
Original article**Environmental and Nutritional Determinants of Diarrhoea Disease Among Children Under Five Years in Rwanda: A Secondary Data Analysis of the Rwanda Demographic and Health Survey 2014-15**Christian J. Ishimwe^{1*}, Erigene Rutayisire², Onesmus Marete²¹*Planning Division, Rwanda Biomedical Center, Kigali, Rwanda*²*Mount Kenya University, Kigali, Rwanda****Corresponding author:** Christian J. Ishimwe, Planning Division, Rwanda Biomedical Center, P.O. Box 7162 Kigali, Rwanda. Email: juleschristianishi@gmail.com.

Abstract**Background**

Diarrhoea remains one of the leading causes of deaths in children under five years old globally. Children under five years are more vulnerable to diarrhea especially those from low and middle countries. The aim of this study was to explore the environmental and nutritional factors associated with diarrhea among children under five years in Rwanda.

Methods

A secondary data analysis of the Rwanda Demographic and Health Survey 2014-2015 (RDHS 2014-2015) was used. A total sample of 7,558 children under five years old was included. The data were analysed using Stata 13. Bivariate with Chi-square test and multivariable logistic regression analysis were performed to assess the relationship of factors associated with diarrhea. A 95% confidence interval and a significance level of 0.05 were set.

Results

Two environmental factors (Source of drinking water and shared toilets facilities with other households) were associated with child diarrhea. P-values: 0.029, OR:1.79, CI [1.06-3.01]; 0.019, OR:1.26, CI: [1.04-1.53] respectively. None of the selected nutritional factors was associated with childhood diarrhea.

Conclusion

Based on the findings, drinking borehole water and shared toilet facilities were associated with diarrhea. The study therefore recommends the provision of potable water and supporting/enabling the households to own toilets.

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Keywords: Under five children, environmental and nutritional determinants, diarrhea, Rwanda

Background

Diarrhoea is one of the leading causes of death in children under-five old globally, and it is responsible for an estimated 525 000 deaths annually.[1,2] Diarrhea causes nearly 1.7 billion cases every year, and high estimates were documented mainly in low and middle income countries (LMICs). Diarrhea commonly affect children especially those living in the areas with poor hygiene and sanitation and with limited access to safe water. It is estimated that 1.5 to 2.2 million people die each year from diarrhea and its related diseases and high vulnerability occur particularly in young children in their first two years of live.[3,4]

Diarrhoea is the passage of three or more loose or watery stools within a day or unusual frequency of diarrhea episodes.[5]It can be prevented through a community led total sanitation and hygiene interventions. Preventive measures to reduce exposure to enteric pathogens responsible for diarrheal diseases can include improved quality drinking and cooking water, hand-washing practice, safe storage of food, and sanitary disposal of fecal waste.[6]

Some initiatives have been established to lessen the burden of diarrhea, including notably a Global Action Plan for Pneumonia and Diarrhoea (GAPPD) with goals

to ensure child access to appropriate preventive and treatment services.[7] However, diarrhea is still a high burden disease and it results from a complex interaction of environmental and food, sanitation and hygiene.[8,9] The global burden of diseases, injuries and risk factors study estimated that diarrhea was responsible for an estimated 330000 deaths among children under five years of age in 2015.[7,10]

Children younger than five years old in LMICs in South Asia and Sub-Saharan Africa experience an average of three episodes of diarrhea per year. Incidence rates vary but are higher in children in low income countries, and highest in Sub-Saharan Africa where a child can experience three diarrhea episodes per year. An estimated 526,000 under five child deaths due to diarrhea occurred in 2015, representing a fifty-eight percent reduction from 2000 to 2015.[6] The 2014-15 Rwanda Demographic and Health Survey reported that 12% of children under five years old had diarrhea within the two weeks preceding the survey [11] but factors behind diarrhea occurrence were not reported. The present study therefore explored environmental and nutritional determinants of diarrhoea among children under 5 years in based on data from the Rwanda National survey.

Methods

Design and setting

A secondary data analysis was used to explore factors associated with diarrhea among children under five years old. This study used the data from the National Demographic and Health Survey conducted by the 2014-2015 RDHS.

Population

The current study has used a total of 7,558 children under five years included in the survey and whose information was collected by the RDHS.[11]

Sample size and sampling strategy

The study used a sample from the Rwanda Demographic and Health Survey (RDHS) conducted by the National Institute of Statistics of Rwanda (NISR) in November 2014-April 2015. The 2014-15 RDHS used a two-stage sample design to get a national representative sample. The first steps consisted of identification of 492 villages that were clustered proportionally into village size. The second sampling phase consisted of comprehensive mapping and listing of households in selected villages. Identified households provided a mapping frame in aiding the selection of the second sample. Systematic selection of households was done from the list to participate in the survey .[12] From all 492 villages

surveyed. Of 12,793 households were selected and 12,717 households were identified as occupied during the survey period. Among the selected households, 12,699 households completed the questionnaire. In the 12,699 households surveyed, 13,564 women age 15-49 were identified as being eligible for the individual interview; interviews were completed with 13,497 of these women. We used a sample of 7,558 children whose information was collected and available in the Kid Record dataset (RWKR70FL). The Kids Record dataset was considered because it holds child and maternal information that is relevant to this study.[11]

Data collection tools

This study used a secondary data analysis of the data that was collected by the Rwanda demographic and health survey 2014-15.[11] The survey used the Household Questionnaire, the Woman's Questionnaire, and the Man's Questionnaire. These questionnaires were adapted from the questionnaires developed by the worldwide DHS Program. Different stakeholders from governmental ministries and agencies, nongovernmental and international donors participated in adaptation of the questionnaires. The questionnaires were translated from English into Kinyarwanda.

Data analysis

The analysis was performed using Stata13. Bivariate analysis was performed with was used chi-square tests to compare each risk factor between the groups of children who had diarrhea and those reported not to have diarrhea during the two weeks preceding the survey. Multivariate analysis was conducted to determine the relationship between selected environmental and nutritional factors with diarrhea has been estimated using binary logistic regression model. Odds ratio with corresponding 95% confidence interval (CI) was used to quantify the strength of association.

Ethical considerations

The present study used a secondary data analysis of the data from the Rwanda

Demographic Health Survey. The ethical clearance was obtained from the Rwanda National Ethic Committee (RNEC). Confidentiality and privacy were ensured during the survey data collection and only codes were used for the recording of data and no names of respondent were used.

Results

Sociodemographic characteristics of respondents

Table 1 shows that male children were 55.1%, all children were almost equally distributed into five age categories with age difference of 12 months. 55.9% mothers were aged 25-34 years.

Table 1. Sociodemographic characteristics of respondents (N=7558)

Variable	Frequency	Percentage (%)
Child age in months		
>12	1617	21.39
12-24	1537	20.34
24-36	1533	20.28
36-48	1584	20.96
48-60	1287	17.03
Sex of child		
Male	3810	50.41
Female	3748	49.59
Mother's age in years		
15-24	1460	19.32
25-34	4232	55.99
35-44	1727	22.85
45-55	139	1.84

Wealth index		
Poorest	1796	23.76
Poorer	1581	20.92
Middle	1427	18.88
Richer	1288	17.04
Richest	1466	19.4
Type of place of residence		
Urban	1671	22.11
Rural	5887	77.89

Nutritional factors associated with under five child diarrhea

Table 2 shows that breastfeeding and duration of breastfeeding were strongly associated with child diarrhea with P-value= 0.001. Other factors like receiving vitamin A, feeding the child any fruit rich in vitamin A, or getting iron tablets during pregnancy were not linked with child diarrhea.

Table 2. Bivariate analysis of nutritional factors associated with under five child diarrhea

Variable	Had diarrhea		P-Value
	No n(%)	Yes n(%)	
Breastfeeding during the period of the survey (n=7558)			
No	2000(30.06)	195(21.55)	0.001***
Yes	4653(69.9)	710(78.45)	
Duration of breastfeeding (n=7537)			
Ever breastfed	3366(50.7)	309(34.2)	0.001***
Still breastfeeding during the survey	3245(48.9)	591(65.45)	
Never breastfed	23(0.35)	3(0.33)	
Received Vitamin A (n=7558)			
No	1333(20.04)	156(17.24)	0.047
Yes	5320(79.96)	749(82.76)	
Gave child mangoes, papayas, other vitamin A fruits(n=4481)			
No	3193(82.72)	513(82.61)	0.946
Yes	667(17.28)	108(17.39)	
During pregnancy, given or bought iron tablets/syrup(n=5810)			
No	1,007(20)	167(21.58)	0.308
Yes	4,029(80)	607(78.42)	

p < 0.05; *p < 0.01

Environmental factors associated with under five child diarrhea

All selected environmental factors for diarrhea in this study associated with under five child diarrhea as shown in Table 4. The source of drinking water, the types of toilet facility, sharing toilet facilities with other households, and place of residence are significantly associated with child diarrhea. P-value=0.001, P-value=0.007 and P-value=0.006 respectively. Time spent to get to water source and are also associated with child diarrhea. P-value=0.026

Table 3. Bivariate analysis of environmental factors associated with under five child diarrhea

Variable	Had diarrhea		P-Value
	No n(%)	Yes n(%)	
Type of place of residence (n=7558)			
Urban	1503(22.59)	168(18.56)	0.006***
Rural	5150(77.41)	737(81.44)	
Source of drinking water (n=7557)			
Piped into dwelling	44(0.66)	7(0.77)	0.001***
Piped to yard/plot	592(8.9)	41(4.53)	
Public tap/standpipe	1823(27.41)	262(28.95)	
Tube well or borehole	87(1.31)	23(2.54)	
Protected well	121(1.82)	27(2.98)	
Unprotected well	117(1.76)	16(1.77)	
Protected spring	2026(30.46)	267(29.5)	
Unprotected spring	958(14.4)	122(13.48)	
Surface water	736(11.06)	116(12.82)	
Rainwater	56(0.84)	4(0.44)	
Cart with small tank	2(0.03)	0(0)	
Other	1(0.02)	0(0)	
Not a de jure resident	89(1.34)	20(2.21)	
Time (in hour) to get to water source(n=6675)			
<1	5495(94.04)	773(92.91)	0.026**
1-2	320(5.48)	52(6.25)	
2-3	27(0.46)	5(0.6)	
3-4	1(0.02)	2(0.24)	
Type of toilet facility(n=7551)			
Flush to piped sewer	94(1.41)	3(0.33)	0.001***
Flush to septic tank	15(0.23)	0(0)	
Flush to pit latrine	32(0.48)	1(0.11)	
Flush to somewhere else	19(0.29)	3(0.33)	
Flush, don't know where	5(0.08)	0(0)	
Ventilated improved pit	325(4.89)	48(5.3)	

Pit latrine with slab	4189(63.03)	504(55.69)	
Pit latrine without slab	1625(24.45)	262(28.95)	
No facility/bush/field	197(2.96)	52(5.75)	
Composting toilet	46(0.69)	10(1.1)	
Other	10(0.15)	2(0.22)	
Not a de jure resident	89(1.34)	20(2.21)	
Toilet facilities shared with other households(n=7309)			
No	4949(76.66)	618(72.45)	
Yes	1418(21.96)	215(25.21)	0.007***
Not a de jure resident	89(1.38)	20(2.34)	

** $p < 0.05$; *** $p < 0.01$

Multivariate logistic regression model for factors associated with child diarrhea

Of all factors that showed association with child diarrhea bivariate analysis, only two factors remain consistent. Those are the source of drinking water with OR: 1.8, CI [1.06-3.01], P-value=0.029; and sharing toilet facility with other households OR: 1.3 CI [1.04-1.53], P-value=0.019

Table 4. Multivariate logistic regression analysis of nutritional and environmental factors for child diarrhea

Variable	OR	95% CI	P-Value
Not breastfeeding			
Breastfeeding	1.00	[0.77-1.31]	0.998
Duration of breastfeeding (ever breastfed)			
Never breastfed	1.30	[0.29-5.83]	0.730
Still breastfeeding	0.96	[0.72-1.28]	0.786
Has not received vitamin			
Received vitamin	1.17	[0.92-1.48]	0.200
Urban residence			
Rural residence	0.85	[0.66-1.09]	0.200
Source of drinking water(piped into dwelling)			
Tube well or borehole	1.79	[1.06-3.01]	0.029**
Protected well	1.32	[0.81-2.16]	0.269
Unprotected well	0.95	[0.55-1.66]	0.864
Protected spring	0.84	[0.69-1.04]	0.104
Unprotected spring	0.79	[0.61-1.02]	0.069
Surface water	0.98	[0.76-1.27]	0.875

Cart with small tank	1.00		
Other	1.00		
Time to get to water source(<1 hour)			
1-2	1.13	[0.81-1.57]	0.482
2-3	1.62	[0.60-4.38]	0.345
3-4	7.77	[0.52-115.61]	0.137
Type of toilet facility(flush to piped sewer system)			
Flush to septic tank	1.00		
Flush to pit latrine	1.00		
Flush to somewhere else	1.31	[0.14-11.98]	0.812
Ventilated improved pit latrine	1.15	[0.23-5.72]	0.867
Pit latrine with slab	0.85	[0.18-4.11]	0.842
Pit latrine without slab/open pit	1.02	[0.21-4.92]	0.983
Composting toilet	1.00	[0.17-5.67]	0.996
Other	1.00		
Not sharing toilet facilities with other households			
Toilet facilities shared with other households	1.26	[1.04-1.53]	0.019**

** $p < 0.05$; *** $p < 0.01$

Discussion

This study investigated the nutritional and environmental determinants of diarrheal diseases among children under-five years. In 7558 children sampled, 12% had diarrhea within two weeks preceding the data collection for the Rwanda demographic and health survey.[11]

The overall patterns in the associations between nutritional, and environmental factors with diarrhea in under-five observed in the bivariate and multivariate analysis. Multivariate regression analysis shows that two environmental factors (using borehole water source and shared toilet facilities with other

households) were consistently associated with under five child diarrhea.

Consistent with other studies, the quality of household drinking water has been linked to the quality of life among populations; and using unimproved water causes various diseases, including diarrhea.[13–15] Borehole waters are possibly not treated before usage while it is a reservoir of waterborne pathogenic organisms and causes enteric diseases including diarrhea. A study conducted in Nigeria on bacteriological analysis of borehole water showed that the water from the boreholes do not meet the WHO standards for drinking water.[15] The research evidence emphasize on the importance and the necessity of boiling and

filtration of water from borehole before consumption to prevent the spread of water borne diseases diarrhea included. For example, Okolo and his colleagues conducted a comparative analysis of three borehole water sources from Nigeria. They analysed the quality of borehole water samples from three locations and concluded that borehole water was contaminated. They therefore recommended treatment of borehole water before consumption to prevent the spread of water borne diseases.[16,17] This study revealed that sharing toilets is associated with diarrhea among children under five years old. A study conducted in Indonesia on the relationship of the presence of a household improved latrine with Diarrhea confirmed that the lack of a household improved latrine is associated with diarrhea and under-five child mortality. Fuller et Al. conducted a study on shared sanitation and the prevalence of diarrhea in young children from 51 low and middle income countries, between the year 2001-2011. In their findings, they came to the conclusion that the households that share toilet facility are likely to experience the higher prevalence of diarrhea than those owning their toilet facilities.[18] The health outcomes for the household members who use to share toilets include diarrhea or other faecal oral diseases. Children less than 5-year-old living in households sharing a toilet with one or more households, are more likely to experience moderate to severe

diarrhea than children living in households with private sanitation.[18,19]

Conclusion and recommendation

The environmental factors including source of water and toilets facilities shared with neighbours are associated with diarrhea among children under five years of age. The study therefore recommends the provision of adequate portable water to the communities should be given a highest priority to prevent child morbidity caused by diarrhea. In addition, efforts from the community health clubs (CHCs) should be driven to the promotion and support of households' ownership and utilization of toilets and therefore cease toilet sharing.

Conflict of interest

The authors declare that there is no conflict of interest related to this manuscript.

Authors' contributions

JCI contributed to all aspects of the work. ER and OM contributed to the scientific review of the manuscript and provided their intellectual inputs.

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