Rwanda to integrate optimal birth spacing more deliberately into child nutrition and broader maternal and child health programs. In response, this study seeks to generate nationally representative evidence on the relationship between birth spacing and undernutrition among children under five years using data from the 2019–2020 Rwanda Demographic and Health Survey (RDHS).

Despite being an important risk factor, the duration between successive live births has often been overlooked. Recent findings from 34 sub-Saharan nations show a strong link between short intervals (under 24 months) and childhood undernutrition, alongside a 57% increase in infant mortality risk.[15] Various reviews and studies confirm that tightly spaced pregnancies negatively impact both maternal and child nutritional health.[16] Nevertheless, the precise impact and extent to which extended birth intervals contribute to improved nutritional outcomes for children remain uncertain.

Therefore, this study aimed to (1) estimate the prevalence of undernutrition among children under five years in Rwanda; and (2) examine whether birth spacing is associated with undernutrition, while accounting for other relevant child, maternal, household, and contextual factors captured in the RDHS 2019–2020 dataset. The findings are expected to inform evidence-based policies and targeted interventions that jointly address family planning, birth spacing, and child nutrition to improve child health outcomes in Rwanda.

Methods

Study design and population

The study utilized secondary data from the Rwanda Demographic and Health Survey (RDHS) 2019/2020, a nationally representative cross-sectional survey. The population of interest included children under five years of age recorded in the survey.

Sample size and sampling procedure

The 2019-2020 RDHS survey employed a two-stage stratified sampling method to ensure national representativeness for key indicators. In the first stage, clusters composed of enumeration areas (EAs) were selected, with a total of 500 clusters, including 112 in urban areas and 388 in rural areas. In the second stage, households were systematically sampled from June to August 2019 within each cluster, with 26 households chosen per cluster, resulting in a total sample of 13,000 households.

The RDHS collected data on a wide range of health indicators, including maternal and child health, through face-to-face interviews conducted by trained field workers using structured questionnaires. Information on child health and birth history was obtained from mothers or caregivers. In addition, anthropometric measurements, including height and weight of children under five, were taken using standardized procedures to assess nutritional status.

This study used the Kids Recode (KR) dataset, which contains detailed information on children under five years. A total of 8,092 children were identified. After data cleaning and handling missing values, a total of 3815 children remained. Sampling weights were applied during analysis to account for the complex survey design and ensure representativeness at the national level.

Study variables and measurements

Dependent (Outcome) variables

The outcome variable for this study was undernutrition among children under five years of age. Undernutrition was assessed using anthropometric indicators derived from the RDHS 2019/2020 dataset, based on the WHO child growth standards. These included stunting (height-for-age), wasting (weight-for-height), and underweight (weight-for-age), expressed as z-scores.[23] Children were classified as stunted, wasted, or underweight if their respective z-scores were below minus two standard deviations (< -2 SD) from the WHO reference median. A composite binary outcome variable was then created. Children who were either stunted, wasted, or underweight were classified as undernourished and coded “1”, while children who did not fall into any of these categories were classified as not undernourished and coded “0”.

Independent (Explanatory) variables

The key independent variable was birth spacing which was defined as preceding birth interval and calculated as the difference in months between current birth and the previous birth, counting twins as one birth. Birth interval was categorized into three groups: short (<24 months), intermediate (24 – 35 months), and optimal (≥36 months).[13,15] The study also explored factors influencing undernutrition in children under five years, including maternal characteristics such as age, education, Body Mass Index (BMI) (calculated as weight(kg)/ Height(m)2), marital status, residence, region ANC visit, and child related factors such as sex, age, birth weight (recorded from health cards), breastfeeding duration, and household wealth assessed using the DHS wealth index, where principal component of household assets and characteristics are analyzed and categorized into five quintiles i.e. poorest to richest.

Analysis and data processing

The RDHS 2019/2020 data were analyzed using STATA version 17. The dataset was checked for missing values, duplicates, and outliers, and inconsistencies were resolved using RDHS coding manuals. Records with missing data on the outcome variable (undernutrition status) were excluded from the analysis to ensure the validity of the outcome measurement. A total of 4,277 records were excluded on this basis.

To account for the complex, multi-stage stratified cluster sampling design of the DHS and ensure nationally representative estimates, all statistical analyses were executed using complex survey estimation commands (svy) in Stata. The data were then adjusted by applying the calculated sample weights (v005/1,000,000), accounting for intra-cluster correlation within the Primary Sampling Units (v021), and accounting for the complex stratification design (v023). This rigorous adjustment ensured that the calculated standard errors, 95% confidence intervals, and adjusted odds ratios (AOR) were appropriately adjusted for potential design effects. The study used descriptive statistics to summarize the prevalence of undernutrition and the characteristics of mothers and children. Bivariate logistic regression was conducted to assess the crude association between each independent variable and undernutrition among children under five years. Variables which were literarily and theoretically relevant were then included in the multivariable logistic regression model to control for potential confounding.

Multicollinearity among independent variables was assessed using the Variance Inflation Factor (VIF), with a threshold of 10. In cases of multicollinearity, only one variable from each correlated pair was included in the final model based on conceptual relevance. Consequently, maternal education and breastfeeding practices were retained in the final model.

Ethical consideration

The dataset used in this study is publicly available through the DHS Program database.[24] These were ethically approved surveys whose protocols had been reviewed and approved by the relevant national ethics committees in each participating country and by the ICF Institutional Review Board. All surveys were conducted in accordance with established ethical standards; consequently, no further institutional ethical approval was required for this analysis.

Results

Sociodemographic characteristics of mothers and their children

Most participants resided in rural areas (83.3%). Nearly half of the mothers were aged 25-34 years (49.3%), and the majority had primary education (64.9%). Most mothers had normal BMI (67.0%), and 43.4% of households were classified as poor.

Approximately half of the mothers (50.1%) attended at least three antenatal care visits. Child characteristics showed a nearly equal sex distribution, with 37.8% aged above 36 months (Table 1).

Table 1. Sociodemographic characteristics of mothers and their children

Variables	Frequency (%)
Region	
Kigali	540 (13.7)
South	788 (20.1)
West	955 (24.3)
North	598 (15.2)
East	1043 (26.6)
Residence	
Urban	656 (16.7)
Rural	3267 (83.3)
Women's age in years	
15-24	595 (15.2)
25-34	1934 (49.3)
35-49	1394 (35.5)
Mother's education	
No education	472 (12.0)
Primary	2535 (64.9)
Secondary	749 (19.1)
Higher education	157 (4.0)
Mother's BMI	
Underweight	131 (3.3)
Normal weight	2630 (67.0)
Overweight	887 (22.6)
Obesity	276 (7.0)
Marital status	
Single	325 (8.3)
Married/cohabiting	3284 (83.7)
Others	315 (8.02)
Wealth status	
Poor	1703 (43.4)
Middle	758 19.3
Rich	1463 (37.3)

Table 1.Continued

Variables	Frequency (%)
ANC visit during pregnancy	
No visit	70 (1.78)
1 visit	130 (3.3)
2 visits	365 (9.3)
3 visits	1966 (50.1)
Above 3 visits	1393 (35.5)
Sex of child	
Male	1963 (50.0)
Female	1960 (49.9)
Child age	
Under 6 months	397 (10.1)
6-23 months	1246 (31.7)
24-35 months	798 (20.3)
Above 36 months	1483 (37.8)
Birth weight	
< 2.5 kg	220 (5.6)
2.5-4 kg	3194 (81.4)
>4kg	509 (12.9)
Breast feeding status	
< 6 months	389 (9.9)
6-24 months	3252 (82.9)
> 25 months	283 (7.2)
Stunting	
Yes	1294 (32.9)
No	2630 (67.1)
Underweight	
Yes	294 (7.5)
No	3630 (92.5)
Wasting	
Yes	45 (1.2)
No	3878 (98.8)

Prevalence of birth spacing and undernutrition

The prevalence of undernutrition among children under five was 34.1%. Most children (69.1%) were born after a birth interval greater than or equal to 36 months (Table 2).

Table 2. Prevalence of birth spacing and undernutrition

Variables	Frequency (%)
Birth spacing	
< 24 months	425 (10.8)
24-35 months	786 (20.1)
≥ 36 months	2712 (69.1)
Nutrition status	
Undernourished	1339 (34.1)
Not undernourished	2585 (65.9)

Association between undernutrition and independent variables among children under five years

Optimal birth interval (≥ 36 months) was associated with lower odds of undernutrition among children after adjustment for confounding factors (AOR = 0.8, 95% CI: 0.6–0.9, p = 0.034). In addition, the odds of undernutrition were significantly higher among children from poor household (AOR = 1.6, 95% CI: 1.3-1.9, P<0.001) as well as children whose mothers had no education (AOR = 3.5, 95% CI: 1.5-7.7, P=0.003), and only primary education (AOR = 2.9, 95% CI: 1.3-6.2, P=0.008). Male children had higher odds of undernutrition than their female counterparts (AOR = 1.5; 95% CI: 1.3–1.8; p < 0.001). Conversely, children having a married or cohabiting mother was associated with lower odds of undernutrition (AOR = 0.7; 95% CI: 0.5 – 0.9; p = 0.003) (Table 3).

Table 3. Association between undernutrition and independent variables among children under five years

Variables	Undernourished, n (%)	Bivariate analysis			Multivariate analysis		
		COR	95% CI	p value	AOR	95% CI	p value
Birth spacing							
< 24 months	144 (10.9)	Ref			Ref		
24-35 months	310 (23.6)	1.1	(0.9-1.5)	0.380	0.9	(0.7-1.3)	0.972
≥ 36 months	860 (65.4)	0.8	(0.6-1.0)	0.078	0.8	(0.6-0.9)	**0.034**
Women's age in years							
15-24	173 (13.2)	Ref			Ref		
25-34	635 (48.3)	1.1	(0.9-1.4)	0.311	1.2	(0.9-1.5)	0.215
35-49	506 (38.5)	1.3	(1.0-1.6)	0.022	1.3	(0.9-1.7)	**0.050**
Mother's education							
No education	214 (16.3)	8.6	(3.9-18.9)	<0.001	3.5	(1.5-7.7)	**0.003**
Primary	907 (69.0)	5.9	(2.7-12.5)	<0.001	2.9	(1.3-6.2)	**0.008**
Secondary	180 (13.7)	3.5	(1.6-7.6)	0.002	2.4	(1.0-5.4)	**0.030**
Higher	13 (0.9)	Ref			Ref		
Mothers BMI							
Underweight	55 (4.2)	Ref			Ref		
Normal weight	963 (73.3)	0.8	(0.5-1.2)	0.285	0.9	(0.6 -1.5)	0.882
Overweight	244 (18.6)	0.5	(0.4-0.8)	0.004	0.9	(0.6-1.4)	0.642
Obesity	52 (3.9)	0.3	(0.2-0.6)	<0.001	0.8	(0.4-1.5)	0.503
Marital status							
Single	121 (9.2)	0.7	(0.5-1.1)	0.104	0.9	(0.6-1.3)	0.667
Married/cohabiting	1060(80.9)	0.6	(0.5-0.9)	0.002	0.7	(0.5-0.9)	**0.003**
Divorced/separated	133 (10.1)	Ref			Ref		

COR: Crude Odds Ratio, CI: Confidence interval and AOR: Adjusted Odds Ratio

Table 3. Continued

Variables	Undernourished, n (%)	Bivariate analysis			Multivariate analysis		
		COR	95% CI	p value	AOR	95% CI	p value
Household wealth							
Poor	779 (59.3)	1.7	(1.3-2.0)	<0.001	1.6	(1.3-1.9)	**<0.001**
Middle	245 (18.6)	Ref			Ref		
Rich	290 (22.1)	0.5	(0.4-0.7)	<0.001	0.7	(0.5-0.9)	**0.002**
Residence							
Rural	1143 (86.9)	2.1	(1.7-2.7)	<0.001	1.3	(0.9-1.7)	0.053
Urban	171 (13.0)	Ref			Ref		
Region							
Kigali	99 (7.5)	Ref			Ref		
South	295 (22.4)	1.6	(1.2-2.2)	0.003	0.8	(0.5-1.1)	0.198
West	390 (29.6)	2.2	(1.6-2.9)	<0.001	1.2	(0.8-1.7)	0.330
North	249 (18.9)	2.9	(1.6-3.2)	<0.001	1.2	(0.8-1.8)	0.291
East	281 (21.4)	1.4	(1.0-1.8)	0.036	0.7	(0.5-1.1)	0.142
Sex of child							
Male	737 (56.1)	1.4	(1.3-1.7)	<0.001	1.5	(1.3-1.8)	**<0.001**
Female	577 (43.9)	Ref			Ref		
Birth weight							
< 2.5 kg	133 (10.1)	Ref			Ref		
2.5-4 kg	1063(80.9)	0.3	(0.2-0.5)	<0.001	0.3	(0.2-0.5)	**<0.001**
>4kg	118 (8.9)	0.2	(0.2-0.3)	<0.001	0.2	(0.1- 0.3)	**<0.001**
Breastfeeding							
< 6 months	67 (5.1)	0.2	(0.2-0.4)	<0.001	0.3	(0.2-0.4)	**<0.001**
6-24 months	1120 (85.2)	0.7	(0.5-0.9)	0.003	0.8	(0.6-1.0)	0.061
>25 months	127 (9.7)	Ref			Ref		

COR: Crude Odds Ratio, CI: Confidence interval and AOR: Adjusted Odds Ratio

Discussion

This study determined the estimated prevalence of undernutrition and examined its association with birth spacing and other factors among children under five years in Rwanda. The findings revealed that, in addition to birth spacing, maternal education, household wealth status, marital status, child sex, and birth weight were independently associated with undernutrition. This section discusses these findings in relation to previous studies and existing literature and highlights their implications for interventions aimed at improving child nutritional status and reducing the burden of undernutrition among children under five in Rwanda.

The study showed that the estimated prevalence of undernutrition among children under five years was 34.1%, which indicates a substantial public health burden, because it means about one in three under-five children is affected by at least one form of anthropometric failure: stunting, wasting, or underweight, which remains consistent with the persistent burden reported nationally and across several districts in Rwanda.[6,25] This finding is also consistent with broader evidence from Africa and low-income countries showing that undernutrition remains highly prevalent, with Africa bearing some of the world's highest burdens and progress remaining uneven across settings.[26] In Rwanda, this burden is repeatedly linked to poverty, maternal nutrition, low birth weight, infection, poor water and sanitation, and limited dietary quality, all of which interact across the child's first two years of life and beyond.[25] Undernutrition is associated with increased child morbidity, mortality, impaired cognitive development, and reduced adult productivity.[6,25] Therefore, a 34.1% prevalence in Rwanda may not be interpreted as an isolated estimate, but as evidence that undernutrition remains entrenched and requires multisectoral interventions targeting household livelihoods, child feeding, and early-life health risks to reduce the burden sustainably.[25]

The findings also showed that optimal birth spacing (≥ 36 months) was associated with reduced odds of undernutrition. This is consistent with a broad body of evidence showing that short intervals between births increase the risk of stunting, underweight, and sometimes wasting, while intervals of 36 months and above appear to be the most protective range.[15,27] Studies from India, Bangladesh, El Salvador, Ghana, and Ethiopia similarly showed that children born after shorter intervals face higher odds of undernutrition, whereas spacing beyond 24 months and especially 36 months and above is linked to improved nutritional outcomes.[8,20,26,27] This can be explained by the fact that longer spacing gives mothers more time to recover nutritionally from the previous pregnancy and lactation, reduces the risk of low birth weight, and allows families to allocate more caregiving time, breastfeeding, and household resources to each child.[15,20]

However, the evidence is not fully uniform; one recent small hospital-based study from Pakistan found no significant association between preceding birth interval and undernutrition, and the study noted that associations vary across settings and may be partly affected by residual confounding such as breastfeeding practices, maternal height, and socioeconomic conditions.[12] Overall, the evidence supports the interpretation that optimal birth spacing is an important, modifiable factor associated with lower odds of childhood undernutrition, particularly stunting and underweight, and strengthens the rationale for integrating family planning with maternal and child nutrition programs.[15,20]

Maternal education was significantly associated with undernutrition among under-five children in Rwanda. Compared with the reference category, children of mothers with no education, primary education, and secondary education had 3.5, 2.9, and 2.4 times higher odds of undernutrition, respectively, indicating a clear inverse relationship between maternal education and child nutritional status. This finding is consistent with evidence from Rwanda, East Africa, and sub-Saharan Africa showing that children of less educated mothers are more vulnerable to undernutrition.[25] This can be explained by the fact that educated mothers are more likely to have better nutrition knowledge, greater use of health services, improved childcare and feeding practices, and stronger economic and decision-making capacity, all of which support better child growth outcomes.[12,19] Therefore, promoting female education and maternal health literacy remains important for improving child health and nutrition outcomes.[2]

Household wealth status was also a significant predictor of undernutrition. Children from wealthier households were less likely to be undernourished, while those from poorer households had higher odds of undernutrition. Similar findings have been reported in previous studies.[15,29] The observed association is plausible since families with greater financial resources are able to provide balanced diets, adequate healthcare, proper sanitation, and improved living conditions for their children.[29] In contrast, children from low-income households may experience food insecurity, limited healthcare access, and inadequate childcare practices, all of which increase the risk of undernutrition.[29]

These findings highlight the importance of strengthening poverty reduction strategies, improving household food security, and promoting equitable access to maternal and child healthcare services.

Marital status was also found to be significantly associated with undernutrition, with children born to married or cohabiting mothers having a lower risk of undernutrition compared to those born to unmarried mothers. This finding may be explained by the increased family stability, shared parental responsibilities, and improved emotional and financial support often present in partnered households, which can positively influence childcare practices and child nutrition.[10,15,29] The findings highlight the importance of strengthening social and family support systems as part of strategies aimed at improving child nutritional outcomes.

Furthermore, male children had a higher risk of undernutrition compared to female children, consistent with previous studies,[29] suggesting that male children may have higher nutritional requirements and may be more biologically vulnerable to undernutrition, particularly in resource-limited settings.[19] Cultural and caregiving differences may also contribute to this disparity in some communities. These findings highlight the need for targeted nutritional interventions and close monitoring of vulnerable child groups, especially in low-resource settings.

Finally, low birth weight was also identified as a predictor of undernutrition, consistent with findings from other developing countries.[15,29] Low birth weight is often associated with poor foetal growth, maternal undernutrition, and increased susceptibility to infections and growth failure during childhood. These findings emphasize the importance of improving maternal nutrition and antenatal care services to prevent low birth weight and subsequent undernutrition.

Overall, the findings suggest that reducing undernutrition among children under five years requires integrated interventions that promote optimal birth spacing, female education, household economic improvement, family support, and strengthened maternal and child health services.[2,6,8,10,12,18,25–29]

Strengths and limitations of the study

This study utilized Rwanda Demographic and Health Survey (DHS) data, which are large, standardized, and nationally representative, allowing for robust estimates and comparability across regions. However, several limitations should be considered when interpreting the findings. First, the cross-sectional design of the study limits the ability to establish causal relationships between the identified factors and undernutrition, as exposure and outcome are measured simultaneously.

Second, the analysis may be affected by residual confounding, as some relevant variables influencing child nutrition, such as dietary diversity, environmental sanitation, and detailed feeding practices, are not fully captured or adjusted for in the dataset. Third, potential measurement issues may have arisen from reliance on self-reported information, particularly for variables such as birth spacing and child-related characteristics, which are subject to recall or reporting bias.

In addition, although RDHS applies standardized data collection procedures, missing data and the way such missing values are handled in analysis may introduce bias. Despite these limitations, the study provides valuable nationally representative evidence on the prevalence of undernutrition, the associations between birth spacing and undernutrition, and the determinants of undernutrition among children under five. Future research should use longitudinal designs to establish causality and include detailed assessments of dietary, environmental, and healthcare factors to better understand determinants of child nutrition.

Conclusion

This study highlights the significant association between birth spacing and childhood undernutrition in Rwanda, demonstrating that longer birth intervals are associated with improved nutritional outcomes among children under five years. The findings underscore the importance of strengthening family planning services and policies that promote optimal birth spacing as part of broader strategies to improve child health and nutrition.

The study further suggests that reducing undernutrition requires integrated reproductive, maternal, newborn, and child health interventions, alongside efforts to address broader socioeconomic determinants. Policymakers and healthcare providers should strengthen access to family planning services, improve maternal and child healthcare, enhance nutrition education, and implement interventions to reduce poverty and improve household food security. Such comprehensive approaches are essential for sustainably reducing undernutrition and improving the health and well-being of children under five years in Rwanda.

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Authors' contribution
BE, AC, BJA, HJ, FP, GE, SC, and TJ contributed to the study's conceptualization, data collection, analysis, and initial manuscript drafting. NJ contributed to manuscript preparation and editorial refinement. MH provided overall guidance, supervision, referencing and critical revisions. All authors reviewed and approved the final version of the manuscript.

Conflict of interest
The authors declare that they have no competing interests.

Generative AI declaration
During the preparation of this manuscript, the authors used ChatGPT (OpenAI) to assist with language editing, including improving grammar, clarity, and readability. The authors reviewed and edited all AI-assisted content and take full responsibility for the manuscript's final content. Generative AI was not used for data collection, data analysis, or interpretation of the study findings.

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References

1. Mukeshimana M, Ntakirutimana T, Ishimwe Bazakare ML, Krantz G. Factors contributing to the persistence of undernutrition among children under 5 years of age in Rwanda: a community participatory qualitative study. *Glob Health Action.* 2025;18:2581454. doi:10.1080/16549716.2025.2581454
2. Martins VJB, Toledo Florêncio TMM, Grillo LP, Do Carmo P. Franco M, Martins PA, Clemente APG, et al. Long-Lasting Effects of Undernutrition. *IJERPH.* 2011;8:1817–46. doi:10.3390/ijerph8061817
3. World Health Organization, United Nations Children's Fund (UNICEF) & International Bank for Reconstruction and Development/The World Bank. Levels and trends in child malnutrition: UNICEF / WHO / World Bank Group joint child malnutrition estimates: key findings of the 2023 edition. *WHO.* 2023. https://iris.who.int/handle/10665/368038. Accessed 20 Aug 2025
4. World Bank Group. Stunting Reduction in Sub-Saharan Africa. *World Bank, Washington, DC.* 2017. https://hdl.handle.net/10986/29722 doi:10.1596/29722. Accessed 10 July 2026

5. Mertens A, Benjamin-Chung J, Colford JM, Hubbard AE, Van Der Laan MJ, Coyle J, et al. Child wasting and concurrent stunting in low- and middle-income countries. *Nature*. 2023;621:558–67. doi:10.1038/s41586-023-06480-z
6. Sunday FX, Ilinde DN, Izabayo Rudatinya P, Kwizera P, Kanimba P, Rutayisire R, et al. Factors affecting nutritional status among children aged below five years in Rwanda's Western and Southern Provinces. *BMC Public Health*. 2024;24:2053. doi:10.1186/s12889-024-19451-4
7. Ricci H, Schmid D, Kruger S, Terzoni S, Ricci C. Factors Associated With Childhood Undernutrition in Sub-Saharan Africa: A Systematic Review and Meta-Analysis. *Matern Child Nutr*. 2026;22:e70083. doi:10.1111/mcn.70083
8. Essilfie G, Kofinti RE, Asmah EE. Reducing stunting and underweight through mother's birth spacing: evidence from Ghana. *BMC Pregnancy Childbirth*. 2024;24:624. doi:10.1186/s12884-024-06824-1
9. Kundu RN, Borah J, Chatterjee A, Mukherjee K, Bharati S, Hossain MdG, et al. Short birth spacing and its impact on maternal and child health in India with urban-rural variation: An epidemiological study using the National Family Health Survey Data. *PLoS One*. 2025;20:e0325461. doi:10.1371/journal.pone.0325461
10. Youssef RM. Duration and determinants of interbirth interval: community-based survey of women in southern Jordan. *East Mediterr Health J*. 2005;11:559–72. PubMed PMID: 16700370.
11. Santosh A, Zunjarwad G, Hamdi I, Al-Nabhani JA, Sherkawy BE, Al-Busaidi IH. Perinatal Mortality Rate as a Quality Indicator of Healthcare in Al-Dakhiliyah Region, Oman. *Sultan Qaboos Univ Med J*. 2013;13:545–50. doi:10.12816/0003314
12. Kaleem R, Adnan M, Anwar A, Maqsood M. Birth interval and birth order relationship with undernutrition among children under-five: A hospital-based cross-sectional study. *J Fatima Jinnah Med Univ*. 2024;17:137–42. doi:10.37018/JFJMU/RAM/3568
13. Rutstein SO. Effects of preceding birth intervals on neonatal, infant and under-five years mortality and nutritional status in developing countries: evidence from the demographic and health surveys. *Int J Gynaecol Obstet*. 2005;89 Suppl 1:S7-24. doi:10.1016/j.ijgo.2004.11.012 PubMed PMID: 15820369.
14. World Health Organization. Report of a WHO technical consultation on birth spacing: 2007. Geneva, Switzerland: WHO.2007 13-15. https://www.who.int/publications/i/item/WHO-RHR-07.1. Accessed 10 July
15. Ntambara J, Zhang W, Qiu A, Cheng Z, Chu M. Optimum birth interval (36–48 months) may reduce the risk of undernutrition in children: A meta-analysis. *Front Nutr*. 2023;9:939747. doi:10.3389/fnut.2022.939747
16. Miller R, Karra M. Birth Spacing and Child Health Trajectories. *Population & Development Rev*. 2020;46:347–71. doi:10.1111/padr.12335
17. Hassen TA, Harris ML, Shifti DM, Beyene T, Khan MN, Feyissa TR, et al. Effects of short inter-pregnancy/birth interval on adverse perinatal outcomes in Asia-Pacific region: A systematic review and meta-analysis. *PLoS ONE*. 2024;19:e0307942. doi:10.1371/journal.pone.0307942
18. Kiome M, Kimiywe J, Njogu E. Does Child Spacing Influence Nutritional Status of Children 6-59 Months. *J Pediatr Womens Healthcare*. 2019; 2 (2). 1019:7–9.
19. Korsa E, Ibrahi M F, Hajito KW. Effects of Short Birth Interval on Birth Outcomes among Term Pregnant Mothers in Labor. *Journal of Health Systems and Policies*. 2021;3:55–74. doi:10.52675/jhesp.869997

20. Chungkham HS, Sahoo H, Marbaniang SP. Birth interval and childhood undernutrition: Evidence from a large scale survey in India. *Clin Epidemiol Glob Health.* 2020;8:1189–94. doi:10.1016/j.cegh.2020.04.012
21. NISR. National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF. Rwanda Demographic and Health Survey 2019-20 Final Report. *Kigali, Rwanda, and Rockville, Maryland, USA: NISR and ICF.* 2021. ISBN: 978-99977-43-07-7
22. Ndahimana R, Uwase M, Muragire R, Uwase A, Uwamahoro E, Flavia B, et al. Prevalence and associated risk factors of stunting too early: analysis of the 2020 Rwanda demographic and health survey. *BMJNPH.* 2025;8:240–8. doi:10.1136/bmjnph-2024-000991
23. WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards based on length/height, weight and age. *Acta Paediatr Suppl.* 2006 Apr;450:76-85. doi: 10.1111/j.1651-2227.2006.tb02378.x.
24. DHS Program. Using Datasets for Analysis. *DHS Program website.*2025. https://dhsprogram.com/data/Using-DataSets-for-Analysis.cfm. Accessed 14 April 2025
25. Kalinda C, Qambayot MA, Ishimwe SMC, Regnier D, Bazimya D, Uwizeyimana T, et al. Leveraging multisectoral approach to understand the determinants of childhood stunting in Rwanda: a systematic review and meta-analysis. *Syst Rev.* 2024;13:16. doi:10.1186/s13643-023-02438-4
26. Nesa MK, Babu MdR, Tasnim S, Uddin MdJ. Assessment of Undernutrition Among Under 5 Children in Developing Countries: A Systematic Review and Meta-Analysis. *Health Science Reports.* 2026;9:e72087. doi:10.1002/hsr2.72087
27. Kamal SM, Moniruzzaman M. Birth Interval and its Association with adverse Childhood Nutritional outcomes among under-Five Children in Bangladesh: A Longitudinal Study. *J Nepal Paedtr Soc.* 2021;41:327–35. doi:10.3126/jnps.v41i3.33562
28. Yigezu M, Zenebe T, Deresse T, Mekonnen H, Woldamanuel T, Hailu M, et al. Undernutrition and its determinants among children aged 6–59 months in Southern Ethiopia. *Sci Rep.* 2024;14:22426. doi:10.1038/s41598-024-73182-5
29. Okutse AO, Athiany H. Socioeconomic disparities in child malnutrition: trends, determinants, and policy implications from the Kenya demographic and health survey (2014 - 2022). *BMC Public Health.* 2025;25:295. doi:10.1186/s12889-024-21037-z