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ANALYSIS OF RISK FACTORS THAT INFLUENCE STUNTING AMONG RWANDAN CHILDREN UNDER THE AGE OF FIVE

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ABSTRACT

In East Africa, 39% of all children were stunted in 2016. Rwanda reported the second highest rate at 37.7%. Globally, deaths from malnutrition stand at 45% of child deaths, creating an economic handicap for all countries. According to the World Health Organization's (WHO) goal to reduce malnutrition by 3.9% per year, all countries must define appropriate strategies. Although related research has been conducted in Rwanda, the issue of malnutrition prevails. This study assesses stunting with multiple factors, with the aim of revealing the system-wide impact of food insecurity on malnutrition. Secondary data from the Rwanda Demographic and Health Survey (RDHS) 2014-2015 were used. Variables were classified into five categories, namely the community, environment, socio-development, media, and proximate factors. To assess the risk factors for stunting, a mixed-effect logistic regression was applied and an association between different factors and stunting was determined. The prevalence of stunting was 37.7%, the average was relatively still high, compared to the global prevalence of 21.3% in 2019, and the city of Kigali comprised the lowest prevalence (22.7%) while the highest prevalence was observed in the Western Province (44.6%). The place of residence and altitude were found to be statistically significant community and environmental factors. Wealth index and parental education level were considered socio-demographic risk factors. All media factors were associated with stunting and in proximate factors, the Body Mass Index (BMI) of the mother, duration of breastfeeding, age and weight of the child at birth, sex, and birth order were statistically significant factors. In addition, infection, diarrhoea, and parasitic infection were also associated with stunting. Ensuring sustainable food security in households should go hand in hand with all strategies for eliminating all forms of malnutrition since stunting is observed in most regions where there are cases of food insecurity. Educating children is key to reducing stunting since the parents need nutrition education to better take care of their children. Public policy throughout the country should aim to improve the living standards of people. Generally, all concerned institutions accompanied with policies to eradicate malnutrition and industries providing nutrients should be promoted.

Key words: Stunting, Multilevel logistic, Under-five, Rwandan Demographic and Health Survey

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INTRODUCTION

Globally, childhood malnutrition is a significant public health issue. In 2016, an estimated 155 million children were stunted worldwide [1, 2]. In East Africa, it is estimated that 39% of all children are stunted [3]. This issue was significant in Burundi with 57% of children stunted and was slightly lower in Rwanda at 37.7% [3]. It is a serious problem since the development of the intellectual capacity of children occurs between 0-59 months [4]. Hence, malnutrition leads to insufficient intellectual development and prevents individuals from attaining their expected intellectual abilities [4]. Malnutrition that may begin from conception to birth or during the first two years of life is irreversible. The consequences include lower intelligence levels and reduced physical capacity, reduced productivity, and a slowing of economic growth, thus perpetuating poverty [5].

Globally, approximately 45% of child deaths are due to malnutrition, 3.1 million of which occur annually in low and middle-income countries [6]. The World Health Organization (WHO) classifies under-nutrition into 3 categories: underweight, meaning low weight-for-age, wasting, low weight-for-height, and stunting, or low height-for-age. In all three, low is signified by a standardized score less than -2 standard deviation of the reference population [7]. In the world, an estimated one third of children were stunted (155 million), whereas 58 million were wasted in 2016 [8]. Among the three forms of malnutrition, stunting remains the main public health issue [8]. However, worldwide the prevalence of stunted children decreased from 257 million (40%) to 161 million (25%) between 1990 and 2013 respectively [8]. Estimations of 2016 show that, globally, the prevalence of stunting fell from 29.5% to 22.9% between 2005 and 2016 [8]. In 2012, the WHO set the annual target of reducing stunting by 40%. Globally, this translates to a 3.9% annual reduction.

By this target, the number of stunted children is expected to decrease from 171 million to about 100 million in 2025. Despite this, current results suggest that by 2025, this number will be about 130 million [8, 9]. Therefore, to achieve the global stunting reduction target, all countries must set the proper target [9]. In Africa, there was a lesser decrease in comparison to Asia and to the rest of the world [9]. The rate of decline in Africa is low compared to the increase in population. This results in higher overall numbers of stunted children [8]. The 2014-2015 RDHS [10] shows that 38% of under-five children are stunted, and 14% are severely stunted.

Stunting is a serious public health issue, but the government of Rwanda has a national plan to eliminate all forms of malnutrition and has instituted a number of interventions [11]. From 2005 to 2015, the rate of malnutrition decreased from 51% to 38% [10]. Rwanda Demographic and Health Survey (RDHS) ranked Western as the first Province with 44.6% stunted children seconded by the Southern Province with 41% and Kigali City had the prevalence of 22% [10]. Nutritional status is the result of complex interactions between food consumption and metabolism. Many socio-economic and cultural factors influence decisions on patterns of feeding and nutritional status. Despite efforts taken, malnutrition persists [10]. According to several research, food consumption patterns and dietary diversity are also regarded as major contributors to

malnutrition, and are considered to be contributing causes to Rwanda's high prevalence of stunting [12]. Education level, mother's demographics and nutrition and health status, as well as family size, wealth, and assets have all been found to play a role in predicting nutrition and health outcomes for children. Higher education and/or nutrition education levels of the head of the home and/or the mother have been demonstrated to lessen the likelihood of stunting in children [13]. Gender, underweight, infections, low quality breastmilk from malnourished moms, and a lack of nutritional diversity appear to be individual variables that contribute to child stunting [14]. The prevalence of childhood stunting has been demonstrated to be influenced by geophysical conditions. Distance to the main road and market have both been used as indications of how well linked a home is to marketplaces where food may be purchased and sold. The risk of stunting in children has been linked to household altitude [15].

In Rwanda, there are commitments from the government, in collaboration with its partners and educational institutions, to find solutions. Multi-sectoral initiatives and interventions have been put into place over the past decade aimed at improving the national nutritional status. The efforts include the following: (1) The multisector participation and consensus around Rwanda's First, and Second National Nutrition Summit done in 2009 and 2011, respectively, (2) Completion of health facilities and community level tools to more effectively promote Maternal, Infant, and Young Child Nutrition, (3) A national Joint Action Plan done in 2012 to Eliminate Malnutrition, and (4) District Plans to Eliminate Malnutrition (DPEM) in every district in 2011[5, 10, 11]. However, the country still faces the problem of stunting. Therefore, to better understand this burden, the RDHS 2015 data was used. A multilevel modelling was used to assess factors contributing to stunting in each level in Rwandan context. Through this process, the direct relationship between food insecurity and stunting was revealed. This paper determines the contribution factors influencing malnutrition by tackling the following points: determining the community level and environmental factors that contribute to stunting, demonstrating the socio-demographic and media factors contributing to stunting, and assessing the proximate determinants of malnutrition in Rwanda.

MATERIALS AND METHODS

In this research, the secondary data used were those collected during Rwandan Demographic and Health Survey (RDHS) 2014/2015 [10]. Three anthropometric measurements to classify the nutrition status of under-five year old children were taken into consideration. According to the WHO, the anthropometric measurements are height-for-age, weight-for-age, and weight-for-height taken from the population of reference [10]. In this study, one anthropometric measure, height-for-age, was used to assess the nutritional status of under-five year old children in Rwanda since stunting is very significant compared to other forms of malnutrition. In RDHS the sampling method used in this survey was two-stage stratified. In the first stage, 113 clusters were selected in urban areas and 379 in rural areas with the probability proportional to the number of households residing in the village. The second stage involved a systematic sampling of households where twenty-six (26) households (HHs) were randomly selected on average per cluster in a total of 12,793 households. Height and weight were

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measured for 3,884 children, and only 3,813 were valid anthropometric data [10]. Basis on height for age z-scores, the nutritional status of children was divided into three ordinal categories as in: (<-3.0) standard deviation (SD) which is severely stunted, moderately stunted ranged between -3.0 and -2.0 SD and stunted above (-2 SD) the median of the WHO child growth standards [16]. Stata 13 was used, for analysis where "Svy: tab" Stata command helps to determine the number, the corresponding percentage, and the probability of obtaining test results (p-value) of each characteristic influencing stunting.

Description of variables

The risk factors were classified into five classes: community, socio-demographic, environmental, media, and proximate factors [17]. Community factors include province, place of residence, and altitude. The socio-demographic factors are wealth index, marital status of the mother, father's education, father's occupation, mother's education, and mother's occupation. The environmental factors are the use of toilets and accessibility to clean water. The media factors include reading the newspaper, watching television, and listening to the radio. The fifth class is proximate factors which are divided into four categories: i) maternal factors like mother's age and Body Mass Index (BMI) at child's birth, ii) delivery factors like mode of delivery (normal delivery or Caesarean section) and the place of delivery, iii) Perinatal or postnatal delivery factors like antenatal care clinic visit, current breastfeeding, and duration of breastfeeding iv) children factors like gender, birth order and child age, birth size and birth interval, children infection and child morbidity. More detail is given in Figure 1 conceptual Framework adopted from UNICEF [17]. The dependent variable, stunting, is dichotomous: children with less than minus two standard deviations of reference population are classified as stunted, otherwise normal [18].

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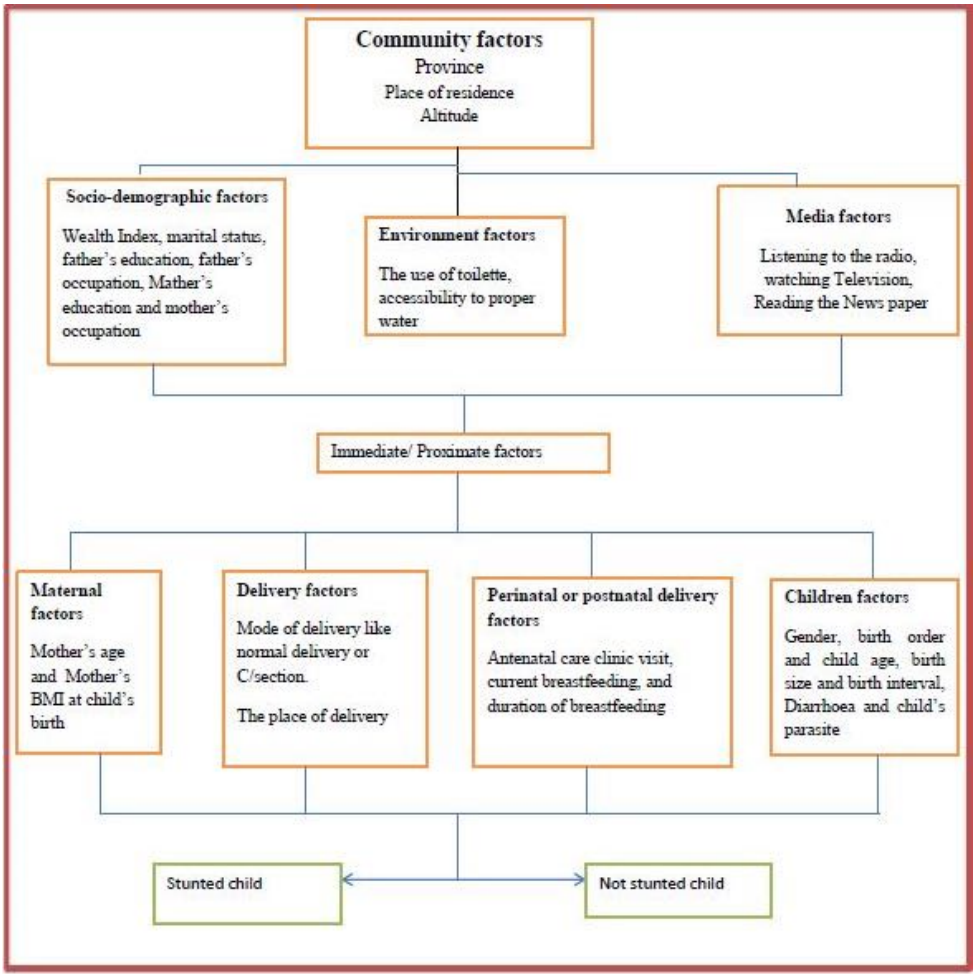

Figure 1: The conceptual Framework adapted from UNICEF [17]

The above variables were adopted from the UNICEF conceptual framework due to different researches indicating them as risk factors for stunting not only in Rwanda [19] but also in other countries [17], thus they were included in this study as well.

The Odd Ratio (OR) was used to determine whether the selected factor is a risk factor of stunting and also to compare the magnitude of various risk factors for stunting. The 95 % confidence interval (CI) was calculated.

Multilevel analysis was initiated by taking into account the significant factors of each level. Finally, all factors were put into multivariate models to search for statistically relevant variables which remained significant at $P<0.05$. The estimation procedure using xtmelogit is maximum likelihood estimation using adaptive quadrature. By default, xtmelogit used adaptive quadrature with seven integration points. To check that seven integration points are adequate, the model can be refitted with a larger number of quadrature points. When the two sets of the model parameters are the same then seven integration points are adequate [20].

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The multilevel model

Multilevel logistic regression is used to model binary outcome variables where the log odds of the outcome are modelled as a linear combination of predictor variables when data are clustered or when there are both fixed and random effects. Generally, the multilevel logistic regression model is presented as

$$\log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p + u. \qquad (1)$$

The fixed βX is analogous to the linear predictors from standard ordinary least squares regression with β being the regression coefficient to be estimated [21]. For this equation (1), the fixed part was examined by using the odds ratio and the random effect was assumed to follow a normal distribution with mean zero and variance δ^2. The interesting part of evaluating equation (1) is the fixed part of assessing their contribution to stunting.

RESULTS AND DISCUSSION

Analysis and Results

To analyse risk factors that influence stunting using a multilevel model, the focus was on the equation (1). The results were obtained using the command described in detail in section 2.1. Before applying the model (1), the bivariate relationship between stunting and explanatory variables was examined and the results were presented in Table 1, then variables that were associated with stunting were applied in the model (1). Table 2 was obtained by using "xtmelogit" Stata command which helps to determine the Odds Ratio (OR) and the corresponding coefficient of factors influencing malnutrition grouping in different levels.

To determine the risk factors associated with stunting, the community level variables were added to the model:

$$\log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 Province + \beta_2 \text{residence} + \beta_3 \text{Altitudes} + u.$$

and did the same for Environment level factors

$$\log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 \text{improved(water)} + \beta_2 \text{improved(toilet)} + u.$$

By using Socio-demographic level factors to the model for assessing the risk factors associated with stunting,

$$\log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 \text{status} + \beta_2 \text{wealth(index)} + \beta_3 \text{mother(education)} + \beta_4 \text{father(education)} + \beta_5 \text{husband(occupation)} + \beta_6 \text{mother(occupation)} + u.$$

The entering of Media level factors into the model is as follows as to

$$\log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 \text{listen(radio)} + \beta_2 \text{watch(television)} + \beta_3 \text{reading(newpaper)} + u.$$

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Finally, the proximate level factors were used to classify the risk factors associated with stunting.

$$\log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 \text{mother(age)} + \beta_2 \text{Mothers(BMI)} + \beta_3 \text{Mode(delivery)} + \beta_4 \text{place(delivery)} + \beta_5 \text{number(antenatal)} + \beta_6 \text{duration(breastfeeding)} + \beta_7 \text{breaststart} + \beta_8 \text{sex} + \beta_9 \text{birthorder} + \beta_{10} \text{age(group)} + \beta_{11} \text{child(birthsize)} + \beta_{12} \text{birthweigh} + \beta_{13} \text{diarrhea} + \beta_{14} \text{parasite} + u,$$

and all procedures of analysis were described in section 2.1. The results are presented in Table 2.

In analysis, RDHS 2014-2015 was used where children who completed 3 anthropometric measures were taken into account [10]. The focus of the analysis was height-for-age. The results found show that the prevalence of stunting was 37.7%. This prevalence is still high compared to the world prevalence which was 21.3% in 2019 [22]. The multilevel logistic regression results in Table 2 demonstrate that residence and altitude are statistically significant at the community level, with ORs of 2.04 and 1.94, respectively, the province is not.

All environmental variables are statistically significant, with improved water having the greatest impact on stunting occurrence with an OR of 1.46 and improved toilets having the least impact with an OR of 0.80. The social demographic factors show that husband's and mother's occupations do not affect children's stunting because they are not statistically significant, whereas wealth index and parental marital status have a greater impact on the occurrence of stunting with ORs of 1.27 and 1.08, respectively. Father's and mother's education have less of an impact on the occurrence of stunting with ORs of 0.81 and 0.73, respectively.

The most proximal factors impacting stunting are a child's birth weight with an OR of 1.94, child's age with an OR of 1.47, child's parasite drug in 6 months with an OR of 1.64, a birth order with an OR of 1.31, and duration of breastfeeding with an OR of 1.16. The mother's BMI and sex of the child are the proximal variables that had the least impact on the occurrence of stunting, at 0.67 and 0.64, respectively. Factors such as the mother's age, mode and place of delivery, and the number of prenatal care visits are not statistically significant. The relationship between the first breastfeeding and the delivery weight is not statistically significant.

The distribution of stunting was given by province, with Kigali City having the lowest percentage (22.7 %), as shown in Table 1. In analysis, many factors contributing to this lowest percentage (22.7 %) were found. Kigali City hosts most public institutions, the biggest private companies, and the most industries in the country, also the rate of access to information is comparatively high [23]. Furthermore, there is food diversity in Kigali city where the household has access to a variety of quality food while in the rural area they have few varieties [24]. As seen in the results, educated people are less likely to have stunted children at 19.36% than individuals with less education at 49.3%. Also, the source of income is concentrated in this city, hence improved life is more likely seen there than in other provinces [25, 26]. Food security also plays an important

role in this low prevalence since this city counts only 3% of households considered as food insecure [24, 27].

The Western province had the highest prevalence of stunting since it is the region with the highest altitude, where altitude was identified as one of the variables contributing to stunting, and most of the province is rural. In this province, there are also few opportunities that involve educated people like in the rest of the country [23]. The geographical situation does not permit easy access to proper water and improved sanitation facilities which are important factors in the reduction of stunting as seen in the results in Table 1. The level of food insecurity in the western province is high compared to the other parts of the country. More than 35% of households are considered food insecure, especially in livelihood zones of Western Congo Nile Crest Tea Zone counts (49%) of insecure households [24].

There was a significant reduction in stunting due to the interventions of the government of Rwanda that aimed at eliminating all forms of malnutrition to achieve the SDGs target [8]. The determination of eradicating stunting is seen in different ways such as: ensuring security in the whole country, increasing the number of health facilities and rehabilitation of existing health facilities, increasing infrastructures and sanitation facilities, promoting female education and emancipation of females in general, the introduction of giving each family a cow, "Girinka", and introduction of a district plan to eliminate malnutrition in each district. In ensuring food security, the government of Rwanda introduced the "Kitchen garden" in all households and bio-fortification: beans improved with iron and potatoes with vitamin A and land use consolidation [24]. The active participation of community health workers in daily activities like screening, follow up, and monitoring child growth also plays an important role in this achievement [14].

Among the community factors, the residence variable is the most factor contributing to stunting with an OR of 2.04. Children from rural areas are more likely to be stunted than urban children. The improvement of living standards should be enhanced. The altitude has an OR of 1.96 which shows that the children from high altitude areas are more likely to be stunted than the children in lower altitude areas [1]. Education of both boys and girls should be enhanced since it contributes a lot to the well-being and health of newborns as seen in the results in Table 1. Even though in multilevel logistic regression results, the occupation of both mother and father are not statistically significant, occupation contributes to the wealth index which is significant with an OR of 1.27, hence the creation of new jobs especially for young people will not only the solution to stunting but will also contribute to the well-being and improved life of the people [3].

Access to proper water and improved sanitation facilities are statistically significant in reducing stunting with 1.46 and 0.80 OR respectively. This is a big opportunity for growth since in Rwanda's national plan these points are highly emphasized. Furthermore, in National strategy for transformation (NST) 1 by 2024, estimates to scale up from 87.4% to 100% of access to proper water and 86.2% to 100% of access to sanitation and hygiene [28]. The marital status of the mother is not statistically

significant to our model but it should be encouraged across the country since legal marriage is related to reducing stunting cases 19]. Access to information also plays an important role in the reduction of stunting; listening to the radio, reading newspapers, and watching television are statistically significant as seen in Table 1 and Table 2 presenting the OR of 0.82, 0.78, and 0.82, respectively. Therefore, the information is also an important part of reducing stunting since through media population is educated.

Nutrition education given in antenatal care provides an important contribution since awareness of 1000 days of first life reduces stunting significantly in children less than 24 months. The parents' education on the preparation of supplementary foods should also be emphasized since after 24 months children are more likely to be stunted at the rate of 42%. The research revealed that the improvements of complimentary food and supplementary foods reduce stunting and related diseases [27]. Nutrition education in antenatal care assists enhances children's birth weight by improving the mother's dietary behaviour and greatly increasing total energy intake, thereby contributing to the welfare of future newborns throughout their lives, as shown in Table 1 [29]. Obese mothers are more likely to give birth to non-stunted children than other categories of BMI mothers as shown in Table 1. Stunted mothers are more likely to give birth to stunted children at the prevalence of 42.83% as reported in Table 1. Therefore, the enhanced life of children under the age of five will have a favourable impact on the lives of future mothers and fathers, and stunting in future generations will be abolished progressively [27].

The proper water and improved sanitation facilities will impact positively the well-being of the child since these two factors contribute more to the problem of diarrhoea and intestinal parasites, which are statistically significant for this study [4]. Table 1 shows that birth weight is significant since 54.11 % of stunted children were underweight. Pregnant women's lives should be improved to give birth to normal children. Children born from mothers less than 19 years of age were not stunted like other age categories of women as shown in Table 1, further studies should be conducted to determine the reason behind this fact. Statistically, gender plays an important role in stunting status, males are more likely to be stunted than girls as mentioned in Table 1 and as shown in different studies [14], the scientific basis of such difference should be investigated.

CONCLUSION

Using multilevel logistic regression, in community-level factors, the residence and altitude were statistically significant and identified as the risk factors of stunting. Therefore, the policies that promote food production, improve living standards, and reduce the poverty of people in rural areas are highly recommended. In socio-demographic factors, it was found that the wealth index of households, the education of both mother and father are statistically significant too. All environmental and media factors are also identified as risk factors for stunting. Among the proximate factors, the factors associated with stunting such as the mother's BMI, duration of breastfeeding, sex, age of the child, birth size of the child, and diarrhoea were statistically significant.

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The awareness campaigns for the eradication of all forms of malnutrition should be conducted in all corners of the country and involve all categories of people since stunting is observed in all categories. Formal education for both girls and boys should continue to be a national priority and should focus on rural areas is where there are large numbers of mothers who are not attending formal education and that are more likely to give birth to stunted children. The health providers and health workers nearby the household should be trained on how to advise pregnant mothers on ways of reducing stunting in children and strengthen the screening of stunting in vaccination activities. Further studies should be conducted on determining the scientific basis of the significant difference in stunting between boys and girls.

Proper water and sanitation facilities should be the main focus of the country and should reach all corners of the country. Food security is extremely related to the causes influencing stunting across the country; therefore, eradicating stunting should go hand in hand with increasing household food security and poverty eradication. Access to quality food intake should also be added to the RDHS survey so that its contribution to stunting is recognized. Access to the internet as a source of information should be taken into account in the survey since nowadays it has become the new main source of information. Public institutions and industries should be extended throughout the country for they attract educated people with high levels of education and enhance lives and change the mindset of rural people.

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Table 1: Characteristics of risk factors associated with stunted children in Rwanda

		Stunting				
	Characteristics	Not stunted		Stunted		
		Number	Percentage	Number	Percentage	P-value
Improved water	unclean water	570	56.24	444	43.76	0.0001
	clean water	1649	64.65	902	35.35	
Improved sanitation facility	Not improved	558	58.28	340	41.72	0.0046
	improved	1658	63.68	945	36.32	
Province	Kigali city	314	77.35	92	22.65	<0.001
	South	506	59.34	347	40.66	
	West	475	55.5	381	44.5	
	North	306	61.18	194	38.82	
	East	637	65.16	341	34.84	
Altitude	"=< 2000 m	1958	65.3	1041	34.7	<0.001
	> 2000 m	281	47.18	314	52.82	
Place of residence	Urban	451	76.38	140	23.62	<0.001
	Rural	1788	59.53	1215	40.47	
Wealth index	Richest	476	79.48	123	20.52	<0.001
	Richer	436	71.14	177	28.86	
	Middle	436	62.3	264	37.7	
	Poorer	430	54.35	361	45.65	
	Poorest	461	48.29	430	48.29	
Mother's education	No education	271	52.57	145	47.43	<0.001
	Primary	1594	69.97	1021	39.03	
	secondary or higher school	373	80.64	90	19.36	
Currently working	No	336	67	166	33	0.0457
	Yes	1901	61.53	1188	38.47	
Father's education	No education	300	53.13	264	48.87	<0.001
	Primary	1451	61.87	894	38.13	
	secondary or higher school	209	73.07	77	26.93	
	Don't know	6	84.32	1	15.68	
Frequency of reading Newspapers	Not at all	1710	59.78	1151	40.22	<0.001
	Less than once a week	110	72.62	166	27.38	
	At least once a week	88	71.79	34	28.21	

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Frequency of watching television	Not at all	1329	57.88	967	42.12	<0.001
	Less than once a week	553	64.56	303	35.44	
	At least once a week	350	81.01	82	18.99	
Frequency of listening to the radio	Not at all	371	53.16	327	46.84	<0.001
	Less than once a week	532	58.21	382	41.79	
	At least once a week	1327	67.39	642	32.61	
Age group of child	<6 month	297	89.39	35	10.61	<0.001
	6-23 month	745	63.66	425	36.34	
	24-59 month	1197	57.23	894	42.77	
Sex of child	Male	1051	57.58	774	42.42	<0.001
	Female	1188	67.16	581	32.84	
Birthweight	<2.5 kg	79	45.89	94	54.11	<0.001
	>= 2.5kg	2025	64.16	1131	35.84	
Maternal height	<145cm	1407	57.17	1057	42.83	<0.001
	>=145cm	830	73.63	298	26.37	
Intestinal parasites	No	699	74.09	244	25.91	<0.001
	Yes	1538	58.11	1108	41.89	
Diarrhea	No	1984	63.36	1147	36.64	0.0011
	yes	255	55.11	297	44.89	
Mother's age category	Greater than 35	457	59.35	313	40.65	0.04
	Between 19-35	1760	62.93	1037	37.07	
	less than 19	22	80.88	5	19.12	
Mother's BMI	underweight	81	51.24	78	48.76	<0.001
	Normal	1531	60.01	1020	39.99	
	overweight	493	69.32	218	30.68	
	Obese	133	77.27	39	22.73	
Place of delivery	Home	149	53.19	131	46.81	0.009
	Health facility	2058	63.1	1203	36.9	
	Other	32	60.93	21	39.07	
Number of antenatal visit	No antenatal	14	54.29	12	45.71	0.0029
	1-4 antenatal	1732	63.89	979	36.11	
	More than 4	493	57.52	364	42.48	
Child's size at birth	Average and More than	1982	64.82	1076	35.18	<0.001
	Less than average	253	48.17	271	51.83	

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Table 2: Odds ratios (OR) (95% CI) for stunted children 0–59 months

Characteristics	Odds Ratio	[95% Conf. Interval]		P-value
Community factors				
Province	0.98	0.92	1.03	0.378
Residence	2.04	1.69	2.47	<0.001
Altitude	1.96	1.64	2.34	<0.001
Environment factors				
Improved water	1.46	1.25	1.70	<0.001
Improved toilet	0.80	0.68	0.93	0.004
Socio-demographic factors				
Status	1.08	1.00	1.16	0.05
Wealth index	1.27	1.20	1.35	<0.001
Mother education	0.73	0.62	0.86	<0.001
Father education	0.81	0.71	0.92	0.001
Husband occupation	1.01	0.97	1.05	0.524
Mother occupation	1.04	0.84	1.30	0.699
Media Factors				
Frequency of listening to radio	0.82	0.75	0.90	<0.001
Frequency of watching television	0.70	0.63	0.78	<0.001
Frequency of reading newspaper	0.78	0.67	0.92	0.002
Proximate factors				
Mother's age	1.09	0.90	1.32	0.368
Mother's BMI	0.67	0.59	0.76	<0.001
Mode of delivery	0.88	0.52	1.00	0.279
Place of delivery	0.87	0.61	1.24	0.446
Number of antenatal care	1.15	0.94	1.40	0.184
Time of 1st breastfeed	1.17	0.99	1.38	0.069
Duration of breastfeeding	1.16	1.04	1.29	0.008
Sex	0.64	0.55	0.74	<0.001
Birth order	1.31	1.10	1.57	0.003
Child's age	1.74	1.45	2.08	<0.001
Child's birth size	1.94	1.53	2.44	<0.001
Child's birth weight	0.78	0 .54	1.12	0.175
Diarrhea	1.21	1.08	1.35	0.001
Child's parasite drug in 6months	1.64	1.32	2.03	<0.001

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Appendix

ICF

Jan 12, 2020

Similien NDAGIJIMANA
University of Rwanda
Rwanda
Phone: +250782876830
Email: similienn@gmail.com
Request Date: 01/11/2020

Dear Similien NDAGIJIMANA:

This is to confirm that you are approved to use the following Survey Datasets for your registered research paper titled: "UNDERSTANDING THE BURDEN OF STUNTING AMONG UNDER-FIVE CHILDREN IN RWANDA":

Rwanda

To access the datasets, please login at: https://www.dhsprogram.com/data/dataset_admin/login_main.cfm. The user name is the registered email address, and the password is the one selected during registration.

The IRB-approved procedures for DHS public-use datasets do not in any way allow respondents, households, or sample communities to be identified. There are no names of individuals or household addresses in the data files. The geographic identifiers only go down to the regional level (where regions are typically very large geographical areas encompassing several states/provinces). Each enumeration area (Primary Sampling Unit) has a PSU number in the data file, but the PSU numbers do not have any labels to indicate their names or locations. In surveys that collect GIS coordinates in the field, the coordinates are only for the enumeration area (EA) as a whole, and not for individual households, and the measured coordinates are randomly displaced within a large geographic area so that specific enumeration areas cannot be identified.

The DHS Data may be used only for the purpose of statistical reporting and analysis, and only for your registered research. To use the data for another purpose, a new research project must be registered. All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. Please reference the complete terms of use at: https://dhsprogram.com/Data/terms-of-use.cfm.

The data must not be passed on to other researchers without the written consent of DHS. However, if you have coresearchers registered in your account for this research paper, you are authorized to share the data with them. All data users are required to submit an electronic copy (pdf) of any reports/publications resulting from using the DHS data files to: references@dhsprogram.com.

Sincerely,

Bridgette Wellington

Bridgette Wellington
Data Archivist
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