Original Article

Association of the daily diet with childhood stunting in Burundi

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Abstract

Background: *Stunting is a major public health problem in Africa, where more than one-third of below 5 years children are stunted. The aim of this paper is to find relation of daily dietary intake of <5 years old children with their height for age status in Burundi.*

Method: *A literature review was done using CINAHL, PubMed, Medline. A grey literature search was done using Google scholar and Bing. The most recent Demographic and Health Survey (DHS) data from the target country was used for the data analysis. The analysis contains the data pertaining to children <5 years of age.*

Results: *information of a total of 6096 children were included in the study among them 55% of children were stunted. Female children are more susceptible to stunting than the male. Children living in rural areas have a higher possibility of having below normal height for age. Children who did not consume milk and sugar in the previous day (1.809 times higher risk and 1.542 times higher risk respectively) are at higher risk of being stunted relative to the normal child. Children who are born in a twin (AOR OR = 3.4, 95% CI = 1.875-6.104) or triplet (AOR = 6.9, 95% CI = 3.204-14.736) pregnancy have high risk of being stunted. The relative risk of stunting increases in people who are in a low socio-economic class.*

Conclusion: *Findings from this national-level data clearly show that there is a need for interventions addressing macro-nutrient deficiency along with special attention to micro-nutrients supplements can solve the problem of stunting in Burundi.*

Keywords: *Burundi, dietary intake, nutrition, stunting.*

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Introduction

Malnutrition refers to deficiencies, excess or imbalance in a person's intake of energy and/or nutrients. The term malnutrition covers 2 broad areas. One is under-nutrition which includes stunting (low height for age), wasting (low weight for height) and underweight (low weight for age). The other is overweight, obesity and diet-related non-communicable disease.[1] According to the 2017 UNICEF data, globally 150.8 million people are stunted. Among these 150.8 million children, 58.7 million children are African. Since 2000, Africa has been the only region where the number of stunted children has risen. According to recent statistics, 36.7% of the 50.8 million stunted children of Africa live in the East African region.[2]

Stunting or linear growth failure is a very common measure of child health inequalities. Stunting is a form of under-nutrition which can occur due to poor nutrition, infections, and environmental problems and many other causes. According to WHO, children are defined as stunted if their height-for-age is more than 2 standard deviations (SD) below the WHO Child Growth Standards Median. Stunting is a major public health problem in Africa, where more than one-third of the children under 5 years of age are stunted. Several types of research have shown that stunting poses severe health, economic and intergenerational consequences: higher risk of death; poorer psycho-motor and mental development and school achievement; loss of human capital and economic productivity in adulthood; increased risk of chronic diseases; and reduced maternal

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reproductive outcomes. There is increasing international recognition that efforts to prevent stunting can improve short- and long-term outcomes at the individual, community and country levels.[3] Maternal stunting can restrict uterine blood flow and growth of the uterus, placenta, and foetus. Maternal stunting is consistently associated with an elevated risk of perinatal mortality. These deaths are mostly related to obstructed labour resulting from a narrower pelvis in stunted women. Also, many of the surviving neonates of obstructed labour often suffer from birth asphyxia. An estimated one million children who survive birth asphyxia live with chronic neurodevelopmental disorders, including cerebral palsy, mental retardation, and learning disabilities. Brain damage due to stunting leads to a delay in the development of cognitive functions as well as permanent cognitive impairments. All the above evidence has been linked to economic productivity.[4] Burundi is situated in East Africa. Since gaining independence in 1962, Burundi has experienced multiple episodes of mass violence. The outbreak of a twelve-year civil war gave rise to extreme poverty. Burundi is consistently listed as one of the top three poorest countries in the world.[5] Since the outbreak of civil war, most people of Burundi have fallen victim to food insecurity. As a result, this conflict-ridden country has the highest percentage of stunted children in the world according to USAID.[6] The most common foods consumed daily in Burundi are beans, corn, peas, millet, sorghum, cassava, sweet potatoes, and bananas. The diet consists mainly of carbohydrates. Due to the high price, little fat and protein are consumed. Meat accounts for 2% or less of the average food intake. Fish is consumed mainly in the areas around Lake Tanganyika[7]. The aim of this paper is to find the relationship between daily dietary consumption of 0-59 months aged children with their nutritional status, specifically stunting. The reason behind undertaking this analysis is to help the concerned organizations that are working in Burundi to reduce food insecurity. This data can motivate them to modify their program policy.

Method

Literature review

The primary stage of this analysis was to be familiarized with the health issue "Stunting", especially in the African region. The official website of WHO, UNICEF and World Bank provided an overview of the current nutritional status in the African region, especially in Burundi. Multiple National and international news release gave a brief idea of the current political situation in Burundi and how did the political situation affect the food security of the general populatio.[8] A literature review was done by searching academic databases CINAHL, PubMed, Medline. Keywords included 'stunting', 'Burundi' 'nutritional intervention' 'nutritional status' 'dietary intake and nutrition' etc. Literature that were published between the year 2000 to 2019 were included in the review. During the literature review, it was noticed that there are not many types of research done in Burundi, probably because of the political unrest. However, the limited number of studies that were found about Burundi and under 5 years children health primarily deals with nutritional intervention. Multiple intervention studies were seen to deal with providing readily available micro-nutrient or artificially made energy enriched food to the children and measuring their improvement of nutritional status.

Data collection

According to the National Institute of Health (NIH) in the United States, 'primary data analysis' is limited to the analysis of data by members of the research team that collected the data. Any other analysis of that collected data for specific research studies' purpose will be considered 'secondary analysis of existing data'. Theoretically, secondary analysis of existing data can be done by taking one of these two approaches: the 'research question-driven' approach and the 'data-driven' approach. In the first approach, the researcher already made the research question in mind and then look for suitable datasets to find the answer. In the data-driven approach, the researcher selects a dataset and based on the variables in that dataset, a research question is decided. However, in practice, the two approaches are often used jointly.[9] The primary advantage of using secondary data is that the researcher does not have to spend money, time and energy. A second major advantage of using secondary data is that they are collected on a large, national scale. So, the result represents the population more reliably. A third advantage of using secondary data is that the data collection process often maintains a level of expertise and professionalism that may not be present in individual researchers.[10]

The main purpose of the study was to find out the relationship of daily dietary intake with the stunting status. It was decided to analyse secondary data is the best way to serve the purpose of this study. FEWS NET, CE-DAT, DHS websites were searched for the appropriate dataset for analysis. Raw Data from the above-mentioned sites are checked to find out the set that has the most relevant indicator that can be utilized to explain the study question. The DHS dataset is noticed to be the most comprehensive dataset to serve the purpose of the study.

About Demographic and Health Survey (DHS)

Demographic and Health Surveys (DHS) are nationally representative population-based surveys with large sample sizes (usually between 5,000 and 30,000 households). Since the start of its operation, DHS has completed a household-based survey in about 70 countries. DHS team has developed a standard model questionnaire that is used in every country, along with a written description of why certain questions or sections have been included. Though a country is asked to follow the model questionnaire, some culture-specific questions or questions of interest can be added, and sensitive or irrelevant questions in a country can be omitted. Although, women age 15-49 in the households are the primary candidate as respondent of the survey in many surveys; in some surveys, men are also eligible to participate. There are three core questionnaires in DHS surveys: A Household Questionnaire, a Women's Questionnaire, and a Men's questionnaire. The collected information from these questionnaires then is compiled into a different dataset with special attention to a specific topic or area of interest[11]. Permission to access the dataset for Burundi is obtained from the DHS archive. Burundi 2016-17 Standard DHS survey data was used for this analysis. Among multiple sets of data, the Birth's Recode (BR) data set was noticed to contain the most appropriate variables for this analysis. This dataset has one record for every child ever born to interviewed women. In this dataset, information on pregnancy and postnatal care, as well as immunization, nutrition, and health for children are also included.

Variable Information

The analysis phase begins with selecting the indicators (variables) necessary for answering the research question. The birth recode set contain about 1250 variable. From these variables, only variables are kept in a new dataset those have importance to this study. This birth recodes dataset contains information on all the children ever born to a woman. However, the interest of this study was only children who were born 5 years prior to the survey. So, we kept only children that are 0-59 months of age in the new dataset. The 'Height/Age standard deviation according to new WHO guideline' variable was selected as the response variable. This variable was further recoded as Height/Age standard deviation according to new WHO guideline >-2 SD = Stunted (No) and Height/Age standard deviation according to new WHO guideline <=-2 SD = Stunted (Yes).

This 'Stunted' variable is the primary outcome of this analysis. The dataset has the dietary intake information based on 24 hours recall. There were multiple variables depending on the type of food. Those variables were further recoded based on the major nutritional content of the food. This further classification was done in accordance with the classification determined by the World Food Program Vulnerability Analysis and Mapping (WFP-VAM) program. In that classification, it was dictated to use a 7-day food intake recall with quantity measurement. However, this dataset had information on only 24 hours recall and it was decided to categorize the food consumption information according to the WFP-VAM classification and build the relation based on available information on the data set. During the literature review, it was noticed that several intervention studies test the efficacy of the artificially made nutrient-enriched food. The dataset contained information on the consumption of such supplement food as well. So, that variable was also included as a predictor. Micro-nutrient deficiency is a common feature in the nutritional supplement. Based on the available information in the dataset we included whether the baby has taken any micro-nutrient supplement (Vitamin A, Iron) variable in our analysis. Table 1 contains a list of variables that were included in the primary stage of this analysis. Our categorization of the daily food intake according to WFP-VAM was this way: 'Main staple' is food made with Maize, maize porridge, rice, sorghum, millet pasta, bread and other cereals Cassava, potatoes, and sweet potatoes, other tubers, plantains. 'Pulse' is food made from beans, peas, lentils, nuts. 'Vegetable' is pumpkin, carrots, squash (yellow or orange inside), dark green leafy vegetables. 'Fruit' is mangoes, papayas, other vitamin A fruits, any other fruits. 'Meat-fish' is fish or shellfish, liver, heart, other organs, egg, meat (beef, pork, lamb, chicken, etc.). 'Milk' is baby formula, milk, milk product. 'Sugar' is juice, sugar, sugar cane, honey. Oil is any oil used to prepare food for the children.

Statistical Analysis

As the outcome of interest is binary so it was decided to build a logistic regression model to determine the relation of daily dietary intake with the outcome of interest (stunting status of the children). Necessary assumptions were checked between the independent and dependent variables. The next step was building bivariate models to determine which independent variable of interest should be included in the final model. The cut-off p-value for an independent predictor to be included in the model was set to p-value<0.2. During this stage, many variables had to be excluded as they could not fulfil the requirement. For the final model building phase, the cut-off p-value was set to p-value <0.05. The Interaction terms were considered and p-value for interaction terms to be included in the final model was decided as p-value <0.05. The Unadjusted model does not contain any confounder. Variables that were thought to have a modifying effect on the outcome variable were checked for confounding effect. Those variables that modified the outcome coefficient by ≥20% were included as a confounder in the adjusted model. SAS windows version 24 and SAS online version was used for the analysis process.

Results

This analysis considered only children of 0-59 months of age. The dataset contained information pertaining to a total of 6096 children of that age. Among these 6096 children, 3354 (55%) children were stunted and the rest of 2742 (45%) were not stunted. The distribution of stunted and normal children within different age groups shows proportion of stunted children is highest in the 0-9 months age group. Children living in urban areas have a higher possibility of having a normal height for age.

Table I contains a list of indicators that were considered in the primary stage of this analysis. The respective frequency of those indicators within normal and stunted children were also shown in that table. It was noticed that a significant proportion of children are devoid of taking protein (meat -fish), milk and fruit. These are the foods that are essential for building up the musculature at an early stage of life.

Table II is showing the variables and associated relative risk (Odds Ratio) for the outcome variable. These are the variables that were included in the final model. So, the odds ratio shown in that table is crude or unadjusted. The final model is showing that children who did not eat vegetables have 0.740 times lower risk of being stunted. Also, children who are taking iron supplements have 0.743 times lower risk of being stunted. Children who did not consume milk and sugar in the previous day are more susceptible (1.809 times higher risk and 1.542 times higher risk respectively) of being stunted.

TableI List of predictors of interest with associated frequency according to stunting status

Predict.ors	Not Stunted	Stunted
Main Staple		
No	1689 (44.24%)	2129 (55.76%)
Yes	1053 (46.22%)	1225 (53.78%)
Pulse		
No	2013 (45.82%)	2380 (54.18%)
Yes	729 (42.81%)	974 (57.19%)
Vegetable		
No	1694 (46.33%)	1962 (53.67%)
Yes	1048 (42.95%)	1392 (57.05%)
Meat-fish		
No	2381 (44.39%)	2983 (55.61%)
Yes	361 (49.32%)	371 (50.68%)
Fruit		
No	2065 (44.29%)	2597 (55.71%)
Yes	677 (47.21%)	757 (52.79%)
Milk		
No	2455 (43.66%)	3168 (56.34%)
Yes	287 (60.68%)	186 (39.32%)
Sugar		
No	2301 (43.44%)	2996 (56.56%)
Yes	441 (55.19%)	358 (44.81%)
Multiple micro-nutrient powder in the last 7 days		
No	1823 (49.43%)	1865 (50.57%)
Yes	37 (59.68%)	25 (40.32%)
Vitamin A supplement in the last 6 months		
No	975 (47.17%)	1092 (52.83%)
Yes	1766 (43.86%)	2260 (56.14%)
Iron Pill or supplement (ongoing)		
No	2576 (45.44%)	3093 (54.56%)
Yes	166 (38.97%)	260 (61.03%)
Birth Status		
Single Birth	2716 (45.63%)	3236 (54.37%)
2^{nd} in twin birth	17 (22.37%)	59 (77.63%)
3^{rd} in triplet birth	9 (13.24%)	59 (86.76%)
Wealth index[11]		
Poorest	384 (31.09%)	851 (68.91%)
Poor	432 (35.79%)	775 (64.21%)
Middle	479 (38.66%)	760 (61.34%)
Rich	600 (50.51%)	588 (49.49%)
Richest	847 (69.03%)	380 (30.97%)

Table II Unadjusted multiple regression model with a respective confidence interval (OR in favour of being stunted)

Predictors	Crude Odds Ratio	95% CI	P-Value
Vegetable (No vs Yes)	0.740	0.662-0.827	<.0001
Milk (No vs Yes)	1.809	1.465-2.233	<.0001
Sugar (No vs Yes)	1.542	1.300-1.830	<.0001
Iron supplement (ongoing) (No vs Yes)	0.743	0.606-0.910	0.0042

The final model was adjusted for taking the confounders into consideration. Table 3 is showing the odds ratio and respective confidence interval for the predictors after adjustment for the confounders. It was calculated that children of 10-19 months age have a 2.7 times higher risk of being stunted relative to the children of 0-9 months of age. Similarly, children of 20-29 months, 30-29 months, 40-49 months and 50-59 months have 3.4 times, 4.8 times, 4.3 times and 3.8 times higher risk of being stunted respectively, relative to 0-9 months children. female children have a significantly higher risk of stunting compared to male children (OR = 1.4, 95% CI = 1.235-1.538). Place of residence has a significant effect on stunting. Children living in rural areas have (OR = 1.6, 95% CI = 1.288-1.898) higher risk of being stunted compared to children living in the urban area. Children of twin pregnancy have a much higher risk of being stunted (OR = 3.4, 95% CI = 1.875-6.104) relative to the children from singular pregnancy. And, the risk of stunting is even higher in children from a triplet pregnancy (OR = 6.9, 95% CI = 3.204-14.736). It is no surprise that stunting status will deteriorate with the lower socio-economic class. This analysis shows the same trend of increasing risk of stunting in the lower socio-economic class.

Table III Adjusted multiple regression model with a respective confidence interval (OR in favour of being stunted)

Predictors	Adjusted Odds Ratio	95% CI	P-Value
Child Age 0-9 Months	1	-	-
10-19 Months	2.666	2.181-3.259	<.0001
20-29 Months	3.482	2.868-4.228	<.0001
30-39 Months	4.846	3.964-5.923	<.0001
40-49 Months	4.291	3.522-5.227	<.0001
50-59 Months	3.755	3.100-4.548	<.0001
Gender (Male vs Female)	1.378	1.235-1.538	<.0001
Main Staple (No vs Yes)	1.038	0.879-1.225	0.6630
Pulse (No vs Yes)	0.886	0.760-1.034	0.1237
Vegetable (No vs Yes)	0.804	0.680-0.950	0.0103
Fruit (No vs Yes)	1.146	0.979-1.343	0.0903
Milk (No vs Yes)	1.211	0.959-1.530	0.1079
Sugar (No vs Yes)	1.005	0.829-1.220	0.9563
Vitamin a supplement in the last 6 months (No vs Yes)	0.997	0.884-1.125	0.9662
Iron supplement (ongoing) (No vs Yes)	0.903	0.726-1.124	0.3604
Birth Status			
Single Birth	1	-	-
2nd in twin birth	3.383	1.875-6.104	<.0001
3rd in triplet birth	6.872	3.204-14.736	<.0001
Wealth index[11]			
Poorest	3.987	3.232-4.918	<.0001
Poor 3.204	2.596-3.955	<.0001	
Middle	2.669	2.172-3.279	<.0001
Rich 1.676	1.372-2.047	<.0001	
Richest	1	-	-
Place of Residence (Urban vs Rural)	1.564	1.288-1.898	<.0001
Number of total children ever born	1.027	1.003-1.051	0.0276

Discussion

Among stunted children, 53.78% had staple food on the previous day whereas, 46.22% children who did not ate staple food are not stunted. Again, 57.19% children who ate pulses on the previous day are stunted and 42.81% children who did not ate pulses on the previous day are not stunted. Similarly, Major portion of children who ate Vegetable (57.05%), Fruit (52.79%) and Meat-Fish (50.68%) on the previous day are stunted. Most of the children (56.14%) under 5 years of age who had vitamin A supplement in previous 6 months are stunted and, 61.03% children who were having iron pill are stunted. This numbers shows evidence against the existing knowledge that macro-nutrients and micro-nutrients are necessary for child growth. This misleading prevalence can be attributed to the missing values. Analysis from this dataset reveals, standard deviation of average height for age of children under 5 years of age in Burundi is -1.87. This value indicates that the percentage of stunting in Burundi for under 5 children may be almost half of the total, but the rest of the children is not sufficiently nourished either. This paper has aimed to find an association between the daily intake of children and their nutritional status. The method used in this paper have limits in this sense that the amount of food consumption could not be determined. Also, food consumption history is only for 24 hours. An ideal nutritional assessment needs at least 7-days food consumption history with the amount. With enough information, the final model could have been more specific to predict the outcome. The model built in this analysis has a specificity of 0.72. Which means this model can predict stunting condition for under 5-years children in 72 % cases accurately. The DHS is a nationally representative data. DHS uses multi-stage sampling technique[12]. So, the result is supposed to represent the population in a way better than the small-scale studies. Using the multivariate analysis has made it possible to show the association of multiple factors in a single model. However, using a multivariate model has its own detrimental effect. This effect is related to the missing value of the individual factor. The final model is built upon the information that is common to all the predictors that were included in the model. As a result, Predictors like meat- fish and main staple could not be included in the model. Though it is scientifically proven protein (meat-fish) and carbohydrate (main staple) essential for body growth. These variables were thought to have a significant effect on stunting but unfortunately, they had to be removed from the final model. Probably because the missing value acted as an obstacle to build a regression model including those variables.

The 1990s were a violent decade in Burundi's history. The political unrest at this time left a long-lasting effect on the country's economy. The country has not been yet able to overcome this situation. As a result, the food price becoming increasingly high. Employment opportunity is very less. the general population has fallen victim to This adverse socio-economic condition. According to USAID, approximately 13% of the total Burundi population are food insecure[6]. The current total annual food production in Burundi would only cover for 55 days per person per year[14]. As result, many children pass days in a week with a little amount of food that is insufficient to meet hunger. This is evident by this statistical analysis that more than half of the total <5 years children are stunted in Burundi. The model built in this article may not be an excellent predictor for stunting status in children Burundi, however, it shows evidence that removing food insecurity in Burundi is an important way to fight stunting. Similar studies to identify nutritional and other factors related to childhood stunting in different communities in Burundi should be carried out and evidence from those studies could help to target strategies to address the stunting problems of the country. Poor nutrition status of the Burundi children could be alleviated by nutrition education to the parents and intervention programmes addressed to remove macro-nutrient and micro-nutrient deficiency.

Conflict of interest: None.

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