

## Factors Contributing to Diarrheal Diseases among Children Less than Five Years in Nyarugenge District, Rwanda

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### Abstract

**Background:** The burden of diarrheal diseases among children is by far more in low and middle-income countries where it is the second leading cause of deaths in children under 5 years. In Rwanda, it is a third leading cause of childhood morbidity and mortality where it counts 15% of deaths.

**Objective:** The aim of this study was to determine factors associated with diarrheal diseases among children less than five years in Nyarugenge district, Rwanda.

**Methodology:** The study was descriptive cross-sectional. Multi stage sampling technique whereby in the first stage 6 health facilities were selected randomly and in the second stage 359 respondents were selected systematically. A Structured pre-tested questionnaire was used to collect data. Pearson's chi-square test ( $p < 0.05$ ) and odds ratio with corresponding 95% confidence interval were used to establish the association between the dependent variable and independent variables.

**Results:** The 2 week period prevalence of diarrhea among less than five children was 26.7%. Factors independently associated with diarrheal diseases occurrence were: children whose mothers/caretakers had never attended school (aOR=3.76; 95%CI=1.26-11.24;  $p=0.018$ ) and attended primary (aOR=2.94; 95%CI=1.04-8.28;  $p=0.042$ ) compared to those who attended tertiary level of education; children who had not vaccinated for Rota virus (aOR=8.11; 95%CI: 1.84-35.70;  $p=0.006$ ); mothers/caretakers who reported presence of feces around their houses (aOR=2.02; 95%CI=1.22-3.35;  $p=0.006$ ) and children living in earthen floor houses (aOR=1.76; 95%CI: 1.05-2.96;  $p=0.031$ ) compared to those living in a cement floors.

**Conclusion:** The prevalence of diarrhea was high compared to national level. Children whose mothers/caretakers had never attended and attended primary school; children who were not vaccinated for Rota virus; children living around houses where feces present and children living in earthen floors were significantly associated with diarrhea. Therefore, we recommend that health education on hygiene, Rota virus vaccination and awareness on environment sanitation should be strengthened to reduce childhood diarrhea.

**Keywords:** Diarrheal diseases; Hygiene; Multi-stage sampling technique; Socio-demographic

### Introduction

Diarrhoeal diseases are major public health problems especially in children in developing countries [1]. Globally, diarrhoea remains the second most common cause of death among children under five years [2]. There are an estimated 1.7 billion cases of diarrhoea with an average of 2.9 episodes/child/year, and an estimated 1.87 million deaths among children under five years [3]. It constitutes a major burden in low and middle-income countries (LMIC) where it is the second leading cause of death in children under 5 years of age with 90% of all diarrhea-related deaths [4]. According to World Health Organization (WHO), Africa and south-East Asia regions have 78% of diarrheal deaths among children less than five years [5]. Children are affected by diarrhea mainly due to poor environmental sanitation and hygiene, inadequate water supplies and poverty [5]. Assessing the

contributing factors for diarrheal disease requires knowledge about interactions between socio demographic, socio-economic, behavioral, and environmental factors.

In Ethiopia the prevalence of diarrheal disease among under-five children in a 2-week period was reported 31.0% in Arba Minch District [6], 26.1% in Hadaleala District [7], 24.9% in northwest Ethiopia [8], 22.5% in the eastern part of Ethiopia [9], 19.6% in a rural area of southern Ethiopia [10] and 18.0% in Mecha District [11]. There are different factors associated with occurrence of diarrhea among children less than five years and these differ from place to place. A study done in Kenya showed that, six factors were independently associated with diarrheal diseases, occupation of the parent/ guardian, care taker not washing hands after changing napkins, child drank untreated water from the river, child not exclusively breastfed, child did not wash hands before eating and after visiting toilet [12].

In Rwanda, according to National Institute of Statistics of Rwanda (2015), prevalence of children under five years who had symptoms of

diarrhea in the two weeks preceding the survey was 12%. This was higher than acute respiratory infections, among children with symptoms of diarrhea and percentage who sought treatment from a health facility/ provider was 44% more than previous surveys [13,14]. According to records from Nyarugenge district by Rwanda Health Management Information System (RHMIS), diarrheal diseases among children less than five years attending Nyarugenge districts health centers was nearly 40%. However, there is limited study about factors associated with diarrheal diseases in the study area.

## Materials and Methods

### Study design and setting

We carried out a descriptive cross-sectional study in Nyarugenge district, Rwanda. The study area was Nyarugenge district located in Kigali city, Rwanda. Nyarugenge district is divided into 10 sectors: Gitega, Kanyinya, Kigali, Kimisagara, Mageragere, Muhima, Nyakabanda, Nyamirambo, Nyarugenge and Rwezamenyo. The district has ten (10) health centers, 192 nurses, (1 nurse for 1, 468.75 inhabitants), 20 doctors (1 doctor for 14,100 inhabitants).

### Study population and sampling techniques

The study population in this study was all mothers/caretakers with children less than five years, resided in the area for at least six months and consented to participate. Multi-stage sampling technique was used. In the first stage, 6 health facilities were selected randomly. In the second stage, children less than five years were selected systematically from each selected health facility. The children were selected from the outpatient department of the respective health facilities. The number of respondents in each selected health facilities were allocated proportionally based on the previous month visited to the health facilities. The first participant in each health facility was selected using simple random sampling technique from the first 4 visitors thereafter every 4th was selected as they come to the health facility.

### Sample population

The sample size for this study was determined using a single population proportion formula ( $n = Z^2 \alpha / 2 * P (1-P) / d^2$ ) by considering the following assumptions: Z is the standard normal deviate that corresponds to 95% confidence interval, d is the degree of precision (5%), p = A prevalence of diarrhea obtained from a study done in Burundi was used (32.6%) [15]. After adding 10% non response rate, the sample size calculated was 367.

### Data collection method

Interviewer administered questionnaire developed based on WHO Core questionnaires related to diarrhea. But it was modified for cultural specificity. The questionnaire was designed in English and then translated into Kinyarwanda. Pretest was done in 5% of the

sample size and the data was collected by trained research assistants. The result of the pretest was used to correct some unclear questions. The questionnaire was divided into the following sections: (1) demographic and socio-economic information, (2) information of the index of the children and (3) environmental factors.

### Measurement of dependent variable

Childhood diarrheal disease, the dependent variable of this study, was defined as having three or more loose or watery stools in 24 hours [15,16] in the previous 2 weeks of data collection. The prevalence of diarrhoea was calculated using the number of children who reportedly had at least one episode of diarrhea within the preceding two weeks of the data collection as numerator (96) and the overall number (359).

### Data management and analysis

Data were checked daily for completeness for accuracy. The data from the questionnaires were then entered into a computer designed using MS-excel application. The data were analysed by using Statistical Package for Social Science [SPSS] Version 22. Descriptive analysis was computed whereby proportion/percentages and frequency were calculated. Pearson's chi-square test and odds ratio with corresponding 95% confidence interval were computed to establish the association between the dependent variable (diarrhoea status) and independent variables. Variables significant (less than 0.05) at bivariate analysis were considered together in multivariate analysis by specifying 'backward LR' method. The level of statistical significance set at p-value <0.05 and 95% CI without including ORs of one in between were considered significant.

## Results

### Socio-demographic characteristics of the children according to diarrhea status

Table 1 shows the distribution of selected socio-demographic characteristics of children and diarrheal diseases. The prevalence of diarrheal diseases was found to be 26.7%. The ages of the children ranged from 1 month to 59 months. The mean age of the children was 16.6 months with a standard deviation of 9.7 months. Highest percentage (47.9%) of the children were within the age category of 13 to 24 months followed by 34% within 1 to 12 months. However, this was not significant. Females were more (53.2%) than males 46.8% and the proportion of diarrhea was more among males (31.0%) compared to females (23.0%) but this was not statistically significant. Almost all children (98.3%) had ever breastfed. Similarly, large percentage (97.5%) of the children had received Rota virus vaccines and this was significant where children who were not vaccinated for Rota virus (66.7%) (OR=5.78; 95%CI: 1.42-23.58; p=0.015) had more risk of developing diarrheal diseases than to those who were vaccinated (25.7%).

Variables	Diarrhea, n(%)	No diarrhea, n(%)	Total, n(%)	COR (95% CI)	χ <sup>2</sup> test
					p value*
Child age					
1-12 months	31(25.4%)	91(74.6%)	122(34)	2.04(0.43-9.64)	0.366

13-24 months	53(30.8%)	119(69.2%)	172(47.9)	2.67(0.58-12.36)	0.208
25-36 months	10(19.6%)	41(80.4%)	51(14.2)	1.46(0.28-7.61)	0.651
37-59 months	2(14.3%)	12(85.7%)	14(3.9)	Reference	
Gender of the child					
Male	52(31.0%)	116(69.0%)	168(46.8)	1.50(0.94-2.40)	0.091
Female	44(23.0%)	147(77.0%)	191(53.2)	Reference	
Ever breastfeeding of the child					
Yes	96(27.2)	257(72.8)	353(98.3)	Reference	
No	0(0.0)	6(100.0)	6(1.7)	UD	0.136
Weather received rota virus vaccine					
Yes	90(25.7%)	260(74.3%)	350(97.5)	Reference	
No	6(66.7%)	3(33.3%)	9(2.5)	5.78(1.42-23.58)	0.015
COR= Crude Odds Ratio; CI= Confidence Interval; UD = Undefined; * Significant at p<0.05 bolded;					

**Table 1:** Socio-demographic characteristics of the children according to diarrhea status.

**Socio-demographic and socio-economic characteristics of mothers/caretakers by children who had diarrhea (n=96) and had no diarrhea (n=263)**

About half (49.9%) of the mothers/caretakers were within the age category of 18 to 25 followed by 40.1% aged between 26 to 32 years. Majority of the respondents (85.2%) were mothers to the children while the remaining (14.8%) were caretaker or guardian. Most of the mothers/caretakers (84.4%) were married and majority (77.2%) were from urban settings. Similarly, majority (81.9%) of the mothers/caretakers were Christian followers. However, these variables were not significant with diarrhea occurrence among children (Table 2).

Regarding level of education, the highest percentage (40.7%) attended primary education whereas only (9.5%) attained tertiary level

of education. This was statistically significant with diarrhea occurrence among children Children whose mothers/caretakers had never attended school (39.4%) (OR=3.77; 95%CI=1.29-10.99; p=0.015) and attended primary level of education (32.9%) (OR=2.84; 95%CI=1.04-7.80; p=0.043) had more risk of developing diarrheal diseases in the last two weeks compared to those who had tertiary level of education (14.7%). Similarly, the highest percentage (41.8%) of the mothers/caretakers were self-employed and this was significant with diarrhea occurrence. Children whose mothers/caretakers were without job (31.7%) (OR=2.48; 95%CI: 1.19-5.19; p=0.015) had more risk of developing diarrheal diseases compared to those whose mothers/caretakers were government employee (15.7%) (Table 2).

Variables	Diarrhea, n (%)	No diarrhea, n (%)	Total, n (%)	COR (95% CI)	χ <sup>2</sup> test
					p value*
Age of mothers/caretakers in years					
18-25	61(34.1%)	118(65.9%)	179(49.9)	1.81(0.78-4.21)	0.169
26-32	27(18.8%)	117(81.2%)	144(40.1)	0.81(0.33-1.97)	0.638
33-40	8(22.2%)	28(77.8%)	36(10.0)	Reference	
Relationship to the child					
Mother	79(25.8%)	227(74.2%)	306(85.2)	Reference	
Caretaker/ guardian	17(32.1%)	36(67.9%)	53(14.8)	1.36(0.72-2.55)	0.343
Residence of mothers/caretakers					
Urban	77(27.8%)	200(72.2%)	277(77.2)	1.28(0.72-2.27)	0.406

Rural	19(23.2%)	63(76.8%)	82(22.8)	Reference	
Marital status of mothers/caretakers					
Married	86(28.4%)	217(71.6%)	303(84.4)	1.98(0.85-4.63)	0.114
Single	3(21.4%)	11(78.6%)	14(3.9)	1.36(0.30-6.19)	0.688
Separated/ widowed	7(16.7%)	35(83.3%)	42(11.7)	Reference	
Religion of mothers/caretakers					
Christian	82(27.9%)	212(72.1%)	294(81.9)	Reference	
Muslim	10(18.9%)	43(81.1%)	53(14.8)	0.60(0.29-1.25)	0.174
Others	4(33.3%)	8(66.7%)	12(3.3)	1.29(0.38-4.41)	0.682
Level of education of mothers/caretakers					
Never attended school	26(39.4%)	40(60.6%)	66(18.4)	3.77(1.29-10.99)	0.015
Primary	48(32.9%)	98(67.1%)	146(40.7)	2.84(1.04-7.80)	0.043
Secondary	17(15.0%)	96(85.0%)	113(31.5)	1.03(0.35-3.03)	0.961
Tertiary	5(14.7%)	29(85.3%)	34(9.5)	Reference	
Occupation of the mother/caretaker					
Government employee	11(15.7%)	59(84.3%)	70(19.5)	Reference	
Self employed	41(27.3%)	109(72.7%)	150(41.8)	2.02(0.97-4.22)	0.062
Jobless	44(31.7%)	95(68.3%)	139(38.7)	2.48(1.19-5.19)	0.015
COR= Crude Odds Ratio; CI= Confidence Interval, * Significant at p<0.05 bolded					

**Table 2:** Socio-demographic and socio-economic characteristics of mothers/caretakers by children who had diarrhea (n=96) and had no diarrhea (n=263).

### Environmental factors stratified by diarrhea occurrence among children

Table 3 summarizes environmental characteristics of the household stratified by diarrhea occurrence among children. The table shows that there was almost equal distribution between natural earth floor (51.8%) and cement floor (48.2%). This was significantly associated with diarrhea occurrence among children. Children living in soil/sand/mud floor houses had more risk of diarrhea (32.8%) (OR=1.92; 95%CI: 1.19-3.11; p=0.007) compared to those living in a cemented floor (20.2%). About half (49.6%) of the respondents indicate presence of feces around the house and this was a significant factor for diarrhea occurrence. Children whose mothers/caretakers who reported presence of feces around the house had significantly increased risk of developing diarrheal diseases (33.1%) (OR=1.93; 95%CI=1.20-3.11; p=0.007) compared to those who indicated otherwise (20.4%).

Majority of the mothers/caretakers indicate that most (93.3%) of the houses were constructed with metal/iron sheet. About half of the mothers/caretakers (51%) claimed that they had three rooms followed by 31.2% with two rooms. Majority (61%) indicate that they did not have hand washing facilities. All the mothers/caretakers reported that they had latrines and more than half (58.8%) were sharing with neighbors. With respect to source of water, 82.7% were using piped and/or public taps, 11.1% get water from unprotected well/spring, 3.1% were using from protected well/spring and 3.1% from rivers/lakes. Almost all the mothers/caretakers (95.5%) indicated that they did not have any livestock in the family. Majority (69.6%) of the mothers/caretakers did not own any agricultural land. However, these variables were not significant with diarrhea occurrence among children.

Variables	Diarrhea, n (%)	No diarrhea, n (%)	Total, n(%)	COR (95% CI)	χ <sup>2</sup> test
					p value*
Type of the floor material of living house					
Earthen	61(32.8%)	125(67.2%)	186(51.8)	1.92(1.19-3.11)	0.007

Cement	35(20.2%)	138(79.8%)	173(48.2)	Reference	
Type of roof material of living house					
Metal/iron sheet	87(26.0%)	248(74.0%)	335(93.3)	Reference	
Thatched	0(0.0%)	3(100.0%)	3(0.8)	UD	0.999
Tile	9(42.9%)	12(57.1%)	21(5.8)	2.14(0.87-5.25)	0.097
Number of rooms in the house					
One to two rooms	40(33.6%)	79(66.4%)	119(33.1)	2.12(0.99-4.53)	0.053
Three rooms	45(24.6%)	138(75.4%)	183(51.0)	1.36(0.65-2.86)	0.411
Four rooms and above	11(19.3%)	46(80.7%)	57(15.9)	Reference	
Having hand washing facility					
Yes	36(25.7%)	104(74.3%)	140(39.0)	Reference	
No	60(27.4%)	159(72.6%)	219(61.0)	1.09(0.67-1.76)	0.725
Ownership of latrine facility					
Private	37(25.0%)	111(75.0%)	148(41.2)	Reference	
Shared	59(28.0%)	152(72.0%)	211(58.8)	1.16(0.72-1.88)	0.533
Whether faeces are around the house					
Yes	59(33.1%)	119(66.9%)	178(49.6)	1.93(1.20-3.11)	0.007
No	37(20.4%)	144(79.6%)	181(50.4)	Reference	
Source of water					
Piped and public taps	77(25.9%)	220(74.1%)	297(82.7)	Reference	
Protected well/spring	5(45.5%)	6(54.5%)	11(3.1)	2.38(0.71-8.02)	0.162
Unprotected well/spring	11(27.5%)	29(72.5%)	40(11.1)	1.08(0.52-2.27)	0.832
River/lake	3(27.3%)	8(72.7%)	11(3.1)	1.07(0.28-4.14)	0.920
Whether the family has livestock					
Yes	5(31.2%)	11(68.8%)	16(4.5)	1.26(0.43-3.72)	0.677
No	91(26.5%)	252(73.5%)	343(95.5)	Reference	
Ownership of agricultural land					
Yes	32(29.4%)	77(70.6%)	109(30.4)	1.21(0.73-1.99)	0.459
No	64(25.6%)	186(74.4%)	250(69.6)	Reference	
COR= Crude Odds Ratio; CI= Confidence Interval; UD= Undefined; * Significant at p<0.05 bolded					

**Table 3:** Environmental factors stratified by diarrhea occurrence among children.

### Factors associated with diarrheal diseases among children aged less than 5 years

Multiple regression analysis was performed in order to identify factors independently associated with diarrheal diseases among children aged less than 5 years. All factors significantly associated at bivariate analysis were considered together in a multivariable analysis. Five factors were considered in the analysis. Upon fitting these factors

using binary logistic regression and by specifying 'backward LR' method with removal at  $p < 0.05$ , four factors remained in the final analysis or reduced model (Table 4).

Children whose mothers/caretakers had never attended school were 3.7 times (aOR=3.76; 95%CI=1.26-11.24;  $p=0.018$ ) and attended primary were 2.9 times (aOR=2.94; 95%CI=1.04-8.28;  $p=0.042$ ) more likely to have diarrheal diseases compared to those who attended

tertiary level of education. Children who had not vaccinated for Rota virus were about 8 times more likely to develop diarrheal diseases (aOR=8.11; 95%CI: 1.84-35.70; p=0.006) than to those who were vaccinated. Mothers/caretakers who reported presence of feces around their houses had 2 times more children with diarrheal diseases

compared to those reported otherwise; (aOR=2.02; 95%CI=1.22-3.35; p=0.006). Children living in earthen floor houses had 1.7 times more risk of diarrhea (aOR=1.76; 95%CI: 1.05-2.96; p=0.031) compared to those living in a cement floors.

Variables	COR (95% CI)	p value*	AOR (95% CI)	p value
Level of education of mothers/caretakers				
Never attended	3.77(1.29-10.99)	0.015	3.76(1.26-11.24)	0.018
Primary	2.84(1.04-7.80)	0.043	2.94(1.04-8.28)	0.042
Secondary	1.03(0.35-3.03)	0.961	1.00(0.33-3.04)	0.999
Tertiary	Reference		Reference	
Occupation of the mother/caretaker				
Government employee	Reference		Reference	
Self employed	2.02(0.97-4.22)	0.062	0.75(0.29-1.92)	0.541
Jobless	2.48(1.19-5.19)	0.015	0.77(0.28-2.10)	0.608
Weather received rota virus vaccine				
Yes	Reference		Reference	
No	5.78(1.42-23.58)	0.015	8.11(1.84-35.70)	0.006
Type of the floor material of house				
Earthen	1.92(1.19-3.11)	0.007	1.76(1.05-2.96)	0.031
Cement	Reference		Reference	
Whether feces are around the house				
Yes	1.93(1.20-3.11)	0.007	2.02(1.22-3.35)	0.006
No	Reference		Reference	

COR= Crude Odds Ratio; CI= Confidence Interval; aOR= Adjusted Odds Ratio

**Table 4:** Factors associated with diarrheal diseases among children aged less than 5 years.

## Discussion

This study provides the prevalence of diarrheal diseases and its determinants among children less than five years in the previous two weeks preceding data collection. Our study found that, the prevalence of diarrhea in children aged less than five years was 26.7%. This was similar to a study of 2-week period prevalence of diarrheal disease among under-five children conducted in Hadaleala District of Ethiopia which reported 26.1% [7]. The finding of this study is slightly lower than the finding of a study conducted in Burundi (32.6%) [15] and in Arba Minch District, Ethiopia (31.0%) [6]. However, it was very high compared to the national prevalence (12%) [13]. Furthermore, it was by far higher compared to a cross-sectional study conducted in Indigenous Batwa Pygmy in southwestern Uganda within the previous 14 days which showed 6.17% [17]. The disparity in prevalence rates may be due to seasonal variation. The data of the present study was collected in October which is a rainy season. During this period water sources are easily polluted, these sources of water are mostly utilized by

households for washing of hands, household activities and even drinking especially for those using streams or boreholes.

This study indicated that mothers/caretakers level of education was statistically associated with the occurrence of childhood diarrhea. Children whose mothers/caretakers had never attended school were 3.7 times and attended primary were 2.9 times more likely to have diarrheal diseases compared to those who attended tertiary level of education. This finding is similar with other studies [6,18-22]. This was also supported by RDHS in 2014-2015 where it was revealed that the prevalence of diarrhea is higher among children whose mothers have no education (14 percent) or a primary education (12 percent) than among those whose mothers have a secondary education or higher (9 percent). This may be due to the fact that education is likely to enhance household health, good feeding and weaning practices and hygiene and sanitation practices. Education can also increase awareness about the transmission and prevention methods of diarrhea. It also encourages changes in behavior at the household level.

Our study found that children who had not vaccinated for Rota virus were 8 times more likely to develop diarrheal diseases than to those who were vaccinated. This finding is similar to a cross-sectional study undertaken during 2012-2013 to determine the prevalence, strains and factors associated with rotavirus infection among under-5-year-old children hospitalized with acute diarrhea in Uganda which found that Rotaviruses are the most cause of diarrhea in children [23]. Rotavirus is the most common cause of severe childhood gastroenteritis worldwide [24]. Rotavirus vaccine resulted in a large decline in diarrhea mortality and concluded that vaccination is the best way to prevent severe rotavirus disease and the deadly, dehydrating diarrhea that it causes [25].

Mothers/caretakers who reported presence of feces around their houses had significantly more children with diarrheal diseases compared to those reported otherwise. Diarrhea is generally due to exposure to diarrhea-causing organisms which is mainly found in feces. The practice of unsafe child feces disposal contaminates the surrounding environment with human excreta which carries many infectious organisms that can cause enteric diseases such as childhood diarrhea [26-28]. This result was consistent with other reports, where environmental sanitations most often linked with the diarrhoea is refuse disposal [29-31]. Therefore, safe feces disposal practice may be particularly important in prevention of fecal-oral transmission as children are more susceptible to these diseases and are often defecating in areas where other children could be exposed.

The occurrence of diarrhoea was 1.7 times higher in children of families whose homes had earth floors than in children whose homes had cemented floors. This is in agreement with a study conducted Saudi Arabia [32]. A possible reason for this could be that the earthen floor serves as a repository for microorganism.

## Conclusions and Recommendation

The study reveals that the prevalence of diarrheal diseases was high (26.7%) compared to National level (12%). Moreover, multiple logistic regressions revealed that the following factors as independent predictors of diarrheal diseases: children whose mothers/caretakers had never attended and attended primary school; children who were not vaccinated for Rota virus; children living around houses where feces present and children living in earthen floors. This finding is important because it has implications on the implementation of healthcare programs to address childhood diarrhea problems in Rwanda. The Ministry of Health and other stakeholders should increase the awareness on sanitation of the environment in order to increase hygiene level around the house (especially feces). Moreover, the mothers/caretakers should be encouraged to fully vaccinate their children against Rotavirus.

## Limitation

The occurrence of diarrhea was determined based on the reports of mothers/caretakers without the confirmation of physicians. As such the study might be affected by social desirability bias. However, the data was collected by trained research assistants. Another important limitation of the study was that the occurrence of diarrhea obtained 2 weeks period prior data collection and data collection was conducted in one month. This does not account for seasonality; hence data are not comparable either across sites or over time.

## Competing Interests

The authors declare that they have no competing interests.

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