Original Article

Risk factors of diarrhea of children under five in Malawi: based on Malawi Demographic and Health Survey 2015–2016

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OPEN ACCESS

Received: Oct 30, 2019

Accepted: Nov 25, 2019

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Conflict of Interest

The authors declare that they have no competing interests.

ABSTRACT

Background: Diarrhea of children under 5 in Malawi, a high-burden country for diarrhea, accounted for 7% of under-5 mortality in 2017. Preceding studies have revealed the association between diarrhea of under-fives and characteristics of children and households including water, sanitation and hygiene (WASH). There has been limited household-level analysis regarding diarrhea in Malawi, thus the aim of our study is to identify risk factors of diarrheal disease among children under 5 in Malawi.

Methods: Data set for this study were drawn from the Malawi Demographic and Health Survey conducted in 2015–2016 and 14,872 children were selected as study samples. Independent variables included social-demographic characteristics, household living conditions and WASH environment. Variables that had a *P*-value lower than 0.05 in the simple logistic analysis were included in multiple logistic regression model.

Results: Approximately 20% of children had diarrhea within 2 weeks. In multiple model, demographic characteristics of sex and age of child, size of child at birth, region, mother's age and working status were associated with the risk of diarrhea. Regarding WASH environment, 30 minutes or longer to get water (adjusted odds ratio [AOR], 1.184; 95% confidence interval [CI], 1.045–1.342), unimproved toilet facilities (AOR, 1.185; 95% CI, 1.088–1.291), toilet facilities located in yard/plot (AOR, 1.344; 95% CI, 1.056–1.711) and elsewhere (AOR, 1.375; 95% CI, 1.048–1.805), and lack of handwashing facility with water and soap (AOR, 1.180; 95% CI, 1.010–1.379) increased the odds of diarrhea.

Conclusion: The findings of this study showed that socio-demographic characteristics and poor conditions of WASH increased the diarrheal risk of young children. The location of toilet facility implies that proximity is important, but it is necessary to determine the location according to local circumstances. Our study suggests that WASH infrastructure and behavior change strategies need to prioritize Malawi's vulnerable groups.

Keywords: Diarrhea; Children; Water; Toilet facilities; Hand hygiene

Author Contributions

Conceptualization: Moon J, Choi JW, Oh J, Kim K; Data curation: Moon J, Oh J; Formal analysis: Moon J, Choi JW, Kim K; Investigation: Moon J, Oh J; Methodology: Moon J, Choi JW, Kim K; Validation: Moon J, Kim K; Writing - original draft: Moon J, Choi JW, Oh J, Kim K; Writing - review & editing: Moon J, Choi JW, Oh J, Kim K.

INTRODUCTION

In 2018 alone, 5.3 million young children died before the age of 5 around the world.¹ In spite of continuous decline with an annual rate of reduction of 3.8% from 2000 to 2018, low income countries mostly located in Sub-Saharan Africa had the highest under-5 mortality across all regions.² Globally, diarrhea is the second leading cause of under-5 mortality and known for the common cause of malnutrition.³ The World Health Organization (WHO) emphasized safe water, improved sanitation facilities, and handwashing behavior using soap to prevent diarrhea.⁴ The integrated Global Action Plan for Pneumonia and Diarrhea proposed a comprehensive approach to end preventable deaths caused by pneumonia and diarrhea including water, sanitation, and hygiene (WASH) intervention.⁵ These efforts resulted in WHO/United Nations Children's Fund (UNICEF) Joint Monitoring Programme (JMP) to estimate status of WASH in households, schools and health care facilities on global level.⁶

The under-5 mortality rate in Malawi in 2018 was 50 per 1,000 newborns, which was higher than the global mortality rate of 39 per 1,000 newborns.² The child mortality rate has been decreasing since 1990, but Malawi is one of the countries that need more concentrated effort to achieve the sustainable development goals 3.2; to reduce neonatal mortality and under-5 mortality to at least as low as 12 and 25 per 1,000 live births respectively by 2030.⁷ In 2016, diarrhea among children under 5 in Malawi accounted for 7% of under-5 mortality.⁸ The Basic Health Care Package from Health Sector Strategic Plan II (2017–2022) established by government of the Republic of Malawi includes promotion of hygiene, safe water and sanitation addressing key role of water-borne diseases.⁹

Previous systematic reviews and meta analyses showed that specific demographic characteristics, household environments such as improved water, sanitation and handwashing had an effect on diarrheal risk.^{10–12} Household living conditions based on the assets and dwelling characteristics of each household were included in the study model, given that children under the age of 5 spend a lot of time indoors.¹³ Malawi is a country with a high burden of child diarrhea, but studies on Malawi have focused analysis based on health facility rather than household level risk factors.^{14,15} Social-demographic characteristics, household living conditions and WASH-related characteristics were analyzed to assess the association between the direct and indirect risk factors and children's diarrhea in Malawi. Therefore, the aim of our study is to identify risk factors of diarrheal disease among children aged under 5 based on data of Malawi Demographic and Health Survey (MDHS) 2015–2016.

METHODS**Data source**

Dataset for this study were drawn from MDHS conducted in 2015–2016. Demographic and Health Survey (DHS) is a nation-wide household survey conducted almost every 5 years and the dataset are allowed to be downloaded from the DHS program web page after getting an approval as a registered user.¹⁶ The National Statistical Office implemented MDHS of 2015–2016 collaborating with the Ministry of Health. The phase of MDHS 2015–2016 was performed with DHS-VII. Data on households and children under the age of 5 was recorded separately in household record (HR) and kids record (KR) files. In order to merge household information of HR and children's characteristics of KR, household variables such as water and sanitation of HR were merged into KR in accordance with DHS statistics guide.¹⁷

Since neither file shares the same ID variable, the combination of the cluster number and household number was created as a matching standard in both files.

Study sample selection

The 2015–2016 MDHS used 2-stage stratified sampling method for sample selection.¹⁸ Sampling frame is the list of all standard enumeration areas (SEAs) completed for the 2008 Malawi Population and Housing Census. As a geographic area, a single SEA covers about 235 households. Malawi consists of 28 districts and each district was stratified into 2 areas: rural and urban. In total, the 2015–2016 MDHS has 56 sampling strata. In the first stage, 850 SEAs were randomly selected with probability proportional to the SEA size from each stratum. Large SEAs with more than 250 households were segmented to list household listing efficiently.

In the second stage, 30 households per cluster in urban and 33 per cluster in rural were chosen by probability systematic selection from the household listing. One cluster is either a SEA or part of a SEA. Among the 27,516 households selected for the sample, 26,361 households accepted the interview with a response rate of 97.7%. All women of reproductive age 15–49 who were usual residents or visitors who stayed the previous night in the selected households were eligible for an interview. A total of 24,562 women completed the interview. If the interviewed woman had given birth, the interviewer asked questions about the characteristics of the 0–59 month-old children. Data from 17,286 children were collected from interviewed mothers.

Among 17,286 children under 5-year old, 16,246 children had data on whether they had diarrhea within the past 2 weeks. The remaining children with missing value on the outcome were excluded from our research. Additionally, children who lacked information about time to get to water source or type of toilet facility were excluded from study analysis. A total of 14,872 children was selected as final study samples (Fig. 1).

Dependent variable

The outcome variable of this study was the prevalence of diarrhea among children aged 0–59 months within the past 2 weeks preceding the survey. The interviewed women were asked whether their children under age 5 had diarrhea in the last 2 weeks. DHS-VII questionnaire defines diarrhea as all types of diarrheal symptoms including bloody stools, watery stools,

Fig. 1. Flow of study sample selection.
MDHS = Malawi Demographic and Health Survey.

etc. The outcome variable of this study was categorized as 0 (no) and 1 (yes, last 2 weeks), excluding 'don't know'.

Explanatory variables

Independent variables included following: 1) social-demographic characteristics (sex and age of child, size at birth, type of place of residence, region, mother's age/education/working status); 2) household living conditions (wealth index, refrigerator, cooking place, type of cooking fuel, construction materials of floor/wall/roof, bed with a mattress); 3) WASH-related characteristics (source of drinking water, time to get to water source, type and location of toilet facility, handwashing facility with available water and soap) (Fig. 2). Conceptual framework of this study was adopted from conceptual framework of the causes of undernutrition including aspects of WASH and diarrhea by WHO, UNICEF, and United States Agency for International Development.¹⁹ Social-demographic characteristics such as size of child at birth, mother's education and working status as well as sex, age, region and etc. were added as basic determinants affecting household living conditions and WASH-related environments. Household living conditions, which are the underlying risk factors of diarrhea, and WASH characteristics, which are the immediate factors, were included.²⁰

The characteristics of a child 0–59 month-old was analyzed by sex, age (less than 12 months, 12–23 months, 24–35 months, 36–47 months, and 48–59 months) and size at birth (average, larger than average and smaller than average). Geographic distributions and characteristics were investigated by the type of place of residence (urban and rural), region (northern, central and southern region). Mother's characteristics consisted of mother's current age (15–29 years and 30–49 years), educational level (primary or below, and secondary or above) and working status.

Wealth index of MDHS 2015–2016 was calculated by measuring ownership of household assets, houses, land and type of water and sanitation facilities compositely.²¹ Refrigerator, cooking place (in the house or separate building, and others), cooking fuel, construction materials of floor/wall/roof and a bed with a mattress were included into independent variables to identify the association between household assets and dwelling characteristics and children diarrhea. Clean fuel for cooking contained electricity, liquefied petroleum gas,

Fig. 2. Conceptual framework of the study.
WASH = water, sanitation, and hygiene.

natural gas, and biogas. Finished materials for floor were parquet or polished wood, vinyl or asphalt strips, ceramic tiles, cement and carpet. Finished wall included materials of cement, stone with lime/cement, bricks, cement blocks, covered adobe and wood planks/shingles, and finished roof includes metal, wood, calamine/cement fiber, ceramic tiles, cement and roofing shingles.

Classification of 'improved/unimproved' of water and sanitation was defined following the Water and Sanitation guidelines by WHO/UNICEF JMP during MDG monitoring period.²² Improved source of drinking water includes piped into dwelling, piped to yard/plot/neighbor, public tap/standpipe, tube well or borehole, protected well/spring, and rainwater. Unimproved water means unprotected well/spring, surface water (river/dam/lake/pond/stream/canal/irrigation channel), cart with small tank, and other. Time to get water source was coded as on premises, less than 30 minutes and 30 minutes or longer.

Improved sanitation facilities include flush to piped sewer system/septic tank/pit latrine, ventilated improved pit latrine, pit latrine with slab and composting toilet that are not shared with other households. Unimproved sanitation facilities mean shared toilet facilities, and flush to somewhere else/don't know where, pit latrine without slab/open pit, no facility/bush/field, bucket toilet, hanging toilet/latrine, and other. Location of toilet facility was divided into in own dwelling, in own yard/plot, and elsewhere.

Regarding the handwashing facility, water and soap were observed whether they were available at the place where household members washed their hands often.

Statistical methods

The χ^2 test was applied to determine whether there was a significant difference between categorical variables with significance level of 0.05. Explanatory variables that had a *P*-value lower than 0.05 in the simple logistic analysis were included in multiple logistic regression model. In the multiple regression, the variables were chosen using backward Wald method with significance level of 0.05 and 95% CI to analyze the determinant of child diarrhea. The association between children diarrhea and explanatory variables were expressed as crude odds ratio in the simple logistic analysis and AOR in the multiple analysis. Hosmer and Lemeshow goodness of fit test was performed to check whether the data fits the multiple logistic regression model. SPSS version 24 (IBM Corp., Armonk, NY, USA) was employed for all data analyses.

Ethics statement

The protocol of MDHS 2015–2016 was approved by the National Health Sciences Research Committee in Malawi and the Inner City Fund Institutional Review Board (IRB). Interviewer received written consent with signature from all participants before starting the interview. This study was reviewed by IRB of the principal author's affiliation and exempted from ethic review by using secondary data which is open to the public (No. IRB-2019-0279).

RESULTS

Socio-demographic characteristics of the study samples

Data of 14,872 children under 5-year old from 11,607 households were collected in the survey. Description of the study samples are summarized in **Table 1**. Overall, 20.7% of under 5-year-old children had diarrhea during the recent 2 weeks. Almost half of the children were

Factors of diarrhea of Malawian children under five

Table 1. Characteristics of the study participants in Malawi, 2015–2016

Variables	Recent diarrhea		Total (%)	χ^2 (P-value)
	No (%)	Yes (%)		
Total	11,790 (79.3)	3,082 (20.7)	14,872 (100)	
1. Socio-demographic factors				
Sex of child				15.176 ($P < 0.001$) ^b
Male	5,790 (49.1)	1,635 (53.0)	7,425 (49.9)	
Female	6,000 (50.9)	1,447 (47.0)	7,447 (50.1)	
Current age of child (mon)				831.731 ($P < 0.001$) ^b
Less than 12	2,284 (19.4)	776 (25.2)	3,060 (20.6)	
12–23	1,885 (16.0)	1,059 (34.4)	2,944 (19.8)	
24–35	2,324 (19.7)	605 (19.6)	2,929 (19.7)	
36–47	2,600 (22.1)	393 (12.8)	2,993 (20.1)	
48–59	2,697 (22.9)	249 (8.1)	2,946 (19.8)	
Size of child at birth				22.211 ($P < 0.001$) ^b
Average	6,061 (51.4)	1,443 (46.8)	7,504 (50.5)	
Larger than average	4,007 (34.0)	1,120 (36.3)	5,127 (34.5)	
Smaller than average	1,722 (14.6)	519 (16.9)	2,241 (15.1)	
Type of place of residence				0.538 (0.463)
Urban	1,981 (16.8)	535 (17.4)	2,516 (16.9)	
Rural	9,809 (83.2)	2,547 (82.6)	12,356 (83.1)	
Region				40.113 ($P < 0.001$) ^b
Northern region	2,332 (19.8)	473 (15.3)	2,805 (18.9)	
Central region	4,059 (34.4)	1,203 (39.0)	5,262 (35.4)	
Southern region	5,399 (45.8)	1,406 (45.6)	6,805 (45.8)	
Mother's current age (yr)				114.449 ($P < 0.001$) ^b
15–29	6,882 (58.4)	2,125 (68.9)	9,007 (60.6)	
30–49	4,908 (41.6)	957 (31.1)	5,865 (39.4)	
Mother's education				3.813 (0.051)
Primary or below	9,125 (77.4)	2,436 (79.0)	11,561 (77.7)	
Secondary or above	2,665 (22.6)	646 (21.0)	3,311 (22.3)	
Mother's working status				7.246 (0.007) ^a
Not working	4,080 (34.6)	987 (32.0)	5,067 (34.1)	
Working	7,710 (65.4)	2,095 (68.0)	9,805 (65.9)	
2. Household living conditions				
Wealth index				15.007 (0.001) ^a
Poor	4,796 (40.7)	1,371 (44.5)	6,167 (41.5)	
Middle	2,409 (20.4)	604 (19.6)	3,013 (20.3)	
Rich	4,585 (38.9)	1,107 (35.9)	5,692 (38.3)	
Has refrigerator				8.8579 (0.003) ^a
Yes	678 (5.8)	135 (4.4)	813 (5.5)	
No	11,112 (94.2)	2,947 (95.6)	14,059 (94.5)	
Place of cooking				2.501 (0.114)
In the house or separate building	8,045 (68.2)	2,057 (66.7)	10,102 (67.9)	
Others	3,745 (31.8)	1,025 (33.3)	4,770 (32.1)	
Type of cooking fuel				4.287 (0.038) ^a
Clean fuel	144 (1.2)	24 (0.8)	168 (1.1)	
Others	11,646 (98.8)	3,058 (99.2)	14,704 (98.9)	
Main floor material				2.454 (0.117)
Finished floor	2,911 (24.7)	719 (23.3)	3,630 (24.4)	
Other	8,879 (75.3)	2,363 (76.7)	11,242 (75.6)	
Main wall material				2.862 (0.091)
Finished walls	9,080 (77.0)	2,329 (75.6)	11,409 (76.7)	
Others	2,710 (23.0)	753 (24.4)	3,463 (23.3)	
Main roof material				11.894 (0.001) ^a
Finished roofing	5,228 (44.3)	1,260 (40.9)	6,488 (43.6)	
Others	6,562 (55.7)	1,822 (59.1)	8,384 (56.4)	
Has a bed with a mattress				17.673 ($P < 0.001$) ^b
Yes	3,240 (27.5)	731 (23.7)	3,971 (26.7)	
No	8,550 (72.5)	2,351 (76.3)	10,901 (73.3)	

(continued to the next page)

Table 1. (Continued) Characteristics of the study participants in Malawi, 2015–2016

Variables	Recent diarrhea		Total (%)	χ^2 (P-value)
	No (%)	Yes (%)		
3. WASH-related factors				
Source of drinking water				0.052 (0.819)
Improved	10,221 (86.7)	2,667 (86.5)	12,888 (86.7)	
Unimproved	1,569 (13.3)	415 (13.5)	1,984 (13.3)	
Time to get to water source (min)				21.532 ($P < 0.001$) ^b
On premises	2,121 (18.0)	463 (15.0)	2,584 (17.4)	
Less than 30 min	4,807 (40.8)	1,229 (39.9)	6,036 (40.6)	
30 min or longer	4,862 (41.2)	1,390 (45.1)	6,252 (42.0)	
Type of toilet facility				26.543 ($P < 0.001$) ^b
Improved	6,742 (57.2)	1,603 (52.0)	8,345 (56.1)	
Unimproved	5,048 (42.8)	1,479 (48.0)	6,527 (43.9)	
Location of toilet facility				17.642 ($P < 0.001$) ^b
In own dwelling	535 (4.5)	91 (3.0)	626 (4.2)	
In own yard/plot	9,999 (84.8)	2,627 (85.2)	12,626 (84.9)	
Elsewhere	1,256 (10.7)	364 (11.8)	1,620 (10.9)	
Handwashing facility with water and soap				12.289 ($P < 0.001$) ^b
Yes	1,154 (9.8)	238 (7.7)	1,392 (9.4)	
No	10,636 (90.2)	2,844 (92.3)	13,480 (90.6)	

WASH = water, sanitation, and hygiene.

^a $P < 0.05$; ^b $P < 0.001$, P -values for χ^2 test.

male (49.9%), and 20.6% of the children were in the group under 12 months. Almost half (50.5%) of the children were average size at birth. Majority of the children lived in rural (83.1%) and southern region (45.8%). More than half (60.6%) of responded mothers were in the age group of 15–29 years old, and the mean of mother's age was 28.18 years old with a standard deviation of 6.82 years. 77.7% of mothers had no education or finished primary level of education. Almost two-thirds (65.9%) of respondents answered that they were currently working and 41.5% of them belonged to poor group in wealth index.

Most (94.5%) of mothers had no refrigerator, and more than two-thirds (67.9%) of those cooked in the house or separate building. Only a few (1.1%) mothers used clean fuel for cooking. Regarding housing construction materials, the percentage of finished materials for floor, wall, and roofing was 24.4%, 76.7%, and 43.6% respectively. Less than a third (26.7%) of respondents had a bed with a mattress.

Concerning the water and sanitation conditions, most (86.7%) of the children had access to improved source of drinking water, but only 17.4% of the water source was on premises. More than half (56.1%) among the children used improved toilet facility without sharing toilet with others, but only a small minority (4.2%) of the facility was located in own dwelling. Handwashing facility with available water and soap was observed only 9.4%.

Risk factors associated with diarrhea

In the simple logistic regression analysis, sex, age of child, size of child at birth, region, mother's current age and working status, wealth index, refrigerator, type of cooking fuel, main roof material, bed with mattress, time to get to water source, type and location of toilet facilities, and handwashing facility with water and soap were associated with diarrhea of under-5 at P -values lower than 0.05. Multiple logistic regression analysis was conducted to identify the association between diarrheal disease and above variables. In the multiple logistic regression model, Hosmer and Lemeshow goodness of fit test showed that the model was good (Hosmer and Lemeshow $\chi^2=5.002$, P -value=0.757). The results of multiple logistic regression presented in **Table 2** show that sex and age of child, size of child at birth, region,

mother's current age and working status, time to get to water source, type and location of toilet facilities, and handwashing facility with water and soap were statistically associated with diarrheal disease of under-5 children in Malawi.

Female children showed 0.851 times (AOR, 0.851; 95% CI, 0.783–0.924) lower odds of suffering from diarrhea than male children. Among the age group of child, 12–23 months showed the highest odds (AOR, 5.969; 95% CI, 5.131–6.944) compared to 48–59 months which is a reference group. The odds of other age groups in months were also higher than the reference group; less than 12 months (AOR, 3.531; 95% CI, 3.025–4.123), 24–35 months (AOR, 2.764; 95% CI, 2.359–3.239) and 36–47 months (AOR, 1.601; 95% CI, 1.353–1.895). Compared to children who were born normal size, children who were born larger (AOR, 1.186; 95% CI, 1.083–1.299) and smaller (AOR, 1.255; 95% CI, 1.115–1.412) than the average were exposed to higher odds of diarrhea.

Table 2. The risk factors of diarrhea in children under 5 in Malawi, 2015–2016

Variables (n = 14,872)	COR (95% CI)	AOR (95% CI)
Sex of child		
Male	Reference	Reference
Female	0.854 ^b (0.789–0.925)	0.851 ^b (0.783–0.924)
Current age of child (mon)		
Less than 12	3.680 ^b (3.157–4.289)	3.531 ^b (3.025–4.123)
12–23	6.085 ^b (5.237–7.070)	5.969 ^b (5.131–6.944)
24–35	2.820 ^b (2.408–3.301)	2.764 ^b (2.359–3.239)
36–47	1.637 ^b (1.385–1.936)	1.601 ^b (1.353–1.895)
48–59	Reference	Reference
Size of child at birth		
Average	Reference	Reference
Larger than average	1.174 ^b (1.075–1.282)	1.186 ^b (1.083–1.299)
Smaller than average	1.266 ^b (1.130–1.418)	1.255 ^b (1.115–1.412)
Region		
Northern region	Reference	Reference
Central region	1.461 ^b (1.299–1.644)	1.438 ^b (1.270–1.628)
Southern region	1.284 ^b (1.145–1.440)	1.242 ^b (1.101–1.401)
Mother's current age (yr)		
15–29	Reference	Reference
30–49	0.631 ^b (0.580–0.687)	0.698 ^b (0.639–0.762)
Mother's working status		
Not working	Reference	Reference
Working	1.123 ^a (1.032–1.222)	1.193 ^b (1.091–1.304)
Time to get to water source (min)		
On premises	Reference	Reference
Less than 30	1.171 ^a (1.040–1.319)	1.059 (0.933–1.201)
30 min or longer	1.310 ^b (1.165–1.472)	1.184 ^a (1.045–1.342)
Type of toilet facility		
Improved	Reference	Reference
Unimproved	1.232 ^b (1.138–1.334)	1.185 ^b (1.088–1.291)
Location of toilet facility		
In own dwelling	Reference	Reference
In own yard/plot	1.545 ^b (1.232–1.937)	1.344 ^a (1.056–1.711)
Elsewhere	1.704 ^b (1.326–2.190)	1.375 ^a (1.048–1.805)
Handwashing facility with water and soap		
Yes	Reference	Reference
No	1.297 ^b (1.121–1.500)	1.180 ^a (1.010–1.379)

The multiple model was defined including sex, age of child, size of child at birth, region, mother's current age and working status, wealth index, refrigerator, type of cooking fuel, main roof material, bed with mattress, time to get to water source, type and location of toilet facilities, handwashing facility with water and soap. The factors that had lower *P*-value than 0.05 in the simple logistic analyses were included into the multiple logistic regression model. COR = crude odds ratio; AOR = adjusted odds ratio; CI = confidence interval.

^a*P* < 0.05; ^b*P* < 0.001.

Children who live in central (AOR, 1.438; 95% CI, 1.270–1.628) and southern (AOR, 1.242; 95% CI, 1.101–1.401) region showed higher odds than those who live in northern region. Children who has mothers aged 30–49 years had 0.698 times (AOR, 0.698; 95% CI, 0.639–0.762) lower odds of diarrhea than those who has mothers aged 15–29 years. Working mothers had 1.193 (AOR, 1.193; 95% CI, 1.091–1.304) higher odds of diarrheal disease of young children compared to mothers who do not work.

Thirty minutes or more time taken to get to water source showed 1.184 times (AOR, 1.184; 95% CI, 1.045–1.342) higher than water source on premises, whereas getting water source within 30 minutes had no statistically significant association with diarrhea. Children who has unimproved toilet facilities had 1.185 times (AOR, 1.185; 95% CI, 1.088–1.291) higher than those who have improved toilet. Location of toilet facility also significantly affected the odds of childhood diarrhea (in own yard/plot: AOR, 1.344; 95% CI, 1.056–1.711 and elsewhere: AOR, 1.375; 95% CI, 1.048–1.805) compared to facility in own dwelling. The odds of children who lacks handwashing facility with available water and soap was 1.180 times (AOR, 1.180; 95% CI, 1.010–1.379) higher than those of children who have the facility with water and soap.

DISCUSSION

The aim of this study was to assess the risk factors of diarrheal disease of children under 5 years in Malawi. Multiple logistic regression model was performed with data on national scale from MDHS 2015–2016. Approximately 20% of children had diarrhea within the past 2 weeks, which is higher than 14.3% in Nigeria and 12% in Ethiopia.^{23,24} This study revealed that sex and age of child, size of child at birth, region, mother's age and working status, time to get to water source, type and location of toilet facility, and handwashing facility with available water and soap were associated with diarrheal disease in under 5 children.

The association between gender of child and diarrhea was consistent to several other studies performed in Ethiopia and in India, presenting that girls were less likely to suffer from diarrhea compared to boys.^{25,26} One-year old children peaked the highest likelihood of diarrheal disease among age groups. It is consistent with other studies performed in Mkuranga district, Tanzania in 2014 and in Benishangul Gumuz Regional State of North West Ethiopia in 2014 supporting that children aged 12–23 in months were the most fragile group of diarrheal risk.^{27,28} Our study also found that larger or smaller size of child at birth increased the diarrheal risk than mean size. This finding was partly supported by the study in India, which showed only significant association between the group of average and larger size.²⁶

Geographical difference showed dissimilar exposure on diarrheal risk. Higher odds of children diarrhea in the central and southern region might be explained by the fact that both regions are more densely populated than in the northern region. Lilongwe city, the national and administrative capital of Malawi, is located in the central region, and Blantyre, the second largest city, is located in the southern region.²⁹

MDHS 2015–2016 data showed that children of younger mother's group (15–19 years old) had higher risk of diarrhea than those of older mother's group (30–49 years old). Similarly, young mothers aged less than 18 years had increased the risk of diarrhea compared to mothers over 18 years old in a study conducted in Brazil.³⁰ On the basis of those studies, the findings suggest that young mothers are the main target group for behavior change strategies

regarding childhood diarrhea. We also found that working mothers increased the likelihood of diarrhea of young children. A study performed in North West Ethiopia reported that children of working mother were more likely to have a diarrheal disease than those of mother who do not work.²⁸ Disparity caused by mother's working status might be explained in that working mothers spend more time outside than housewives.³¹

With regard to household living conditions, we saw no significant evidence of linkage between household living environment and the occurrence of diarrhea. However, other study presented that children of household with concrete roofing and walls are exposed to lower risk of diarrhea.³²

We showed no evidence between improved source of drinking water and diarrhea, consistent with the result of study conducted by Sinmegn Mihrete et al.²⁸ However, time taken longer than 30 minutes to fetch water contributed to higher risk of diarrhea. The children who had access to fetch water within 30 minutes had no significant association with the risk of diarrhea, compared with those who can get water on premises. Time spent to fetch water affects not only health, but also social issues such as low school attendance rate and the risk of rape.³³⁻³⁵ In this context, WASH related intervention has important potentials to play a key role in multi-sectoral issues in African countries.

Findings from 217 surveys by DHS program presented that diarrheal disease were more influenced by sanitation than water conditions.³⁶ In accordance with those findings, our study found that toilet facilities unimproved and located out of dwelling were attributable for young children's diarrhea. The preceding study in Nigeria also indicated that unimproved toilet facility increased the odds of suffering from diarrhea.³²

With regard to the location of sanitation facility, JMP suggests that having a toilet facility on premises (within the dwelling, plot or yard) may be more important than sharing toilet facility for health.^{22,37} In our study, however, toilets in own yard or plot were associated with higher risk of diarrhea in children than those who had toilets within the dwelling. A study of open defecation in Ghana revealed that the lack of toilets at home affected the decision of open defecation.³⁸ Thus, it is necessary to adopt the suggestion related to the location of toilet facility on premises, taking into account the local environment. In addition, a study conducted in Addis Ababa in 2017 provided another important implications on the location of toilets, with a contrary finding such that proximity of sanitation facilities within 15 meters of homes increased acute diarrhea compared to facilities located more than 15 meters away.³⁹ Main reason for the association between proximity of facility and diarrhea may be explained in that closer proximity means increased exposure to pathogens near latrines. In this context, cleanliness near the toilet needs to be emphasized together to avoid the transmission of pathogens, in addition to the location of the toilet on premises.

Children whose household lacks of handwashing facility with water and soap were exposed to higher risk of diarrhea. This is consistent with a study in Northwest Ethiopia presenting that cleansing hands with soap and water can reduce more effectively the likelihood of diarrhea.²⁵ A possible explanation of this result is that handwashing with soap reduced the presence of bacteria than washing hands with water alone.⁴⁰

This study has some limitations. First, this survey includes information about hand washing facilities and availability of water and washing materials, rather than hand-washing related

behaviors or practices of mothers or caregivers. Further studies need to include the number and timing of washing hands a day, usage of soap and appropriate method of washing hands. Second, mothers were interviewed as a proxy respondent instead of young children. This might lead to recall bias depending on mother's memory. This bias would be enlarged when the child received care by others rather than mother. Lastly, potential confounders such as stunting and vaccinations were not included in the logistic regression model due to large missing values, thus future research model needs to adjust the potential factors.

In conclusion, our study showed that demographic characteristics such as child's sex, age and size at birth, region, mother's age and working status were statistically associated with diarrhea of children under the age of 5. Among the variables related to WASH environment, time spent more than 30 minutes to get water, unimproved and location of sanitation facility, lack of handwashing with soap and water were associated with a higher risk of childhood diarrhea. Poor conditions of WASH, especially sanitation and handwashing facility enhanced the diarrheal risk of children under 5 years of age. Findings from this study suggest that WASH infrastructure such as sanitation and hand hygiene facilities, and WASH behavior change strategies need to prioritize vulnerable groups in Malawi.

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