

Original Article

Trends and Risk Factors For Childhood Diarrhoea in Rwanda: A Secondary Data Analysis of Three Rwanda Demographic and Health Surveys (RDHS 2010, 2014/15, and 2019/20)

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Abstract

Background

Diarrhoea continues to be a leading cause of morbidity and mortality among children under five, particularly in developing countries, Rwanda included. This study examined trends and risk factors for childhood diarrhea in Rwanda.

Methods

A secondary analysis of the children's records was conducted among 8,706 households in 2010, 7,261 in 2014/15, and 4,409 in 2019/20. The univariate analysis summarized the variables and described the trends in diarrhoea by districts during 2010, 2014/15 and 2019/2020 RDHS. Simple logistic regression identified associations between diarrhea and potential factors, while a multivariable model retained significant variables after addressing multicollinearity. The results were presented as adjusted odds ratios with 95% confidence intervals and p-values <0.05.

Results

The prevalence of childhood diarrhoea in Rwanda followed a U-shaped trend, falling from 12.81% in 2010 to 11.62% in 2015, and then rising to 13.65% in 2020. Factors independently associated with diarrhea included household heads less than 25 years old, households ≥ 4 members, not breastfeeding, less frequent radio/TV exposure, bottle feeding and unimproved toilet facilities.

Conclusion

Interventions should focus on supporting less educated caregivers through health education, improved water, hygiene, and sanitation practices, and promotion of breastfeeding. Ensuring equitable access to clean water is also essential for reducing diarrhoea.

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Keywords: diarrhea, risk factors, children, Rwanda Demographic and Health Survey, Children Under five, Rwanda

Background

Diarrhoea remains the second leading cause of morbidity and mortality among children under five years of age worldwide, particularly in low- and middle-income countries.[1] According to the World Health Organization (WHO), diarrhoea is responsible for approximately 525,000 deaths per year among children under five.[1] South Asia and sub-Saharan Africa (SSA) together accounted for 88% of mortality among children under five years old children with only SSA reported a prevalence of diarrhoea of 15.3% in 2021.[2] In Rwanda, in 2022, approximately 12.9% of the population was under five years of age,[3] and RDHS reported that 14.3% of children in this age group experienced diarrhoea in 2020,[4] making this a significant public health concern.

World Health organization (WHO) explains diarrhoea as the passage of three or more liquid or loose stools per day.[5] It is often a symptom of an intestinal tract infection, which can be caused by bacteria, viruses, or parasites.[6] Infectious diarrhoea is spread through the fecal-oral route, which can occur through person-to-person contact, contaminated water or food, or direct transfer to the mouth.[7] Other sources of contamination include contact with contaminated surfaces, airborne particles, foodborne toxins, some chemical pollutants, vectors contamination and skin penetration by certain parasites.[8] In addition, most diarrhoea episodes are caused by viral pathogens, which typically show a distinct seasonality, with higher incidence during the rainy months.[9]

Children suffering from diarrhoea might face various immediate challenges, including loss of appetite, electrolyte imbalances, acute weakness and acute malnutrition, dehydration and if left untreated, it can lead to severe more health complications or even death.[10] Additionally, among long term consequences, we can list chronic malnutrition which in turns leads

to delays in physical growth and cognitive development,[11] a higher risk of contracting other infectious diseases such as respiratory infections, measles, and malaria.[12]

The burden of childhood diarrhoea is intricately linked to multiple factors, including inadequate access to clean water, poor sanitation, limited hygiene practices and a high presence of flies.[13, 14] These environmental conditions create a conducive environment for transmitting pathogens, particularly in densely populated or rural areas.[15] Socio-economic status plays an important role, as children from low-income households are more likely to experience higher rates of diarrhoea due to poor living conditions and limited access to resources.[16] Maternal education is another critical determinant, as mothers with higher levels of education are generally better equipped with knowledge about hygiene practices, nutrition, and the importance of seeking timely medical care, which can reduce the incidence and severity of diarrhoea.[6]

Access to healthcare is also a crucial factor, as children with limited access to healthcare services are less likely to receive prompt and effective treatment for diarrhoea, leading to prolonged illness and increased risk of complications.[10] In addition to these factors, malnutrition significantly exacerbates the risk and severity of diarrhoea, as undernourished children have weakened immune systems and are more susceptible to infections.[17] Other infectious diseases, such as respiratory infections, can further compromise a child's health, making them more vulnerable to diarrheal diseases.[18]

During the past decade, Rwanda has made substantial progress in improving these determinants through national initiatives. The Integrated Management of Childhood Illnesses (IMCI) program has been a cornerstone of the country's efforts, with health workers trained to provide early treatment for diarrhoea using oral rehydration salts (ORS) and zinc supplementation.[19] The Community-Based Environmental Health Promotion Program (CBEHPP) emphasizes the adoption

of safe WASH practices,[20] while the Rwandan Community Health Workers (CHWs) program plays a key role in health service delivery.[20] Additionally, the introduction of the rotavirus vaccine as part of the expanded immunization program has been instrumental in reducing severe diarrhoea among infants and young children.[21] Expansion of the healthcare system and improvements in maternal and child health remain central to the country's public health agenda.[22] By 2020, access to essential drinking water services had reached 73%.[23] Despite these achievements, significant challenges remain in addressing the underlying determinants of diarrhoea.[24]

Although Rwanda has achieved notable improvements in child health, the increasing and persistent burden of childhood diarrhoea raising critical concerns whether existing interventions reach every child in need. The downward trends observed in some regions contrast with stagnation or increased diarrhoea in others, suggesting disparities in the impact of public health efforts.[25] There is a pressing need for a comprehensive understanding of how various risk factors have evolved and their current influence on the incidence of childhood diarrhoea in Rwanda to inform targeted interventions and policy decisions making. This study aims to assess the trends and risk factors for diarrhoea among children under five years of age in Rwanda between 2010 and 2020.

Methods

Data source and study design

This study used a secondary analysis of the data sets from the children's records from the Rwanda Demographic and Health Surveys (RDHS) 2010, 2014/15 and 2019/20, which are population-based cross-sectional surveys using nationally representative samples.

Study population and sampling

The population of this study consists

of children aged 0-59 months in Rwanda. RDHSs used a two-stage cluster sampling method. First, villages were selected using probability proportional to size. In the second stage, all households within the selected villages were mapped and listed, and those that met the inclusion criteria were randomly selected for participation. Data were collected from women and children aged 0-59 months who had stayed in the household the night before the survey with a focus on socio demographic and economics attributes, health patterns, and child health indicators, making the children the primary study participants. The total sample size was 8,706 children in 2010, 7,261 in 2015 and 4,409 in 2020.

Variables

The outcome variable of this study was the appearance of diarrhoea among under-five-year-old children in the previous two weeks, as reported by caregivers during interviews. It was dichotomized as 1=Yes or 0=No. Independent variables were defined based on the conceptual framework that shows potential predictors of childhood diarrhoea including socioeconomic demographics, living conditions, water and sanitation, feeding practices, and media exposure. Socio-demographic factors include factors such as the age and sex of the household head, maternal age, marital status, maternal education, partner's education, maternal literacy, maternal employment, partner's employment, religion, province, place of residence (urban/rural), household wealth index, household size, and number of children under five years of age. Household living conditions capture housing quality and sanitation access, measured by floor material and whether the household shares a toilet. WASH-related factors include sources of drinking water, time to fetch water, type of toilet facility, and method of disposing of child stool. Feeding and care practices include breastfeeding status and bottle-feeding. Media exposure reflects information access and health messages through reading newspapers, listening to radio, watching television, and overall exposure to the media.

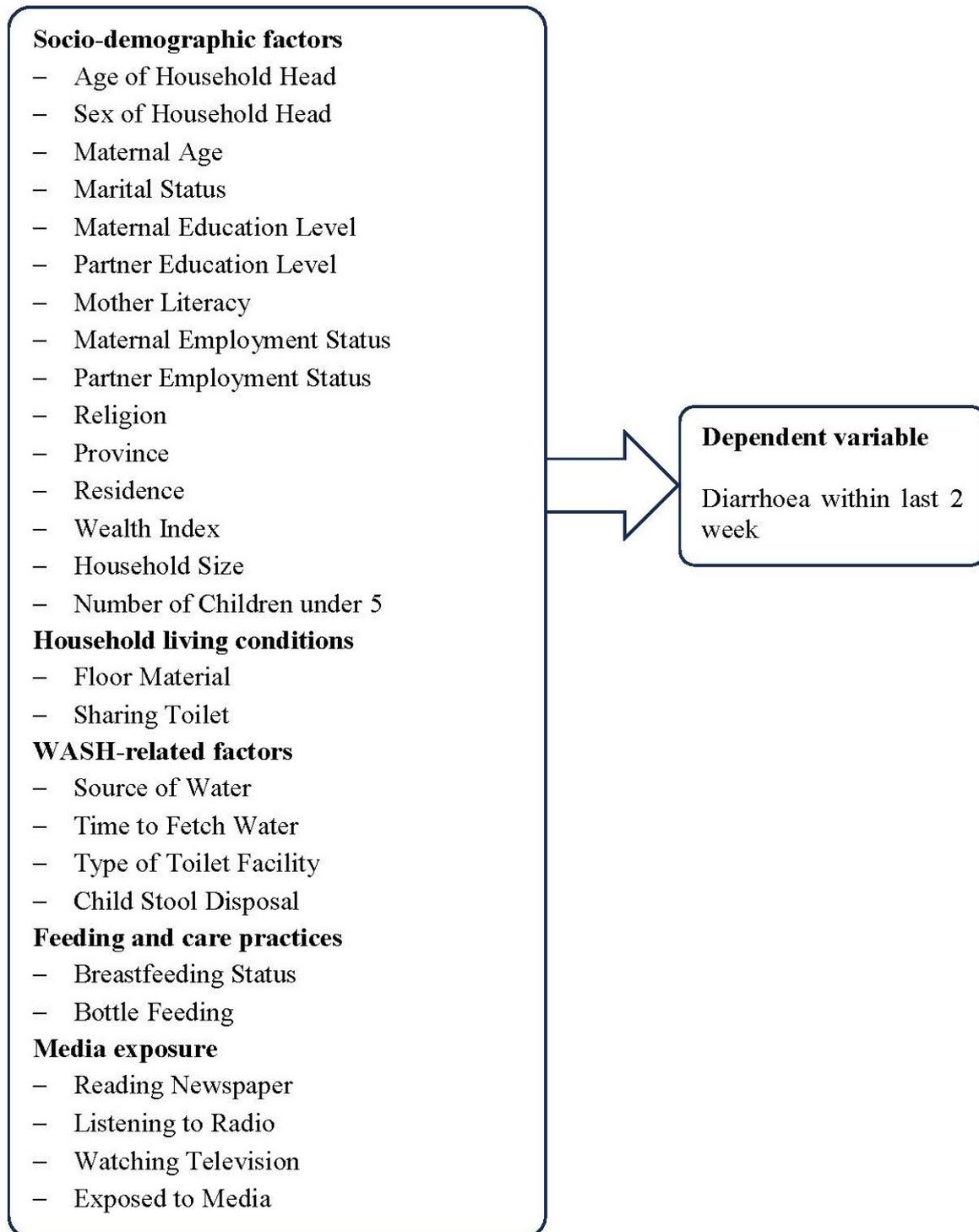


Figure 1. Conceptual framework of the study.[26]

Data Processing and Analysis

We used STATA statistical software version 17.[27] Probability weights were applied to account for the complexity of multi-stage cluster sampling design and unequal selection probabilities, thereby ensuring that the estimates are representative of the target population.

Univariate analysis was performed to determine the frequencies and percentages of the selected variables. The frequencies helped to describe trends in childhood diarrhoea by area of residence and stratified by year. Figures 1 and 2 were produced by calculating the survey-weighted prevalence of diarrhoea among children under five years of age using 2010, 2014/15 and 2019/20 RDHS data and between districts to highlight

temporal trends nationally and spatial differences between districts, informing patterns and interventions priorities. Simple logistic regression assessed the associations between childhood diarrhoea and socio-economic, demographic, environmental, and behavioral factors. Considering a p -value > 0.05 , we retained the variables associated with childhood diarrhoea to be considered in the final multivariate logistic regression model, applying the backward elimination technique. In this method, all potential variables are initially included in the model at once, and the least significant variable is removed stepwise at each iteration based on a pre-specified significance level of $p > 0.05$, until only statistically significant predictors remain.[28] Before using this approach, maternal literacy, exposure to the media, and floor material were excluded due to high multicollinearity (correlation coefficient ≥ 0.6). The results were presented as AOR with 95% confidence intervals (CI), and P -value > 0.05 .

Ethical Consideration

We obtained permission to access the dataset from the DHS Program, and a formal authorization letter was provided by ICF. Because the data were fully anonymised before we received them, no additional ethical approval was required for this secondary analysis.

Results

Characteristics of study participants

As shown in Table 1, most of the heads of households were between 25 and 39 years of age in all three surveys, indicating that this age group consistently dominated over time. Female-headed households remained a minority, representing less than one-fifth in all years, with a slight decline in 2020. The proportion of partners with no formal education declined over the years, while those with secondary or higher education increased, reflecting an improvement in educational attainment. In contrast, formal employment among household managers showed a decreasing trend in all survey years. Additionally, as shown in the same Table, most mothers were between 25 and 34

years old in all three survey years, reflecting a consistently young maternal population. Most mothers had income-generating activities, particularly in 2015, although this slightly declined by 2020. Most mothers were married throughout the study period, with only minimal variation over time. Educational attainment improved steadily, with a noticeable reduction in mothers without formal education and an overall decline in illiteracy levels between 2010 and 2020.

Regional representation was dominated by the Northern Province, which remained the most represented in all three surveys. Urban residence increased slightly with time, suggesting gradual urbanization. Protestant affiliation became more common, showing a consistent upward trend during the decade. Most households continued to have four or more members, and the majority had fewer than three children under five years old.

The economic status of the family improved modestly over the years. The proportion of families in the poorest and poorest categories decreased slightly, while the proportion in the richer and richest categories increased, reflecting a slow but positive shift in wealth distribution. Infant and young child feeding practices also improved significantly. The proportion of children breastfed increased sharply, while bottle feeding declined substantially, indicating progress towards recommended feeding practices.

Exposure to the mass media presented a mixed trend: overall exposure declined, particularly in radio listenership, even though television viewership and newspaper readership increased slightly and access to improved sanitation facilities remained relatively stable, while access to safe drinking water showed a modest rise. However, the proportion of households taking more than 30 minutes to fetch water increased, suggesting ongoing challenges in access to water. The quality of the floor of the home deteriorated over time as the unimproved floors became more common. However, hygiene practices improved, unsafe disposal of child urine declined, and safe disposal practices became more widespread.

Table 1. Sociodemographic, behavioral, and environmental characteristics of participants and their association with diarrhea

Variables	2010			2014/15			2019/20		
	Total (%)	Diarrhea (%)	P-value	Total (%)	Diarrhea (%)	P-value	Total (%)	Diarrhea (%)	P-value
Age of the Household Head									
Less than 25	422 (5.5)	81 (8.3)		304 (4.7)	42 (5.6)		200 (5.2)	33 (5.8)	
25-39	4930 (63.7)	644 (66.4)	<0.001	4385 (67.3)	467 (63)	0.045	2594 (67.7)	400 (69.2)	0.483
40-59	2384 (30.8)	245 (25.2)		1831 (28.1)	232 (31.4)		1037 (27.1)	145 (25)	
Sex of the Household head									
Male	6478 (83.7)	797 (82.2)	0.165	5460 (83.7)	603 (81.4)	0.083	3364 (87.8)	507 (87.7)	0.929
Female	1258 (16.3)	173 (17.8)		1060 (16.3)	138 (18.6)		467 (12.2)	71 (12.3)	
Partner Education level									
No form education	1571 (20.3)	206 (21.2)	0.159	1123 (17.2)	143 (19.3)	0.008	510 (13.3)	104 (18)	0.003
Primary	5312 (68.7)	675 (69.6)		4631 (71)	537 (72.4)		2506 (65.4)	368 (63.7)	
Secondary	852 (11.0)	89 (9.2)		766 (11.8)	62 (8.3)		816 (21.3)	106 (18.4)	
Partner employment status									
No employment	113 (6.3)	15 (5.8)	0.005	106 (3.9)	14 (4.5)	0.257	238 (6.2)	30 (5.2)	0.001
Working	1216 (67.4)	151 (59.4)		1594 (58.2)	170 (53.7)		1268 (33.1)	152 (26.3)	
Casual Work	475 (26.34)	89 (34.8)		1039 (37.9)	133 (41.8)		2325 (60.7)	396 (68.6)	
Maternal Age									
15-24	1153 (14.9)	210 (21.7)	<0.001	975 (15)	135 (18.2)	0.046	556 (14.5)	92 (16)	0.192
25-34	4384 (56.7)	539 (55.6)		3753 (57.6)	412 (55.6)		1947 (50.8)	305 (52.7)	
35-49	2199 (28.4)	220 (22.7)		1793 (27.5)	194 (26.2)		1328 (34.7)	181 (31.3)	
Employment status									
No	1557 (20.1)	224 (23.1)	0.019	898 (13.8)	101 (13.6)	0.882	1081 (28.2)	142 (24.5)	0.048
Yes	6172 (79.9)	746 (76.9)		5618 (86.2)	640 (86.4)		2750 (71.8)	436 (75.5)	
Marital status									
Married	4949 (63.9)	585 (60.4)	0.026	3859 (59.2)	400 (54)	0.003	2275 (59.4)	322 (55.7)	0.075
Cohabiting	2120 (27.4)	283 (29.2)		2054 (31.5)	249 (33.7)		1556 (40.6)	256 (44.3)	
Widowed/divorced	668 (8.6)	101 (10.4)		606 (9.3)	91 (12.3)		0	0	
Maternal education level									
No formal education	1483 (19.2)	159 (16.4)	0.014	975 (15)	124 (16.7)	0.071	430 (11.2)	77 (13.3)	0.001
Primary	5589 (72.2)	740 (76.3)		4769 (73.1)	547 (73.9)		2448 (63.9)	398 (68.9)	
Secondary and higher	664 (8.6)	71 (7.3)		776 (11.9)	70 (9.5)		953 (24.9)	103 (17.8)	
Mother can read									
Cannot read at all /Vision impaired	2099 (27.2)	248 (25.6)	0.509	1482 (22.8)	183 (24.6)	0.386	670 (17.5)	127 (22)	0.014
Able to read only parts of a sentence	826 (10.7)	106 (10.9)		602 (9.2)	62 (8.3)		410 (10.7)	58 (10.1)	
Able to read the whole sentence	4803 (62.1)	615 (63.5)		4426 (68)	497 (67.1)		2751 (71.8)	392 (67.9)	
Province									
Kigali	717 (9.3)	74 (7.7)	0.001	775 (11.9)	56 (7.5)	<0.001	547 (14.3)	62 (10.7)	0.021
South	1795 (23.2)	269 (27.7)		1457 (22.4)	164 (22.2)		765 (20)	116 (20)	
West	1980 (25.6)	256 (26.4)		1593 (24.4)	225 (30.4)		1039 (27.1)	184 (31.8)	
North	3245 (41.9)	371 (38.3)		2695 (41.3)	295 (39.9)		1480 (38.6)	217 (37.5)	
Residence									
Urban	892 (11.5)	110 (11.3)	0.830	1100 (16.9)	106 (14.3)	0.050	639 (16.7)	67 (11.5)	0.001
Rural	6844 (88.5)	860 (88.7)		5419 (83.1)	635 (85.7)		3193 (83.3)	511 (88.5)	

Table 1. Continued

Variables	2010			2014/15			2019/20		
	Total (%)	Diarrhea (%)	P-value	Total (%)	Diarrhea (%)	P-value	Total (%)	Diarrhea (%)	P-value
Rural	6844 (88.5)	860 (88.7)		5419 (83.1)	635 (85.7)		3193 (83.3)	511 (88.5)	
Religion									
No religion	72 (0.9)	8 (0.8)		39 (0.6)	6 (0.8)		48 (1.2)	8 (1.4)	
Catholic	3113 (40.7)	397 (41.2)		2279 (35.1)	263 (35.7)		1220 (31.9)	163 (28.2)	
Protestant	3267 (42.7)	413 (42.8)	0.943	3256 (50.2)	370 (50.3)	0.890	2034 (53.1)	334 (57.8)	0.303
Adventists	1088 (14.2)	136 (14.1)		788 (12.1)	85 (11.6)		473 (12.3)	65 (11.2)	
Muslims	109 (1.4)	11 (1.2)		126 (1.9)	13 (1.7)		57 (1.5)	8 (1.4)	
Number Household members									
Less than 4	1077 (13.9)	184 (19)		1092 (16.8)	150 (20.2)		528 (13.8)	117 (20.2)	
Four and more	6660 (86.1)	785 (81)	<0.001	5427 (83.2)	591 (79.8)	0.012	3303 (86.2)	461 (79.8)	<0.001
Number of children U5									
0-2 Children	6676 (86.3)	840 (86.6)	0.786	5770 (88.5)	657 (88.7)	0.903	3226 (84.2)	479 (82.9)	0.399
3+ Children	1060 (13.7)	130 (13.4)		747 (11.5)	84 (11.3)		606 (15.8)	99 (17.1)	
Wealth index									
Poorest	1767 (22.85)	279 (28.8)		1492 (22.9)	202 (27.3)		835 (21.8)	142 (24.7)	
Poorer	1653 (21.4)	214 (22.1)		1427 (21.9)	189 (25.5)		771 (20.1)	139 (24.1)	
Middle	1554 (20.1)	182 (18.8)	<0.001	1335 (20.5)	144 (19.4)	0.001	727 (19)	125 (21.6)	<0.001
Richer	1477 (19.1)	157 (16.2)		1136 (17.4)	116 (15.7)		759 (19.8)	106 (18.4)	
Richest	1285 (16.6)	138 (14.3)		1130 (17.3)	89 (12.0)		740 (19.3)	65 (11.3)	
Breastfeeding status									
No	2076 (26.8)	216 (22.3)		1917 (29.4)	165 (22.3)		221 (5.8)	39 (5.1)	
Yes	5660 (73.2)	754 (77.8)	0.001	4602 (70.6)	576 (77.7)	<0.001	3610 (94.2)	547.8 (94.8)	0.533
Bottle feeding									
No	6255 (82.6)	848 (88.9)		5425 (86)	649 (90.5)		3454 (96.5)	526 (96.7)	
Yes	1316 (17.4)	105 (11.1)	<0.001	881 (14)	68 (9.5)	0.005	125 (3.5)	18 (3.3)	0.861
Reading newspaper									
Not at all	6333 (81.9)	796 (82.1)		5187 (79.7)	627 (84.7)		3083 (80.5)	484 (83.8)	
Less than one	1271 (16.4)	163 (16.8)	0.389	1120 (17.2)	98 (13.2)	0.002	531 (13.9)	75 (12.9)	0.028
At least once a week	129 (1.7)	11 (1.1)		203 (3.1)	16 (2.2)		217 (5.7)	19 (3.3)	
Listening to the radio									
Not at all	712 (9.2)	118 (12.2)		1176 (18.1)	189 (25.6)		839 (21.9)	140 (24.3)	
Less than one	1973 (25.5)	290 (29.9)	<0.001	1613 (24.8)	182 (24.7)	<0.001	772 (20.1)	122 (21.2)	0.213
At least once a week	5047 (65.3)	561 (57.9)		3719 (57.1)	368 (49.8)		2221 (58)	315 (54.5)	
Watching television									
Not at all	5632 (72.8)	717 (73.9)		4173 (64.1)	516 (69.8)		2244 (58.6)	371 (64.2)	
Less than one	1653 (21.4)	218 (22.5)	0.008	1583 (24.3)	164 (22.2)	0.001	970 (25.3)	144 (24.9)	0.002
At least once a week	446 (5.8)	35 (3.6)		751 (11.5)	59 (8)		618 (16.1)	63 (11)	
Exposed to media									
No	688 (8.9)	113 (11.6)		1083 (16.6)	173 (23.3)		758 (19.8)	131 (22.8)	
Yes	7048 (91.1)	857 (88.4)	0.002	5437 (83.4)	568 (76.7)	<0.001	3073 (80.2)	446 (77.3)	0.074
Type of toilet facility									
Improved	4553 (58.8)	511 (52.7)		3581 (54.9)	353 (47.7)		2214 (57.8)	311 (53.9)	
Not improved	3183 (41.1)	459 (47.3)	<0.001	2938 (45.1)	388 (52.3)	0.001	1617 (42.2)	267 (46.2)	0.055
Source of water									
Improved	5717 (73.9)	696 (71.7)		4719 (72.4)	535 (72.3)		3065 (80.0)	460 (79.6)	
Not improved	2015 (26.1)	274 (28.3)	0.104	1800 (27.6)	206 (27.7)	0.938	766 (20.0)	118 (20.4)	0.789

Table 1. Continued

Variables	2010			2014/15			2019/20		
	Total (%)	Diarrhea (%)	P-value	Total (%)	Diarrhea (%)	P-value	Total (%)	Diarrhea (%)	P-value
Time to fetch water									
Water on source	325 (4.2)	33 (3.5)		596 (9.1)	42 (5.6)		666 (17.4)	74 (12.8)	
30 minutes	4770 (61.7)	557 (57.6)	0.003	3803 (58.4)	450 (60.8)	0.003	1810 (47.3)	274 (47.5)	0.007
30 minutes +	2633 (34.1)	376 (38.9)		2115 (32.5)	249 (33.6)		1354 (35.4)	229 (39.7)	
Floor material									
Improved	6549 (85.4)	849 (88.7)		5052 (78.2)	607 (83.1)		2572 (67.3)	427 (73.9)	
Not improved	1124 (14.6)	108 (11.3)	0.002	1406 (21.8)	124 (17)	0.001	1251 (32.7)	151 (26.1)	0.001
Sharing toilet									
No	6187 (80.9)	718 (75.2)		4955 (78.1)	525 (74.4)		3023 (81.2)	440 (78.3)	
Yes	1463 (19.1)	237 (24.8)	<0.001	1386 (21.9)	180 (25.6)	0.017	701 (18.8)	122 (21.7)	0.092
Child stool disposal									
Improved	6603 (85.4)	788 (81.2)		5745 (88.1)	656 (88.5)		3204 (89.5)	477 (90)	
Not improved	1133 (14.6)	182 (18.8)	0.002	775 (11.9)	85 (11.5)	0.761	375 (10.5)	53 (10)	0.728

Trends in diarrhoea between 2010-2020

The trends in the prevalence of diarrhoea in 2010, 2015, and 2020 are presented below. Figure 2 shows these variations across the three survey years. In 2010, the prevalence was recorded at 12.81%. Over the next five years, the prevalence fell, reaching its lowest point of 11.62% in 2015. But it reversed, and diarrhoea prevalence increased, peaking at 13.65% in 2020. Despite the initial decline, the overall pattern forms a U-shape, with an increase in prevalence toward the end of the decade. The dotted trendline in the graph also suggests a slight upward trend in diarrhoea prevalence over the ten years. The trends in the prevalence of diarrhoea across various districts in Rwanda for 2010, 2015, and 2020 are presented below.

Figure 3 illustrates these district-level variations over time. Each district exhibits fluctuations in diarrhoea rates, represented by blue lines (2010), orange lines (2015), and grey lines (2020). In 2010, the rates generally appeared lower across most districts compared to later years, with a few spikes. By 2015, many districts experienced a decrease in the prevalence of diarrhoea, as indicated by the orange line that dips below the blue in several areas. However, by 2020, some districts (such as Bugesera and Gasabo) saw sharp increases in diarrhoea rates, as indicated by the grey line, while others showed more minor changes or stability. The graph generally emphasizes a complex pattern of increased and decreased prevalence of diarrhoea between districts in the last decade.

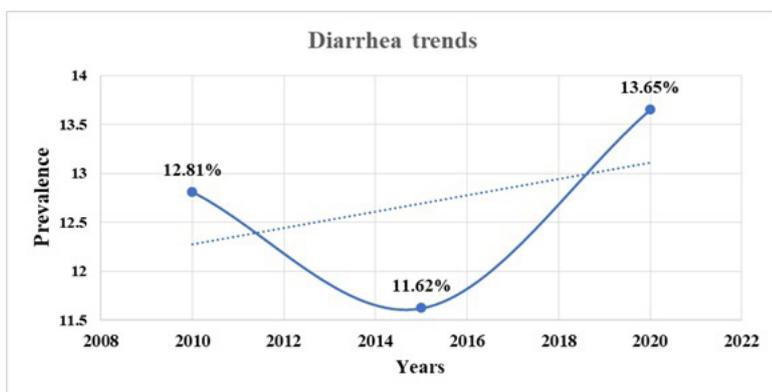


Figure 2. Diarrhoea Trends in 2010, 2015 and 2020

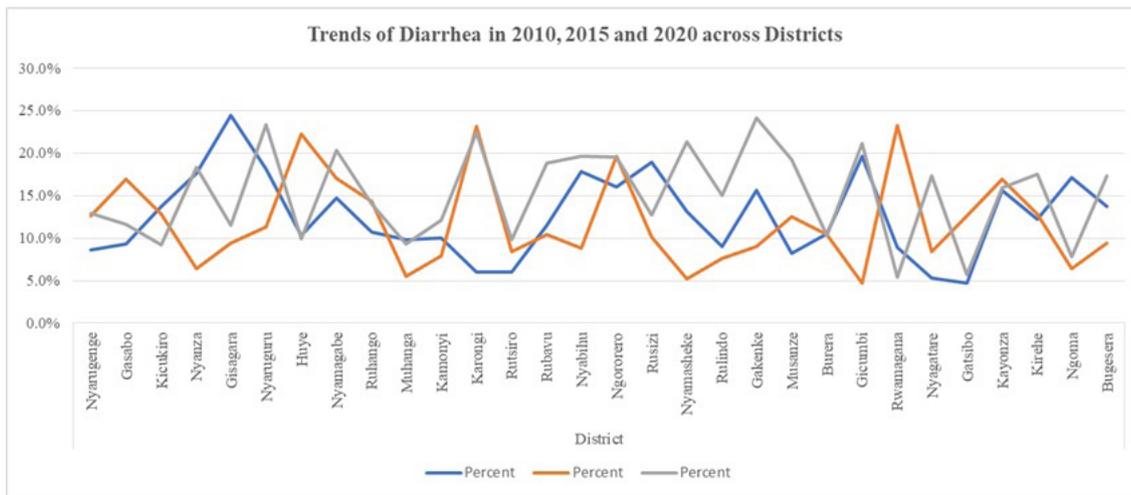


Figure 3. Trends of Diarrhea in 2010, 2015 and 2020 across districts

Association between diarrhoea and other factors

Table 1 elucidates the variables associated with childhood diarrhoea. These include year, age of the head of the household, sex of the head of the household, partner’s education level, partner’s employment status, maternal age, maternal employment status, marital status, maternal education level, maternal literacy, province, residence, religion, number of household members, number of children under five, wealth index, breastfeeding status, reading newspapers, listening to radio, watching television, exposure to the media, bottle feeding, and type of toilet facility, all of which were found to be significantly associated with childhood diarrhoea.

Independent risks factors for diarrhoea

Table 2 shows the independent risk factors for diarrhoea from 2010-2010. In terms of year, both 2010 and 2015 show significantly lower odds of diarrhoea compared to 2020 (AOR:0.87 [0.76-0.99], p-value = 0.029) and (AOR: 0.75 [0.65-0.85], p-value<0.001), respectively. Regarding the age of the household head, only one category of households under 25 years of age was more likely to have children affected by diarrhoea diseases compared to older ages (AOR: 1.33 [1.14-1.56], p-value<0.001). Maternal age plays an important role, with younger mothers (15-24 years) facing significantly higher odds of diarrhoea compared

to older mothers aged 35-49 years (AOR: 1.313 [1.129-1.528], p-value<0.001) and those aged 25-34 also show an elevated risk of having diarrhoea (AOR: 1.124 [1.014-1.247], p-value=0.026).

Compared to households living in Kigali, the North, south, and West provinces showed higher odds of diarrhoea (AOR: 1.23 [1.001-1.51], p-value=0.048; (AOR: 1.43 [1.16-1.76], p-value=0.001; (AOR: 1.47 [1.19-1.82], p-value<0.001), respectively. The partner of education level reveals that people without formal education have a slightly higher risk of developing diarrhoea (AOR: 1.120 [1.000-1.254], p-value=0.050), while those with secondary or higher education experience a significantly reduced risk of having diarrhoea (AOR: 0.849 [0.732-0.986], p-value=0.032).

The marital status analysis highlights that widowed, divorced, or separated individuals are at higher risk of diarrhoea compared to those never in union (AOR: 1.254 [1.053-1.493], p-value = 0.011), while household size also influences the outcome, with larger households (Four and more members) more likely to develop diarrhoea compared to smaller households (AOR: 1.33 [1.16-1.52]; p-value<0.001). Households with inadequate toilet facilities were associated with a higher probability of developing diarrhoea among children compared to those with improved

toilet facilities (AOR: 1.22 [1.10-1.34], p-value<0.001). From the WASH-related indicators, only the type of toilet facility showed a significant association with diarrhoea. Breastfeeding status is associated with an increased chance of diarrhoea, since breastfeeding mothers are at higher risk than non-breastfeeding mothers (AOR: 1.19 [1.04-1.37]; p-value=0.013). Furthermore, children who did not use bottle feeding were less likely to develop diarrhoea compared to those who were fed by bottle (AOR: 0.70 [0.58-0.84], p-value<0.001).

Caregivers who do not listen to the radio and those who listen less than once a week were more likely to have diarrhoea compared to those who listen at least once a week (AOR: 1.37 [1.19-1.57], p-value<0.001; AOR: 1.14 [1.01-1.27], p-value = 0.031), respectively. Similarly, as before, caregivers who did not watch television and those who watched less than once a week exhibited an increased probability of having children with diarrhoea compared to those who watched television at least once a week (AOR: 1.32 [1.06-1.64], p-value=0.012; AOR: 1.30 [1.04-1.63], p-value = 0.022), respectively.

Table 2. Multivariable logistic regression between socio-demographics, behavioral and environmental characteristics, and Diarrhea

Variable	COR	P-value	AOR	P-value
Year				
2010	0.81 [0.72-0.91]	<0.001	0.87 [0.76-0.99]	0.029
2015	0.72 [0.64-0.82]	<0.001	0.75 [0.65-0.85]	<0.001
2020	1		1	
Age of household head				
Less than 25	1.50 [1.23-1.83]	<0.001	1.33 [1.14-1.56]	<0.001
25-39	1.08 [0.97-1.20]	0.152	1.09 [0.98-1.23]	0.123
40-59	1		1	
Sex of the household head				
Female	1.13 [1.00-1.28]	0.050	-	-
Male	1			
Partner education level				
No formal education	1.14 [1.01-1.29]	0.030	-	-
Primary	1			
Secondary and higher	0.78 [0.67-0.90]	0.001	-	-
Partner employment status				
No employment	1.09 [0.81-1.47]	0.566	-	-
Casual works	1.44 [1.24-1.66]	<0.001	-	-
Working	1			
Maternal age				
15-24	1.57 [1.36-1.80]	<0.001	-	-
25-34	1.15 [1.03-1.28]	0.012	-	-
35-49	1			
Employment status				
No	1.02 [0.91-1.15]	0.761	-	-
Yes	1			
Marital status				
Cohabiting	1.18 [1.06-1.30]	0.002	-	-
Widowed/ divorced/ separated	1.42 [1.19-1.69]	<0.001	-	-
Married	1			

Table 2. Continued

Variable	COR	P-value	COR	P-value
Maternal Education level				
No formal education	1.34 [1.11-1.62]	0.002	-	-
Primary	1.42 [1.22-1.65]	<0.001	-	-
Secondary and higher	1			
Maternal literacy				
Cannot read at all /Vision impaired	1.07 [0.95-1.19]	0.259	-	-
Able to read only parts of sentence	0.97 [0.83-1.14]	0.734	-	-
Able to read the whole sentence	1			
Province				
South	1.55 [1.29-1.87]	<0.001	1.43 [1.16-1.76]	0.001
West	1.63 [1.36-1.97]	<0.001	1.47 [1.19-1.82]	<0.001
North	1.32 [1.10-1.58]	0.002	1.23 [1.00-1.51]	0.048
Kigali City	1		1	
Residence				
Rural	1.24 [1.08-1.42]	0.002	-	-
Urban	1			
Religion				
No religion	1.02 [0.64-1.64]	0.921	-	-
Catholics	0.95 [0.86-1.06]	0.358	-	-
Adventists	0.93 [0.80-1.07]	0.305	-	-
Muslims	0.83 [0.54-1.26]	0.371	-	-
Protestant	1			
Number of household members				
Less than three	1		1	
Four and more	1.50 [1.33-1.68]	<0.001	1.33 [1.16-1.52]	<0.001
Number of children U5				
0-2 children	0.98 [0.86-1.13]	0.816	-	-
3+ children	1			
Wealth index				
Poorest	1.77 [1.52-2.07]	<0.001	-	-
Poorer	1.62 [1.38-1.90]	<0.001	-	-
Middle	1.41 [1.19-1.66]	<0.001	-	-
Richer	1.24 [1.05-1.47]	0.013	-	-
Richest	1			
Breastfeeding status				
No	1.38 [1.23-1.56]	<0.001	1.19 [1.04-1.37]	0.013
Yes	1		1	
Reading newspaper				
Not at all	1.71 [1.25-2.35]	0.001	-	-
Less than one	1.49 [1.07-2.08]	0.020	-	-
At least once a week	1			
Listening to the radio				
Not at all	1.53 [1.35-1.74]	<0.001	1.37 [1.19-1.57]	<0.001
Less than one	1.25 [1.12-1.39]	<0.001	1.14 [1.01-1.27]	0.031
At least once a week	1		1	

Table 2. Continued

Variable	COR	P-value	AOR	P-value
Watching television				
Not at all	1.68 [1.39-2.02]	<0.001	1.32 [1.06-1.64]	0.012
Less than one	1.55 [1.27-1.89]	<0.001	1.30 [1.04-1.63]	0.022
At least once a week	1		1	
Exposed to media				
No	1.43 [1.26-1.62]	<0.001	-	-
Yes	1			
Bottle feeding				
No	1		1	
Yes	0.60 [0.51-0.71]	<0.001	0.70 [0.58-0.84]	<0.001
Type of toilet facility				
Improved	1.32 [1.20-1.45]	<0.001	-	-
Not improved	1			
Source of water				
Improved	1.07 [0.96-1.19]	0.219	-	-
Not improved	1			
Time to fetch water				
Water on source	1			
Less than 30 minutes	1.45 [1.20-1.76]	<0.001	-	-
30 minutes +	1.66 [1.36-2.02]	<0.001	-	-
Floor material				
Improved	1		1	
Not improved	1.42 [1.25-1.62]	<0.001	1.22 [1.10-1.34]	<0.001
Sharing toilet				
No	0.75 [0.67-0.83]	<0.001	-	-
Yes	1			
Child stool disposal				
Not improved	1.17 [1.02-1.33]	0.024	-	-
Improved	1			

Discussion

Trends in Childhood Diarrhoea

The present study aimed to assess trends and risk factors for diarrhoea among children under five years of age in Rwanda. The prevalence of diarrhoea showed a fluctuating trend over the 15-year period. Between 2010 and 2015, there was a modest decline (from 12.81% to 11.62%), which can be attributed to the positive effects of national interventions such as the introduction of the rotavirus vaccine in 2012, improvements in water and sanitation infrastructure, and the strengthening of community health programs.

However, the reversal observed between 2015 and 2020, when prevalence rose to 13.65%, suggests that these early gains were not fully sustained.[16,25,28,29] This upward trend may also be related to emerging challenges, such as population growth, rural exodus, and urbanization, that outpaced the capacity of health and sanitation infrastructure.[3] Although investments in public health continued during this period, the rapid increase in population and service demands likely stretched available resources, reducing their effectiveness and contributing to disparities in access to clean water, sanitation, and healthcare.

These findings highlight the need to not only maintain investments but also adapt them to the realities of demographic change and urbanization pressures to sustain long-term progress in diarrhoea prevention.[30]

However, at the district level, trends reveal significant variation. Districts such as Kicukiro, Nyabihu, and Musanze recorded sharp declines between 2010 and 2015, reflecting strong uptake of vaccination and effective WASH interventions. Similarly, Huye, Gasabo, and Kamonyi showed sustained reductions up to 2020, indicating steady progress in preventive and curative child health services. In contrast, districts such as Rubavu, Nyagatare, and Bugesera consistently reported higher prevalence rates throughout the years, with slower progress compared to the national trend.

These districts face challenges such as high population density (Rubavu), cross-border dynamics (Nyagatare, Bugesera) and limited access to safe water, which may have slowed the impact of national programmes. Furthermore, districts like Ngoma and Kirehe showed some fluctuations rather than a consistent downward trajectory. This gap between growth and infrastructure development could explain why certain areas or populations still experience an elevated risk of diarrhoea, even as the overall prevalence trends downward.

Socio-Demographic Factors

Household heads under 25 years of age were more likely to have children affected by diarrhoea compared to older ages. According to previous studies, younger household heads often have limited access to resources and health education, which can impact their ability to provide adequate sanitation and clean water. It can be because they lack knowledge or experience in child-rearing practices that reduce the risk of infections. For example, a study in Uganda highlighted that the caregiver's age was significantly associated with the prevalence of diarrheal diseases among children under five years of age.[31]

Similarly, research from the National Health Interview Survey in the United States indicated that younger parents were more likely to experience food insecurity, which is closely related to higher rates of childhood illnesses, including diarrhoea.[32]

Maternal age plays a key role, and younger mothers (15-24 years) face significantly higher odds of having diarrhoea compared to older mothers 35-49 years and those 25-34 years also show an elevated risk of having diarrhoea. Older mothers have good knowledge and experience of child health in general and diarrheal diseases.[34] For example, younger mothers may face higher risks due to factors such as limited access to healthcare, lower socio-economic status and less experience in childcare. Middle-aged mothers, although more experienced, may still face challenges that elevate the risk of diarrhoea in their children. In contrast, older mothers likely benefit from more incredible experience, stability, and resource access, contributing to lower incidence rates.[33]

The size of the households also influenced the outcome, and larger households (Four or more members) are more likely to develop diarrhoea than smaller households. This increased likelihood is often attributed to overcrowding, which is more prone to reduced hygiene conditions, shared toilet facilities, and increased exposure to insanitation and hygiene resources are more significant, making it more difficult to maintain clean living conditions and proper sanitation practices. [37] Furthermore, limited resources may be spread thin, leading to compromised health-seeking behaviors and delayed access to treatment when symptoms of diarrhoea appear.[38,39] These factors highlight the need for targeted interventions in larger households to reduce the incidence of diarrheal diseases. Compared to households living in Kigali, the Northern, Southern, and Western provinces have demonstrated higher odds of diarrhoea. In a study conducted in Rwanda, the western province had an increased odds of diarrhoea, which was associated with lower economic status and poor maternal education.[16]

Households in these regions often face challenges such as unimproved sanitation, limited access to clean water, and lower levels of maternal education, which are critical determinants of child health. For example, a study published in Rwanda highlighted that the West and North Provinces had the highest prevalence rates of diarrhoea, with significant spatial clustering observed in these areas.[25]

The education level of the partner reveals that people without formal education have a slightly increased risk of developing diarrhoea, while those with secondary or higher education experienced a significantly reduced risk of having diarrhoea compared to those with only primary education. Education equips people with the knowledge and skills to prevent and manage diarrheal diseases. Regarding the partner, progress in education contributes a lot to the household's socio-economic situation, improving the overall economics of the household.[16]

The marital status analysis highlights that widowed, divorced, or separated individuals are at increased risk of diarrhoea compared to those who have never had a relationship. Widowed, divorced, or separated individuals tend to experience a higher incidence of diarrhoea compared to those who have never been in a union, likely due to a combination of economic, social, and psychological factors. Marriage dissolution can be associated with financial instability, reducing access to clean water, sanitation, and healthcare, and increasing susceptibility to diarrhoea diseases.[34] Psychological stress associated with losing a spouse or relationship can compromise immune function, making people more vulnerable to infections.[35]

Child Feeding and Care Practices

Breastfeeding status is associated with a lower probability of diarrhoea. Breastfeeding appeared to expose a child to less contamination, which reduced the risk of contracting diarrheal diseases again.[36] The researchers also revealed that lactating

mothers tend to adopt healthier practices and behaviors related to hygiene and sanitation, reducing episodes of diarrheal diseases among their children.[37–39] Therefore, promoting and supporting breastfeeding practices can significantly improve child health outcomes by mitigating the risk of diarrhoea.

Caregivers who do not use or radio use these media less than once a week exhibited amplified odds of having children with diarrhoea compared to those who consume those media at least once a week. Recurring exposure to radio and television can serve as essential sources of health-related information, promoting awareness of hygiene practices, nutrition, and preventive health measures against diarrhoea.[40] Specifically, educational programming and public health messages distributed through these channels can equip caregivers with vital knowledge about sanitation and child health, thus reducing the incidence of diarrhoea diseases in children.[41] On the contrary, caregivers with limited media engagement may lack access to such information, leading to inadequate awareness and practices regarding diarrhoea prevention.[42] Thus, improving media literacy and increasing the accessibility of health-related programming through television and radio could significantly mitigate the risk of diarrhoea among children.

Children who did not use bottle feeding were less likely to develop diarrhoea than those using the bottle. This association might be ascribed to poor hygiene related to bottle feeding. Bottles can hold bacteria if not cleaned correctly or if milk is not kept properly, increasing the risks of introducing pathogens into an infant's diet when bottle feeding is not done in sanitary settings.[43] Furthermore, bottle feeding may encourage overfeeding or inappropriate feeding practices, leading to gastrointestinal disturbances and increasing the likelihood of diarrhoea.[36] In contrast, breastfeeding, which is more likely to occur without bottles, provides essential antibodies and nutrients that enhance the child's immune response

and protect against infections, including those that cause diarrhoea.[44] Therefore, promoting breastfeeding and discouraging bottle feeding can be essential strategies for reducing the incidence of diarrhoea among children.

Environmental and WASH Factors

Finally, households with non-improved toilet facilities had a higher probability of developing diarrhoea among children than those with improved toilets. Unimproved toilet facilities significantly increase the risk of fecal contamination in the household environment, which increases the likelihood of ingesting harmful pathogens- the primary cause of diarrhoea in children.[45] On the contrary, households with improved sanitation are more likely to practice better overall hygiene, reducing the risk of diarrhoea.[46] Therefore, promoting the construction and use of improved sanitation facilities is essential to prevent diarrhoea in children, especially in low-resource settings.

Study limitation

This study has some strengths as it used nationally representative data from three RDHS surveys (2010, 2014/15, 2019/20), ensuring reliable estimates of childhood diarrhoea trends and associated factors over a decade. The large sample size, standardized data collection, and inclusion of diverse socio-demographic, environmental, and behavioral variables strengthen the findings. However, as a cross-sectional secondary analysis, causality cannot be established. Diarrhoea prevalence relied on caregiver self-reports, which may introduce recall or social desirability bias. Moreover, key variables such as seasonal effects, water quality, and pathogen-specific data were unavailable, limiting deeper insights into underlying causes. Future studies should adopt longitudinal designs, incorporate pathogen-specific and seasonal data, explore caregiver perspectives through mixed-methods approaches, and evaluate the effectiveness of WASH programs, health education, and breastfeeding promotion to better inform targeted interventions against childhood diarrhoea.

Conclusion

As conclusion, this study revealed a U-shaped trend in childhood diarrhoea prevalence in Rwanda between 2010 and 2020, with an initial decline followed by a resurgence. Significant risk factors for diarrhea include socio-demographic, environmental, and behavioral determinants. These include maternal age, education level, marital status, household size, breastfeeding status, media exposure, bottle feeding, and access to sanitation facilities. These findings emphasize the need for targeted interventions focusing on health education, breastfeeding promotion, improved WASH practices, and equitable access to clean water and sanitation. Strengthening community-based programs and integrating tailored public health strategies are essential to reducing the burden of childhood diarrhoea and improving child health outcomes in Rwanda. Future studies should employ more robust research designs and focus on other contextual factors such as regional inequalities, urbanization, and climate-related changes, which may provide deeper insights into the persistent burden of childhood diarrhoea in Rwanda.

Authors' Contributions

All authors contributed significantly to the preparation of the manuscript and have given their final approval for publication.

Conflict of Interest

The authors certify that they have no potential conflicts of interest concerning the research, authorship, or publication of this article.

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