ORIGINAL ARTICLE

A multilevel analysis of the predictors of diarrhea among children under 5 years of age in Eswatini

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DOI: 10.4081/jphia.2023.1149

Abstract. Diarrhea remains a public health challenge and persistently affect children under 5 years of age, primarily in developing countries. The aim of the study was to investigate the effects of individual, household and community level factors on child diarrhea. Using combined data 2010 and 2014 Eswatini Multiple Indicator Cluster surveys, data for 4,363 under five children was analysed. Univariable, bivariable and multivariable multilevel logistic regression models were used for data analysis. We found that the prevalence of diarrhea was 16.2%, (95% confidence interval (CI): 15.3-18.1). Higher odds of diarrhea were observed among children aged 6-11 months (AOR: 2.67, 95% CI: 1.93, 3.71) and 12-23 months (AOR=2.12, 95% CI: 1.56, 2.87) compared to those aged less than 6 months. However, lower odds of diarrhea were observed among children aged 36-47 months (AOR=0.68, 95% CI: 0.48, 0.97) and 48-59 months (AOR=0.39, 95% CI: 0.26, 0.58), compared to children aged less than 6 months. Children born to mothers aged 35-39 years had lower odds of having diarrhea, (AOR=0.48, 95%CI: 0.30, 0.79) compared to those born to mothers aged 15-19 years. Higher odds of having diarrhea were observed among children from communities with a low proportion of households with improved toilet facility (AOR=1.29, 95% CI: 1.01, 1.66) compared to those from communities with a high proportion of households with improved toilet facility. We found that individual- and community-level factors were associated with child diarrhea in Eswatini. Programmes and policies that aim to mitigate child morbidity due to diarrhea should pay attention to the individual and community factors.

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Key words: multilevel logistic regression, child diarrhea, community factors, factors, Eswatini

Introduction

Diarrhea remains a public health challenge and persistently affect children under 5 years of age, primarily in developing countries (1,2). Diarrhea is defined as the passage of three or more loose or liquid stools per day or more frequent passage than is normal for the individual (3). Approximately 525 000 children under five years die due to diarrhea per annum, making diarrhea the second leading cause of death, and attributed about 8% of all death among children under five years in 2019 (4-6). About 80% of the estimated children that die globally due to diarrhea are from developing countries (5,7).

Despite initiatives and efforts implemented by international organizations and national governments to impact positively on child health, including the introduction of Sustainable Development Goals (SDGs) post 2015 to 2030 (8), diarrhea still remains a public health problem. South Asia and Sub Saharan Africa (SSA) record the highest death rates, and is where about 80% of childhood diarrheal diseases occur (1,9). Many developing countries have poor sanitation and hygiene systems among other factors that predispose children to diarrhea (10,11). The prevalence of diarrhea varies from 10.8% in Benin, and South Africa and, Ethiopia (11.1%), Lesotho (12.2%), Zimbabwe (16.9%), Senegal (20.3%), Uganda (22.4%), Malawi (20.6%), and Liberia (24.8%) between 2010 and 2018 (1,12).

Eswatini recorded a slight increase of diarrhea, from a prevalence of 16.0% in 2010 to 16.4% in 2014 among children under five years (13,14). Previous studies from developing countries provide evidence that some of the factors associated with child diarrhea include: the age of the child; sex of the child; maternal age; maternal education; the number of children under five years in the household; the source of drinking water; the household wealth index; the place of residence; and the region of residence (15-18). Even though several studies have reported the correlates of child diarrhea elsewhere (19-21). Eswatini depends on descriptive reports (13,14). To control the occurrence of diarrhea among children under five years, there is a need to conduct robust inferential analysis to examine the extent to which characteristics at individual, and community levels are associated with child diarrhea.

Study context. Eswatini is a landlocked country in Southern Africa surrounded by Mozambique on the East and South Africa on the western side, measuring 17,364 km^2 with a population of about 1,093,238 million, 531,111 males and 562,127 females, 78% of whom live in rural areas (22). Eswatini has experienced a rapid fertility decline over the years, with 3.3 children per woman in 2014 (23). The country has a per capita Gross Domestic Product (GDP) of US$ 2,776, with the main drivers of the economy being agriculture and manufacturing. Of the total population, 53.5% of children aged 0-14 years, 64.1% of those aged 15-24 years, and 54.1% of those aged 15-35 years live below the poverty line of US$1.90 per day (24). Overall, in 2017, 58.9% of the population lived below the poverty line, a decrease of 4.1% from 2010. The literacy level stands at 87.5%, while unemployment stands at 28.1%, with about 44.0% of women and 52.0% of men benefiting from paid employment. Eswatini experienced a substantial increase in under five mortality from 67.4 per 1000 live births in 1990 to 116.7 per 1000 live births in 2005, and a sharp reduction was observed to 67 deaths per 1,000 live births in 2014 and 49.4 deaths per 1000 live births in 2019 (23). The reduction of child mortality could be a result of initiatives by the government of Eswatini to improve access to potable water and improved sanitation systems (25). Other programs include the child vaccination program, and efforts to strengthen the Eswatini epidemiological unit (EPU) to have an effective disease case notification on diarrhea outbreaks and other related childhood diseases (26).

Materials and methods

Data source. This study was a secondary analysis of the combined data from the 2010 and 2014 Eswatini Multiple Indicator Cluster Surveys (EMICSs). The Multiple Indicator Cluster Survey (MICS) is an international initiative by the United Nations Children's Fund (UNICEF) to assist countries in collecting and analysing data for monitoring the situation of children, women, and men in developing countries. It is a cross-sectional household survey conducted every 3-5 years to enable countries to capture rapid changes in key indicators, such as those related to health, education and development. In the EMICS, data were collected using standardised survey tools through face-to-face interviews among nationally representative samples of households (13,23).

Sampling design and study samples. The sampling frame of the enumeration was based on the 2007 Eswatini Population and Housing Census (27). A two-staged sampling technique and a systematic random sampling were applied. First, enumeration areas (EAs), also known as the primary sampling units (PSUs), were selected. Second, households were selected, stratified by rural and urban residence, and the four regions of the country, which are Manzini, Hhohho, Shiselweni, and Lubombo. To collect data for under-5s, a standardised questionnaire was used to obtain information for each child in the selected households. The mother or caregiver was the respondent for the child questionnaire. For the 2010 EMICS, 5 475 households were selected from 345 EAs, with a total of 4 834 households successfully interviewed. Overall, caregivers and mothers provided data for of 2,647 children aged under 5 years.

In the 2014 EMICS, a total of 347 EAs and 5 211 households were selected for the survey. Using the systematic probability proportional to size (PPS) sampling method, 15 households were selected in each EA. In the 2014 EMICS, at total of 2,693 children had data provided by caregivers and mothers during the interviews. However, for the combined 2010 and 2014 surveys, only 4363 under-5s with complete data on diarrhea and other characteristics were included in the analysis.

Study variables

Outcome variable. The study outcome variable was child diarrhea. In this study, we considered child diarrhea if the mother/caregiver reported that the child had diarrhea in the last two weeks preceding the survey. The variable was coded as binary: (1) for those with diarrhea, (0) for those without diarrhea.

Explanatory variables. The explanatory variables included child factors, maternal factors, and household and community factors (17,28-30). Individual-level variables were child age in months, sex, child stunting status, maternal education, maternal age, parity, marital status, household toilet facility, source of drinking water, number of children under 5 years, household wealth index. The household wealth index had been calculated in the EMICS dataset and was categorised into five quartiles, namely the poorest, poor, middle, rich and richest. Wealth indices use information about household durable assets, such as housing materials, toilet or latrine access, phone ownership, or agricultural land and livestock, which are regularly collected in most household surveys to create an index of household wealth (31). Community-level variables were area of residence, region of residence, community poverty (proportion of households in the communities classified in the poorest and poor wealth quantiles), community maternal education level (proportion of mothers with at least secondary level education in the community), community improved toilet facility (proportion of households with flush, and pit latrine in the community) and community improved source of water (proportion of households with piped in the community). To generate the community variables, the individual-level variables were aggregated by cluster and categorised as low, medium and high or low and high (18,32,33).

Statistical analysis. Descriptive statistics were used to assess the distribution of the sample and the magnitude of child diarrhea. A bivariable analysis through the chi-square test was performed to test the crude association between each explanatory variable and diarrhea. The variance inflation factor (VIF) was used to test for strongly correlated explanatory factors, and no factors were strongly correlated to each other. Due to the hierarchical nature of the dataset, a multilevel model that controls for clustering of diarrhea across communities was used. Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were used to establish the fixed effects of the models. Random effects, important to establish the random variation of diarrhea across communities, was denoted by the intraclass correlation (ICC) and median odds ratio (MOR). The higher the value of MOR from 1 the greater is the between-community variation. Four models were fitted to analyse the data. Model 1: An empty model to produce a random variation of the intercept (random effects) and the ICC. Model 2 included only individual-level variables. Model 3 included only community-level factors. Model 4 included individual and community-level variables in one model. The entire analysis took into account survey weights and was done in Stata 15 (Stata Corp., USA).

Ethical considerations. The UNICEF team granted permission for the access and use of the EMICS datasets from http://mics.unicef.org/surveys. They are anonymous and do not allow the identification of participants. The data is publicly available and the authors had no special access privileges to the data and that other researchers will be able to access the data in the same manner as the authors. This study was approved by the University of KwaZulu-Natal's Humanities and Social Science Research Ethics Committee as part of the Doctoral (PhD) studies.

Results

Of the 4363 children included in the analysis, slightly above half (51.5%) of the children were females and just over a quarter (26.2%) were stunted. Nearly three fifths (59.2%) of the children were born to married mothers, with almost half (48.1%) of the mothers having parity of less than three children. The majority of the children were born to women with secondary education level (32.9%) while only 7.8% had tertiary education level. About seven out of ten (69.5%) were from households that used a pit latrine, and just over three fifths (62.5%) were from households that had piped water sources. Over three quarters (76,1%) were from rural areas, with just over a third (34.5%) resident in the Manzini region. There was a similar distribution of the child-level factors: by age group and sex, maternal-level factors: age group, household factors: household wealth index and community-level factors: region of residence, community poverty, and the community maternal education (Table I).

Overall, 16.6% of the children were reported to have had diarrhea in the past two weeks before the surveys. A significantly higher proportion of children who had diarrhea were aged 6-11 months (20.1%), 12-23 months (32.3%), and 24-35 months (18.3%) compared to 6.3% among those aged 48-59 months ($P<0.001$). A significantly higher proportion of children who had diarrhea were born to women aged 20-24 (30.3%) and 25-29 (23.8%) vs. only 3.3% among those born to women aged 45-49 years ($P=0.001$). A significantly higher proportion (71.2%) of the children reported to have had diarrhea were from households with a pit latrine compared to only 9.9% with a flush toilet ($P<0.007$) (Table I).

Factors associated with diarrhea among under five children. The fixed effects results of the multilevel models are shown in Table II. At the individual level, even after controlling for community level factors, child age was associated with diarrhea. Children aged 6-11 months, 12-23 months had higher odds of having diarrhea, (AOR=2.67, 95% CI: 1.93, 3.71), and (AOR=2.12, 95% CI: 1.56, 2.87) respectively while lower odds of having child diarrhea were observed among those aged 36-47 months (AOR=0.68,95% CI:0.48,0.97) and 48-59 months (AOR=0.39, 95% CI: 0.26,0.58), compared to children aged less than 6 months. Controlling for all other factors in the model, children born to mothers aged 35-39 years had lower odds of having diarrhea, (AOR=0.48,95%CI: 0.30,0.79) compared to those born to mothers aged 15-19 years. At the community level, higher odds of having diarrhea were observed among children from communities with a low proportion of households with improved toilet facility (AOR=1.29, 95% CI: 1.01,1.66) compared to those from communities with a high proportion of households with improved toilet facility, holding other factors constant in the model.

Random-effects results (measures of variation). The analysis also showed the random effect estimates. The intercept only model (empty model) was fitted to justify if there was random effect at the community level. In Table III, the empty model (model 1), there was a significant community difference in the odds of experiencing diarrhea among children ($\tau=0.387$, $P<0.001$). The variance remained significant even after controlling for individual, household and community level factors (Model 4). The intra-cluster variability of the study participants showed that children from the same cluster were significantly likely to share common characteristics than children outside the cluster. Therefore, the intercept intercept-only model (null model) showed that there was am ICC of 4.4% of the variation of the diarrhea is attributed to the difference between clusters. The MOR increased from 1.81 (Model 1) to 1.84 (Model 4), implying a significant differences between communities in the odds of diarrhea among under five children (Table III).

Discussion

The study aimed to investigate the individual and community level factors associated with child diarrhea. The study showed that the two weeks' prevalence of diarrhea among children under five years was 16.2% (95% CI: 15.2-17.2%) in Eswatini. Compared to other countries national surveys on the same time period, this prevalence was similar to Kenya (15.0%) and Togo (16.4%), but higher than that of Ghana (12.1%), Lesotho (12.2%), and South Africa (10.8%), while lower than that of Namibia (20.4) and Malawi (20.6) (12). This variation in the prevalence of diarrhea is possibly attributable to a difference in socio-economic and demographic characteristics, sanitation and access to improved water sources between the countries. Eswatini continues to monitor and manage illnesses, including diarrhea, which is in in line with global agenda, sustainable development goal number 3, target 3.2, to end preventable diseases and deaths of under-5-year-old children by the year 2030 (8,34).

The odds of having diarrhea were higher among children aged 6-11 months, and 12-23 compared to those aged less than 6 months. This finding is consistent with evidence from Ethiopia (28) and East Africa (35). A possible explanation for this finding could be that at the age of 6 months children are often introduced to solid foods, which has a much higher risk of contamination than breastmilk. In addition, children in rural settings are more likely to be exposed and ingest infectious agents in the soil as their mobility increases at around the same age that can increase the risk of diarrhea. Conversely, we found that children aged 36-47 months and 48-59 months

Table I. Sample characteristics and distribution of child diarrhea by the explanatory variables.

Variables	n (%)	Child had diarrhea Yes n (%)	Child had diarrhea No n (%)	P-value
Total	n=4363	733	3630	
Diarrhea prevalence		16.6 (15.3,18.1)	83.4 (81.9,84.7)	
Child level factors				
Child age				<0.001
<6months	488 (11.5)	73 (11.7)	415 (11.5)	
6-11 months	486 (11.1)	151 (20.1)	335 (9.3)	
12-23 months	905 (20.7)	237 (32.3)	668 (18.4)	
24-35 months	895 (20.9)	139 (18.3)	756 (21.4)	
36-47 months	814 (18.2)	84 (11.3)	730 (19.5)	
48-59 months	775 (17.6)	49 (6.3)	726 (19.9)	
Gender				0.192
Female	2,243 (51.5)	374 (48.9)	1,869 (52.0)	
Male	2,120 (48.5)	359 (51.1)	1,761 (48.0)	
Stunting				0.581
Yes	1,157 (26.2)	204 (27.1)	953 (26.0)	
No	3,206 (73.8)	529 (72.9)	2,677 (74.0)	
Maternal level factors				
Maternal age				0.001
15-19	299 (6.8)	74 (10.3)	225 (6.1)	
20-24	1,132 (25.9)	212 (30.3)	920 (25.1)	
25-29	1,098 (25.2)	184 (23.8)	914 (25.5)	
30-34	737 (17.6)	108 (14.7)	629 (18.1)	
35-39	520 (11.6)	62 (7.7)	458 (12.4)	
40-44	397 (8.8)	71 (9.9)	326 (8.6)	
45-49	180 (4.1)	22 (3.3)	158 (4.2)	
Maternal education				0.235
None	283 (6.3)	45 (5.7)	238 (6.4)	
Primary	1,297 (29.5)	242 (32.1)	1,055 (29.0)	
Secondary	1,460 (32.9)	246 (34.0)	1,214 (32.7)	
High school/tertiary	1,002 (23.5)	165 (22.6)	837 (23.7)	
Tertiary	321 (7.8)	35 (5.7)	286 (8.2)	
Parity				0.367
<3	2,072 (48.1)	362 (50.8)	1,710 (47.5)	
3-4 children	1,294 (29.1)	208 (27.2)	1,086 (29.5)	
>=5	997 (22.8)	163 (22.0)	834 (23.0)	
Marital status				0.066
Currently married	2,578 (59.2)	409 (54.3)	2,169 (60.2)	
Formerly married	359 (8.4)	67 (10.7)	292 (7.9)	
Never married	1,426 (32.4)	257 (35.0)	1,169 (31.9)	
Household level factors				
Household wealth index				0.052
Poorest	1,064 (22.3)	196 (24.3)	868 (21.9)	
Poor	955 (21.9)	169 (23.3)	786 (21.6)	
Middle	899 (19.8)	164 (21.5)	735 (19.5)	
Rich	732 (18.4)	118 (18.0)	614 (18.5)	
Richest	713 (17.5)	86 (12.9)	627 (18.5)	
Toilet facility				0.007
Flush toilet	604 (14.6)	69 (9.9)	535 (15.6)	

Table I. Continued.

		Child had diarrhea		
Variables	n (%)	Yes n (%)	No n (%)	P-value
Pit latrine	3,013 (69.5)	520 (71.3)	2,493 (69.1)	
No facility, Bush, Field	746 (15.9)	144 (18.8)	602 (15.3)	
Source of drinking water				0.167
Piped	2,588 (62.5)	403 (58.7)	2,185 (63.3)	
Protected well	375 (7.6)	74 (8.7)	301 (7.4)	
Unprotected	927 (19.9)	88 (10.4)	385 (9.8)	
Surface water	473 (9.9)	168 (22.3)	759 (19.4)	
Number of children under 5 years per households				0.06
One	2,021 (47.1)	338 (48.2)	1,683 (46.8)	
2-3	2,039 (46.3)	331 (42.9)	1,708 (46.9)	
>=4	303 (6.7)	64 (8.8)	239 (6.3)	
Community factors				
Area of residence				0.223
Rural	3,362 (76.1)	584 (78.9)	2,778 (75.6)	
Urban	1,001 (23.9)	149 (21.4)	852 (24.4)	
Region of residence				0.29
Hhohho	1,058 (24.8)	154 (21.8)	904 (25.4)	
Manzini	1,153 (34.5)	184 (34.4)	969 (34.5)	
Shiselweni	1,150 (20.6)	216 (22.7)	934 (20.2)	
Lubombo	1,002 (20.1)	179 (21.1)	823 (19.9)	
Community poverty				0.634
Low	2,382 (57.2)	393 (56.2)	1,989 (57.4)	
High	1,981 (42.8)	340 (43.8)	1,641 (42.6)	
Community maternal education level				0.419
Low	2279 (53.7)	374 (52.5)	1,905 (54.0)	
Medium	654 (14.3)	102 (13.0)	552 (14.5)	
High	1430 (32.0)	257 (34.5)	1,173 (31.5)	
Community source of improved water				0.484
Low	2,175 (47.1)	377 (48.6)	1,798 (46.8)	
High	2,188 (52.9)	357 (51.4)	1,832 (53.2)	
Community improved toilet facility				0.05
Low	2,131 (45.8)	393 (50.0)	1,738 (45.0)	
High	2,232 (54.2)	340 (50.0)	1,892 (55.0)	

had lower odds of having diarrhea, compared to children aged less than 6 months. At older ages children might have greater immunity to resist diarrheal diseases when compared to those who are younger.

In this study, children born to mothers aged 35-49 years had lower odds of having diarrhea when compared to those born to mothers aged 15-19 years. This finding is in agreement with data from Ethiopia (36) and Tanzania (37). Older women are likely to have greater experience with child health care practices than young mothers.

Consistent with the literature (36,38), children from communities with a low proportion of households with improved toilet facility had higher odds of having diarrhea compared to those from communities with a high proportion of households with improved toilet facility. Access to improved toilets facilities reduces open defecation and encourages proper disposal of child excreta which may result to higher risk of diarrhea.

Study strengths and limitations. This study should be interpreted with caution, due to some limitations. It used cross-sectional datasets from MICS, hence it was not possible to establish causal inference between diarrhea and individual and community-level factors. Some useful variables, such

Table II. Results of the individual, and community-level factors associated with child diarrhea, Eswatini.

Fixed effects	AOR(95%CI)	AOR (95%CI)	AOR(95%CI)
Child age (months)			
<6	1		1
6-11	2.69 (1.94,3.73)[a]		2.67 (1.93,3.71)[a]
12-23	2.11 (1.56,2.86)[a]		2.12 (1.56,2.87)[a]
24-35	1.08 (0.78,1.50)		1.09 (0.78,1.51)
36-47	0.68 (0.48,0.96)[a]		0.68 (0.48,0.97)[a]
48-59	0.39 (0.26,0.58)[a]		0.39 (0.26,0.58)[a]
Sex			
Male	1		1
Female	1.01 (0.85,1.19)		1.01 (0.85,1.19)
Stunting			
Yes	1.01 (0.83,1.23)		1.01 (0.85,1.19)
No	1		1
Maternal level factors			
Maternal age			
15-19	1		1
20-24	0.87 (0.62,1.21)		0.88 (0.63,1.23)
25-29	0.80 (0.55,1.15)		0.81 (0.56,1.17)
30-34	0.68 (0.45.1.04)		0.68 (0.44,1.04)
35-39	0.48 (0.30,0.79)[a]		0.48 (0.30,0.79)[a]
40-44	0.86 (0.52,1.42)		0.86 (0.52,1.42)
45-49	0.56 (0.29,1.06)		0.57 (0.30,1.09)
Maternal education			
None	0.90 (0.51,1.60)		0.90 (0.50,1.61)
Primary	1.17 (0.73,1.87)		1.16 (0.73,1.86)
Secondary	1.04 (0.66,1.63)		1.04 (0.66,1.64)
Higher	1.09 (0.70,1.71)		1.10 (0.71,1.72)
Tertiary	1		1
Parity			
Less than 3	1		1
3-4	1.09 (0.86,1.38)		1.09 (0.86,1.39)
5 and above	1.23 (0.88.1.71)		1.24 (0.89,1.73)
Marital status			
Married	1		1
Formerly married	1.33 (0.98,1.82)		1.32 (0.97,1.80)
Never married	0.90 (0.73,1.12)		0.90 (0.72,1.11)
Household level			
Household wealth index			
Poorest	1.19 (0.77,1.83)		1.22 (0.78,1.91)
Poor	1.19 (0.83,1.83)		1.24 (0.82,1.87)
Middle	1.24 (0.83,1.83)		1.24 (0.83,1.85)
Rich	1.16 (0.80,1.70)		1.16 (0.79,1.70)
Richest	1		1
Source of drinking water			
Piped	1		1
Protected well	1.30 (0.96,1.76)		1.34 (0.98,1.85)
Surface water	1.07 (0.85,1.36)		1.11 (0.86,1.42)
Unprotected	1.07 (0.80,1.44)		1.12 (0.79,1.70)
Toilet facility			
Flush toilet	1		1
Pit latrine	1.26 (0.86,1.84)		1.29 (0.88,1.91)
No facility, Bush, Field	1.40 (0.88,2.22)		1.35 (0.84,2.17)

Table II. Continued.

Fixed effects	AOR(95%CI)	AOR (95%CI)	AOR(95%CI)
Number of under five children in the household			
1	1		1
2-3	0.92 (0.77,1.11)		0.93 (0.77,1.11)
4 and more	1.21 (0.86,1.69)		1.22 (0.87,1.71
Community level			
Area of residence			
Rural		1.13 (0.88,1.45)	0.94 (0.71,1.26)
Urban		1	1
Region of residence			
Hhohho		1	1
Manzini		1.14 (0.88,1.49)	1.08 (0.82,1.43)
Shiselweni		1.33 (1.02,1.74)[a]	1.25 (0.94,1.67)
Lubombo		1.19 (0.90,1.57)	1.20 (0.89,1.63)
Community poverty			
Low		1	1
High		0.84 (0.66,1.06)	0.83 (0.64,1.08)
Community maternal education level			
Low		1	1
Medium		0.87 (0.66,1.15)	0.83 (0.61,1.12)
High		1.07 (0.86,1.34)	1.02 (0.80,1.30)
Community source of improved water			
Low		0.97 (0.79,1.21)	0.87 (0.68,1.11)
High		1	1
Community improved toilet facility			
Low		1.31 (1.05,1.65)[a]	1.29 (1.01,1.66)[a]
High		1	1

[a]Significant at P<0.05, AOR-adjusted odds ratio.

Table III. Measures of variation on individual and community-level factor associated with childhood diarrhea in Eswatini.

	Model 1	Model 2	Model 3	Model 4
Random effects	Empty	Individual	Community	Final model
Community variance (SE)	0.387 (0.073)	0.435 (0.075)	0.351 (0.077)	0.406 (0.078)
P-value	<0.001	<0.001	<0.001	0.001
VPC=ICC (%)	4.4	5.5	3.6	4.8
MOR	1.81	1.88	1.76	1.84
Log likelihood	-1969.6	-1,837.9	-1,961.8	-1,832.7
Observations	4363	4,363	4,363	4,363
Model fit statistics				
AIC	3943.1	3,743.8	3,945.5	3,751.3
BIC	3955.9	3,960.7	4,015.7	4,025.7

SE refers to standard error. VPC refers to the variance partition coefficient, ICC refers to intraclass correlation coefficient. MOR refers to median odds ratio. AIC refers to Akaike information Criterion, BIC refers to the Bayesian information criterion. [a]Significant at P-value <0.05.

breastfeeding, child weight, and the safe disposal of child fecal matter were not included in the analysis due to extensive missing data. The outcome variable (child diarrhea) was asked as a binary variable (yes, no), without the classification of diarrhea as being acute watery diarrhea, acute bloody diarrhea or persistent diarrhea. Recall bias, is one of the key limitations in cross sectional studies, however, the mother or caregiver were asked if their children had diarrhea in the past two weeks prior to the MICS. Regardless of the above limitations, the study has several strengths: MICS is a representative sample that allows for the results to be generalized to the entire population of children under five years in Eswatini. The application of the multilevel logistic regression approach control for the clustering of child diarrhea, hence incorporate a design based approach. We accounted for the multistage complex sampling design of the mics through weighting, which further increased the validity of the study.

Conclusions

In summary, child diarrhea remain a public health problem in Eswatini. Diarrhea is high among children aged 6-11 months, and 12-23 vs. those aged less than 6 months, born to women younger than 35 years vs. those aged 35-039 years and from communities with low access to improved toilets facilities than those from communities with high proportion of households with improved toilets facility. Policy makers and organizations working toward improving child health should continue to spearhead programs that aim to reduce the incidence of diarrhea. Such programs should include awareness on the factors associated with child diarrhea that emanate from research.

Acknowledgments

The authors would like to thank the Multiple Indicator Cluster Survey for providing access to the dataset and also the Eswatini Central Statistical Office for providing access to the MICS 2010 and 2014 sampling frame.

Contributions

MSS, conceived the research idea, performed statistical analysis, wrote the methods, results, and discussions, and prepared the initial draft of the manuscript; KV, critically reviewed the manuscript and contributed to the study design and manuscript writing. All the authors approved the final version to be published.

Funding

The work was done under the Population Studies Doctoral (PhD) program in the School of Built and Development Studies, University of KwaZulu-Natal.

Ethical approval and consent to participate

The UNICEF team granted permission for the access and use of the EMICS datasets from http://mics.unicef.org/surveys. They are anonymous and do not allow the identification of participants. This study was approved by the University of KwaZulu-Natal's Humanities and Social Science Research Ethics Committee as part of the Doctoral (PhD) studies.

Conflict of interest

The authors declare no potential conflict of interest.

Accepted: 04, July 2019; submitted: 05, March 2023.

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