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Maternal Determinants of Stunting Among Children Under Five Years Old in Kamonyi District, Southern Rwanda

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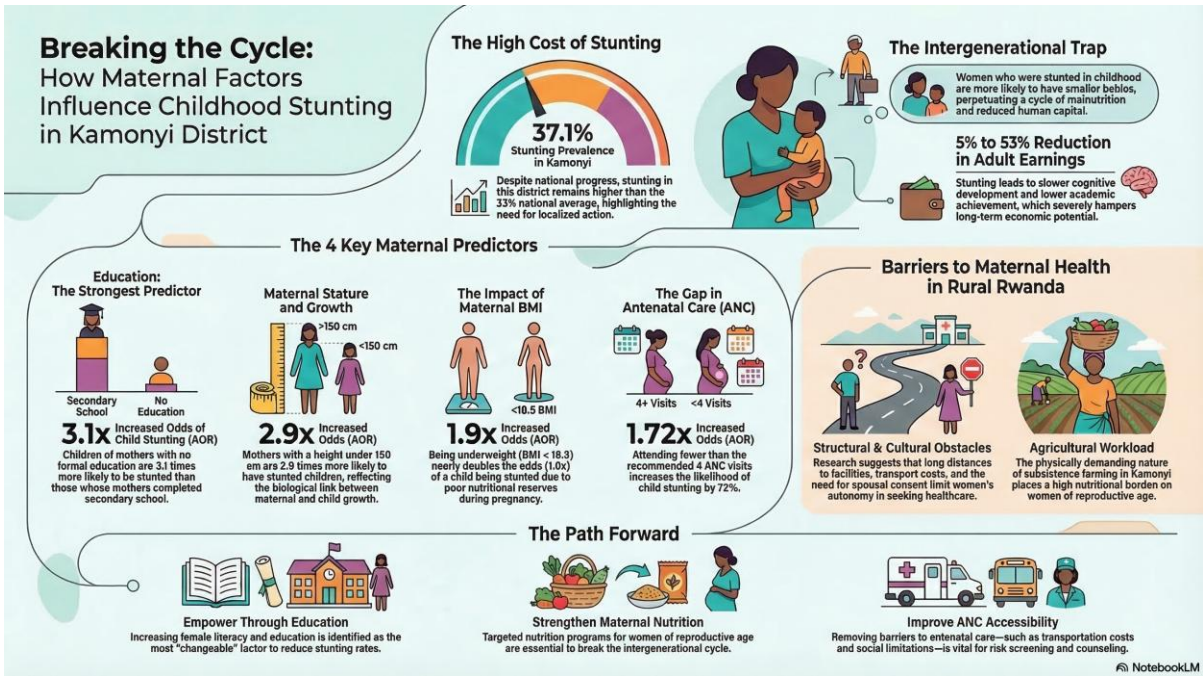
ABSTRACT

Childhood stunting persists as a major public health concern in Rwanda, characterized by significant sub-national inequalities despite broader national improvements in health indicators. This research evaluated the impact of maternal characteristics on stunting among children under five in Kamonyi District. A cross-sectional design was utilized, assessing 420 mother-child pairs selected via two-stage cluster sampling. Child nutritional status was determined using WHO standard HAZ scores, while maternal socio-demographic and health data were gathered through structured questionnaires. Statistical analysis identified a 37.1% stunting rate in the study population. Key maternal predictors significantly associated with child stunting ($p<0.05$) included limited education, short physical stature (<150 cm), underweight status (BMI <18.5 kg/m^2), and inadequate utilization of antenatal care (ANC) services. Conversely, maternal age and employment status were not statistically correlated. The study concludes that addressing structural barriers to maternal education, nutritional health, and ANC utilization is crucial in high-risk districts to interrupt the intergenerational transmission of undernutrition.

Key Messages:

- In the Kamonyi District, maternal predictors are the most significant, such as low education, short stature, undernourishment (low BMI), and poor antenatal care, due to which childhood stunting persists at a high level of 37.1%.
- To address stunting in high-burden districts, a localized, mother-centered approach to enhancing the education of women, the state of their nutrition, and ANC use should be increased to interrupt the intergenerational cycle of undernutrition.

GRAPHICAL ABSTRACT



INTRODUCTION

Childhood stunting represents one of the most critical global public health challenges, arising from chronic malnutrition, recurrent infections, and inadequate psychosocial stimulation during the first 1,000 days of life (1). Characterized by a height-for-age Z-score below the WHO Child Growth Standards, stunting serves as a sensitive metric for socioeconomic disparities. Globally, approximately 21.3% of children under five are affected (2), facing long-term detrimental consequences, including impaired cognitive development, reduced educational attainment, and an increased susceptibility to non-communicable diseases in adulthood, which collectively impede national economic productivity (3).

In Rwanda, despite significant economic advancements and poverty reduction, stunting remains a persistent health issue with a prevalence of 33% in 2023 (4). However, these national figures mask substantial geographical variations, with stunting rates in certain rural districts exceeding 50%. Conversely, Kamonyi District in the Southern Province has emerged as a notable success case, achieving a reduction in stunting prevalence among children under two by over 70% in recent years, thereby offering a valuable opportunity to investigate the localized factors driving these positive outcomes (5).

Evidence consistently identifies maternal characteristics as foundational determinants of a child's nutritional status (6). Factors such as maternal education, physical anthropometry (maternal height and Body Mass Index), and health-seeking behaviors—specifically the utilization of antenatal care (ANC) services—profoundly influence the risk of growth failure. Mothers with low educational attainment or poor nutritional status are significantly more likely to have stunted children, a dynamic that facilitates the intergenerational cycle of undernutrition.

While Rwanda has adopted multisectoral strategies to combat malnutrition, a gap remains in understanding the specific maternal dynamics within Kamonyi District that have contributed to its rapid nutritional improvements. Establishing localized evidence is essential to refining nutrition-sensitive interventions and replicating Kamonyi's success in higher-burden regions. Therefore, the primary objective of this study is to investigate the association between maternal factors and stunting among children under five years of age in Kamonyi District, Southern Rwanda.

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METHODS

Study Design and Setting

A community-based cross-sectional study was conducted to evaluate the association between maternal characteristics and stunting among children aged 0 to 59 months in Kamonyi District, Southern Province, Rwanda. Kamonyi was selected due to its persistently high stunting rates relative to national averages and its predominantly rural socio-economic profile, where subsistence agriculture is the primary livelihood. The target population comprised mother-child pairs (children aged 0–59 months) residing in Kamonyi District. A two-stage cluster sampling technique was employed. In the first stage, 12 out of 22 sectors were selected using probability proportional to size (PPS). In the second stage, households with eligible children were systematically identified using updated Community Health Worker (CHW) lists. The sample size was calculated using a single population proportion formula, assuming a 33% stunting prevalence, a 5% margin of error, and a design effect of 1.5, resulting in a final sample of 420 mother-child pairs.

Data Collection and Variables

Data were collected between February and April 2025 using a structured questionnaire adapted from DHS core modules. The primary outcome variable was childhood stunting, defined as a height-for-age Z-score (HAZ) of less than -2 standard deviations (SD) based on WHO standards. Independent maternal variables included socio-demographic characteristics (age, education level, and occupation), anthropometric status (height/age and Body Mass Index [BMI]), and health-seeking behaviors (number of antenatal care [ANC] visits). Specifically, maternal education was categorized into none, primary, and secondary/tertiary levels; maternal height was dichotomized at 150 cm; BMI was categorized as underweight (<18.5 kg/m^2) or normal/overweight; and ANC utilization was assessed based on the completion of the recommended minimum of four visits.

Anthropometric Assessment and Data Analysis

Maternal and child anthropometry followed standard WHO protocols. Child height was measured to the nearest 0.1 cm using a UNICEF-length/height board, and weight was recorded to the nearest 0.1 kg using a SECA digital scale. Data analysis was performed using Stata version 17 and WHO Anthro software. Descriptive statistics characterized the sample, while Pearson's chi-square tests assessed bivariate associations between maternal factors and stunting. Variables with a p-value < 0.10 in the bivariate analysis were entered into a multivariate logistic regression model to identify independent predictors. Results were reported as Adjusted Odds Ratios (AOR) with 95% Confidence Intervals (CI), and statistical significance was set at $p < 0.05$.

Ethical Considerations

This study was approved by the Institutional Review Board of the College of Medicine and Health Sciences, University of Rwanda (Ref: CMHS/IRB/087/2024).

RESULTS

Table 1 details the sociodemographic profiles and health-related characteristics of the maternal cohort (N = 420). The data indicate a predominantly low level of educational attainment among the participants; the majority of mothers (59.76%) had only completed primary education, while 13.33% reported having no formal education. Access to higher education was notably limited, with merely 2.86% reaching the tertiary level. Regarding maternal employment, the study population was almost evenly distributed between farming (49.52%) and non-farming (50.48%) occupations. Crucially, the assessment of maternal nutritional status revealed a severe public health concern, as a substantial majority of the mothers (76.67%) were classified as underweight (BMI < 18.5 kg/m^2).

Furthermore, an evaluation of health-seeking behaviors demonstrated suboptimal utilization of maternal healthcare services. More than half of the mothers (52.62%) attended fewer than four antenatal care (ANC) visits during their pregnancy, indicating inadequate adherence to the conventionally

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recommended minimum standards for prenatal care.

Table 1. The characteristics of respondents

Characteristic	Category	n	%
Education	None	56	13.33
	Primary	251	59.76
	Secondary+	101	24.05
	Tertiary	12	2.86
Occupation	Farming	208	49.52
	Non-farming	212	50.48
BMI (kg/m^2)	<18.5 (Underweight)	322	76.67
	18.5 – 25.00 (Normal)	98	23.33
ANC Visits	<4	221	52.62
	>4	199	46.38
Total		**420**	**100**

Table 2 presents the results of the bivariate analysis examining the associations between maternal sociodemographic/health characteristics and children's nutritional status under five. The findings reveal that all analyzed maternal variables—education, height, body mass index (BMI), and antenatal care (ANC) utilization—are significantly associated with childhood stunting. Maternal educational attainment demonstrated a highly significant inverse relationship with stunting prevalence ($p < 0.001$). A disproportionately larger segment of the stunted children belonged to mothers with only primary education (24.29% of the total sample) or no formal education (7.62%), compared to those whose mothers attained secondary or tertiary education.

Furthermore, maternal anthropometric indicators were robust predictors of child nutritional outcomes. Short maternal stature, defined as a height of less than 150 cm, was strongly correlated with stunting ($p < 0.001$). More than half of the entire study population (52.38%) comprised stunted children born to mothers in this category. Similarly, maternal undernutrition was a critical factor; mothers with a BMI below 18.5 kg/m^2 had a significantly higher likelihood of having stunted children compared to mothers with a normal BMI ($p < 0.001$). Finally, maternal health-seeking behavior, specifically the frequency of ANC visits, was significantly associated with child stunting ($p < 0.002$). While the distribution between the two categories (<4 and >4 visits) appears relatively close, the statistical significance indicates that inadequate prenatal care correlates with poorer child growth outcomes.

Table 2. Bivariate Analysis of Maternal Factors Associated with Stunting

Variable	Category	Stunted		Normal		p-value
		n	%	n	%	
Education	None	32	7.62	24	5.71	<0.001
	Primary	102	24.29	139	33.10	
	Secondary	25	5.95	76	18.10	
	Tertiary	12	2.86	10	2.38	
Height	<150 cm	220	52.38	102	24.29	<0.001
	>150 cm	73	17.38	25	5.95	
BMI	<18.5	185	44.05	100	23.81	<0.001
	18.5 – 25.00	90	21.43	45	10.71	
ANC Visits	<4	107	25.48	114	27.14	<0.002
	>4	102	24.29	97	23.10	

Table 3 presents the results of the multivariate logistic regression analysis, which was conducted to identify the independent maternal predictors of child stunting while controlling for potential confounding variables. The findings confirm that maternal education, height, body mass index (BMI), and healthcare utilization are significant, independent determinants of stunting in children under five. Maternal educational attainment emerged as the strongest predictor in the model. Children born to mothers with no formal

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education had 3.1 times higher odds of being stunted compared to children whose mothers had completed secondary education or higher (AOR = 3.1; 95% CI: 1.8–5.4; $p < 0.01$).

Furthermore, maternal anthropometric characteristics significantly and independently predicted child nutritional outcomes. Short maternal stature, defined as a height of less than 150 cm, was associated with a nearly threefold increase in the odds of child stunting (AOR = 2.9; 95% CI: 1.6–4.8; $p < 0.01$). Similarly, maternal undernutrition was a critical risk factor; mothers classified as underweight (BMI < 18.5 kg/m^2) had 1.9 times the odds of having a stunted child compared to mothers with a normal BMI (AOR = 1.9; 95% CI: 1.1–3.4; $p < 0.05$). Finally, inadequate engagement with prenatal healthcare services remained a significant risk factor after adjustment. Mothers who attended fewer than the recommended four antenatal care (ANC) visits had 1.72 times higher odds of having a stunted child (AOR = 1.72; 95% CI: 1.1–2.6; $p < 0.05$), highlighting the protective effect of consistent maternal healthcare access on early childhood development.

Table 3. Multivariate Logistic Regression Analysis of Maternal Factors Associated with Child Stunting

Variable	Category	AOR	95% CI	p-value
Education	Secondary+ (Ref.)	Ref.	-	-
	None	3.1	1.8–5.4	<0.01
Height	<150 cm	2.9	1.6–4.8	<0.01
BMI	<18.5	1.9	1.1–3.4	<0.05
ANC Visits	<4	1.72	1.1–2.6	<0.05

DISCUSSION

This study explored the connection between maternal characteristics and childhood stunting in Rwanda's Kamonyi District. The findings reveal a stunting prevalence of 37.1%, slightly higher than the national average of 33% in 2019-2020, suggesting that national progress does not fully address numerous local challenges related to this issue(7,8). The key findings emphasize the significance of maternal education, nutrition (height and BMI), and antenatal care utilization as some of the most influential and independent factors predicting child stunting in this district. The strong protective effect of maternal education aligns with extensive evidence from Rwanda and other low- and middle-income countries. (9,10). A consistent dose-response relationship, where the risk of stunting decreases with higher education levels, underscores its vital role. This relationship is believed to be mediated by various social and cultural factors prevalent in rural Rwandan settings. For instance, historical gender disparities in education access and early marriage rates may limit women's access to formal education and, consequently, health literacy(11,12). Educated mothers are more likely to adopt optimal infant feeding practices, exercise greater autonomy in decision-making, and effectively utilize healthcare services, all of which are crucial for child nutrition. The study also confirms the intergenerational cycle of malnutrition, where maternal malnutrition, indicated by low BMI and short stature, is closely linked to stunting in subsequent generations. This biological link is well-established, as an undernourished mother may face challenges in fetal development and postnatal nutrition. In Kamonyi district, local socioeconomic conditions may exacerbate this biological vulnerability. The physically demanding nature of subsistence farming, combined with potential seasonal food shortages, likely imposes a significant burden on the nutritional status of women of reproductive age (13,14). Additionally, inadequate attendance at ANC visits emerged as a significant risk factor.

This issue may extend beyond clinical care, reflecting broader barriers to healthcare access in the district. Sociological research in rural Rwanda suggests these barriers may include long distances to health facilities, unaffordable transportation, and social and cultural beliefs, such as the requirement for spousal consent before accessing care, which may limit women's autonomy (15). ANC visits are crucial for providing nutritional counseling, micronutrient supplements, and risk screening, making attendance vital for reducing stunting (16). Study limitations. The current research has several limitations that should be considered when interpreting the results. Firstly, the cross-sectional design does not establish causality; it only indicates associations. Second, the memories regarding variables such as ANC attendance were based on maternal recollections, which may be subject to recall bias. Third, the study did not account for several potentially important confounding factors, including, but not limited to, household income, food security

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status, paternal involvement, and local cultural beliefs about feeding and childcare. Our findings, which attribute these to factors such as agricultural workload or gender barriers, are therefore hypotheses that require dedicated investigation. Finally, the results are specific to Kamonyi District and cannot be generalized to other districts in Rwanda with different socioeconomic, cultural, or environmental contexts.

CONCLUSION

The study successfully identified the key maternal factors contributing to childhood stunting in Kamonyi District, offering crucial local insights to guide the community's health strategy. Among the factors examined, maternal education emerged as the most changeable, with children of mothers lacking formal education being over three times more likely to experience stunting compared to those whose mothers had completed secondary education.

This finding underscores the significance of empowering women through education as a vital means to break the cycle of malnutrition. Furthermore, the research highlighted the significant impact of maternal nutritional status and healthcare utilization. The strong association with maternal short stature and low BMI illustrates the multigenerational and intergenerational nature of undernutrition, while the lack of antenatal care attendance points to persistent barriers in accessing essential health services. Collectively, these findings suggest that a comprehensive, district-focused strategy is necessary. Interventions should not only aim to enhance educational opportunities for girls and women but also improve maternal nutrition programs and remove obstacles to antenatal care. These tailored initiatives, attuned to Kamonyi's local context, are essential to accelerating development and ensuring that every child can reach their full potential. To build on these findings, future longitudinal studies are needed to establish causal links, particularly regarding unmeasured variables in this study, such as paternal roles in childcare, dietary intake quantification, and household food security dynamics.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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