



RESEARCH ARTICLE

**REVISED** The association of socio-demographic and environmental factors on childhood diarrhea in Cambodia [version 5; peer review: 2 approved]

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**Abstract**

**Background:** Diarrhea diseases remain the leading cause of death among children under-five in lower and lower-middle-income countries. This study was conducted to investigate the factors related to diarrhea among children aged 12 to 35 months in Cambodia.  
**Methods:** We analyzed cross-sectional data from the Cambodia Demographic and Health Survey 2014 using a combination of household and children’s datasets. A generalized linear mixed model was used to analyze the determinant factors of diarrhea.  
**Results:** The survey included 2,828 children aged 12 to 35 months. The prevalence of diarrhea in the last 2 weeks was 16.44% (95% CI: 14.72%-18.31%). Factors significantly associated with childhood diarrhea were: maternal unemployment (AOR = 1.43; 95% CI: 1.14-1.78); the child being male (AOR = 1.25; 95%CI: 1.02-1.53); the presence of unimproved toilet facilities (AOR = 1.17; 95%CI: 1.05-1.31); and unhygienic disposal of children’s stools (AOR = 1.32; 95%CI: 1.06-1.64) when controlling for other covariates. Both maternal age (one year older; AOR = 0.85; 95%CI: 0.78- 0.93) and child age (one month older; AOR = 0.86; 95%CI: 0.78-0.94) had significant negative associations with the occurrence of childhood diarrhea.  
**Conclusion:** Childhood diarrhea remains a public health concern in Cambodia. Intervention programs should focus on reducing diarrheal diseases by constructing improved toilet facilities and promoting behavior to improve hygiene, specifically targeting younger mothers.

**Open Peer Review**

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**REVISED Amendments from Version 4**

We have edited the manuscript according to the recommendation of the reviewers. Some general updates to Geographical Regions and Operational Definition of Diarrhea were made. Rational of the study had been clearly mentioned and improved. Its study method and statistical analysis had been clearly detailed. In-depth discussion of key findings in Discussion part had been improved.

**Any further responses from the reviewers can be found at the end of the article**

**Introduction**

Diarrhea is the second leading cause of death in children under the age of five years, with an estimated 1.7 billion cases of childhood diarrhea and 525,000 deaths caused by diarrhea each year<sup>1,2</sup>. Globally, 88% of diarrhea cases are attributable to poor water, poor sanitation or poor hygiene<sup>3</sup>. Childhood diarrhea is associated with multiple factors, including unimproved drinking water sources<sup>4–7</sup>, untreated water<sup>8–10</sup>, unimproved toilet facilities<sup>6,8,9,11</sup>, unhygienic disposal of children's stools<sup>12–14</sup>, lack of hand washing facilities<sup>15,16</sup>, type and location of residence<sup>11,16</sup>, the child's age<sup>4,13,16</sup>, the child's sex (male)<sup>13</sup>, maternal illiteracy<sup>12,13,17</sup>, the mother's occupation<sup>9,12</sup>, maternal age<sup>14,18</sup>, wealth index<sup>4,19</sup>, and whether or not the child is breastfed<sup>10,15</sup>.

In 2014, Cambodia still had one of the highest prevalence levels of diarrhea among children under the age of five amongst countries in South-East Asia, at 12.8%<sup>20</sup>. By comparison, Myanmar had a prevalence of 10.4% in 2015–16<sup>21</sup>, Malaysia 4.4% in 2016<sup>7</sup>, Laos 6.5% in 2017<sup>22</sup>, Philippines 6.1% in 2017<sup>23</sup>, and Indonesia 14.1% in 2017<sup>24</sup>. According to a 2014 report from UNICEF Cambodia, diarrhea alone accounted for one fifth of the deaths of children under the age of five in Cambodia, and an estimated 10,000 deaths overall each year<sup>25</sup>. However, according to a 2018 report from UNICEF, in 2016, Cambodia had 5,947 total neonatal deaths, of which 20 were due to diarrhea; 5,248 post-neonatal deaths, of which 672 were due to diarrhea (13%); and 692 deaths of children under five due to diarrhea (6%)<sup>26</sup>. This demonstrates that diarrhea is the most common cause of death in Cambodian children. According to the Cambodia Demographic and Health Survey (CDHS) 2014, the prevalence of diarrhea among children aged 12 to 35 months was high compared with other age groups and this age period is known to be crucial for child development and growth<sup>20</sup>.

It is of great importance to understand the factors related to the prevalence of diarrhea among children aged 12 to 35 months. There are no existing studies on the factors affecting the prevalence of diarrhea in this age group, and no national studies on the factors associated with childhood diarrhea in Cambodia have yet been published. This study was therefore conducted to investigate the factors associated with diarrhea among children aged 12 to 35 months in Cambodia.

**Methods****Ethical statement**

This research project received approval from the Khon Kean University Ethics Committee in Human Research (HE632097).

This study uses existing CDHS data and re-analysis was done under the original consent provided by the participants.

**CDHS 2014**

The CDHS 2014 collected data nationally across the country, which is subdivided into 19 province domains. Its sampling frame consisted of 28,455 eligible enumeration areas (EAs), which comprised the 2008 Cambodian General Population Census (GPC). The sample was proportionately allocated to urban and rural in each domain with a power allocation preventing the oversampling of urban, areas, in order to represent the fact that Cambodia is mainly rural. The stratified sample was selected in two stages. In the first stage, a fixed number of EAs were chosen using probabilities weighted proportional to the size of the EA. In the second stage, 24 and 28 households were picked up from every urban cluster and rural cluster, respectively, through a systematic sampling process with equal probability weighting. 15,825 households, 17,578 women, and 5,190 men were interviewed between the 2<sup>nd</sup> June and the 12<sup>th</sup> December, 2014, across the country; further details can be found in the CDHS 2014 report<sup>20</sup>.

**Population and Sample size**

Among 7,044 children aged under five years, in our analysis, we included only children aged 12 to 35 months (n=2,828) due to the high prevalence of diarrhea among this age group compared to other age groups. We analyzed the sample power and it was found to provide a suitable degree of power, and was sufficient for this study (0.9627, 0.9682).

**Data use**

Two raw CDHS 2014 datasets, comprising household data and children's data, were combined for use in this analytical cross-sectional study. All entries and variables in these datasets were included in the study.

**Dependent variable**

The operational definition of diarrhea used by the CDHS was the occurrence of three or more loose or liquid bowel movements over a 24 hour period, as reported by the mother/caregiver, in any given 24 hour period during the preceding 2 weeks, as described in a French article<sup>27</sup> cited by, and in agreement with, multiple other sources<sup>1,9</sup>. The prevalence of diarrhea was the dependent variable considered in this study. This is referred to the questionnaire thus: "Has (NAME) had diarrhea in the last 2 weeks?" The dichotomous variable *childhood diarrhea* can take values "1" representing a response of "yes" or "0" representing "no" and "don't know" responses.

**Independent variables**

Socio-demographic characteristics take the form of continuous variables such as maternal age, child's age, and number of household members and categorical variables such as maternal education (no education/primary/secondary/higher), maternal occupation (employed/unemployed), mother's knowledge of oral rehydration salts (ORS) (good/poor)<sup>28</sup>, exposure to media (yes/no)<sup>29</sup>, sex of the child, breastfeeding (ever/never), deworming (yes/no)<sup>28</sup>, vaccination (ever/never), residence (urban/rural) and wealth index (poorest/poorer/middle/richer/richest)<sup>28</sup>.

CDHS data were organized in 19 province domains, which were regrouped into four regions: Central Plain; Tonle Sap; Coastal and Sea; and Plateau and Mountains<sup>30</sup> (Figure 1). Environmental characteristics were also treated as categorical variables, including drinking water source (improved/unimproved)<sup>31</sup>, whether or not the same source of drinking water was used during wet and dry seasons (same/different), whether or not water was treated before drinking (always/no), type of toilet facility (improved/unimproved)<sup>31</sup>, hygiene (adequate/inadequate)<sup>31</sup>, and disposal of children’s stools (sanitary/unsanitary)<sup>32</sup>. The World Health Organization (WHO) guidelines on water, sanitation and hygiene (WASH) were used to classify each WASH facility as either improved or unimproved, and either sanitary or unsanitary according to the WHO/UNICEF Joint Monitoring Programme (Table 1 and Table 2)<sup>31,32</sup>

### Statistical analysis

Statistical data analyses were performed using STATA/SE 14.0<sup>33</sup> as follows.

Categorical variables were analyzed using frequency and percentage. Continuous variables were analyzed as means, standard

deviations, and ranges. A weighting variable was used in the form of the woman’s individual sample weighting. Cross-tabulations were run with the appropriate sample weights to provide nationally representative results<sup>19</sup>. The *svyset* command was used to test for complex survey sampling methods used in the original surveys, in order to adjust for differences in the probabilities of sample selection and to avoid using over-sampled strata within the survey data<sup>28</sup>.

The prevalence of diarrhea was estimated as a percentage. The numerator was the number of living children aged 12 to 35 months with an occurrence of diarrhea during the two weeks preceding the interview (i.e. an answer “yes” to, “Has (NAME) had diarrhea in the last 2 weeks?”) and the denominator was the number of living children aged 12 to 35 months.

A bivariate analysis with simple logistic regression was performed using the *svyset* (*svy* command). A linearity test was conducted between the continuous variable and dependent variable. Variables associated with diarrhea in the bivariate analyses at a level of  $p < 0.25$  were included in the multivariable model<sup>34,35</sup>. Multicollinearity assessment of the independent

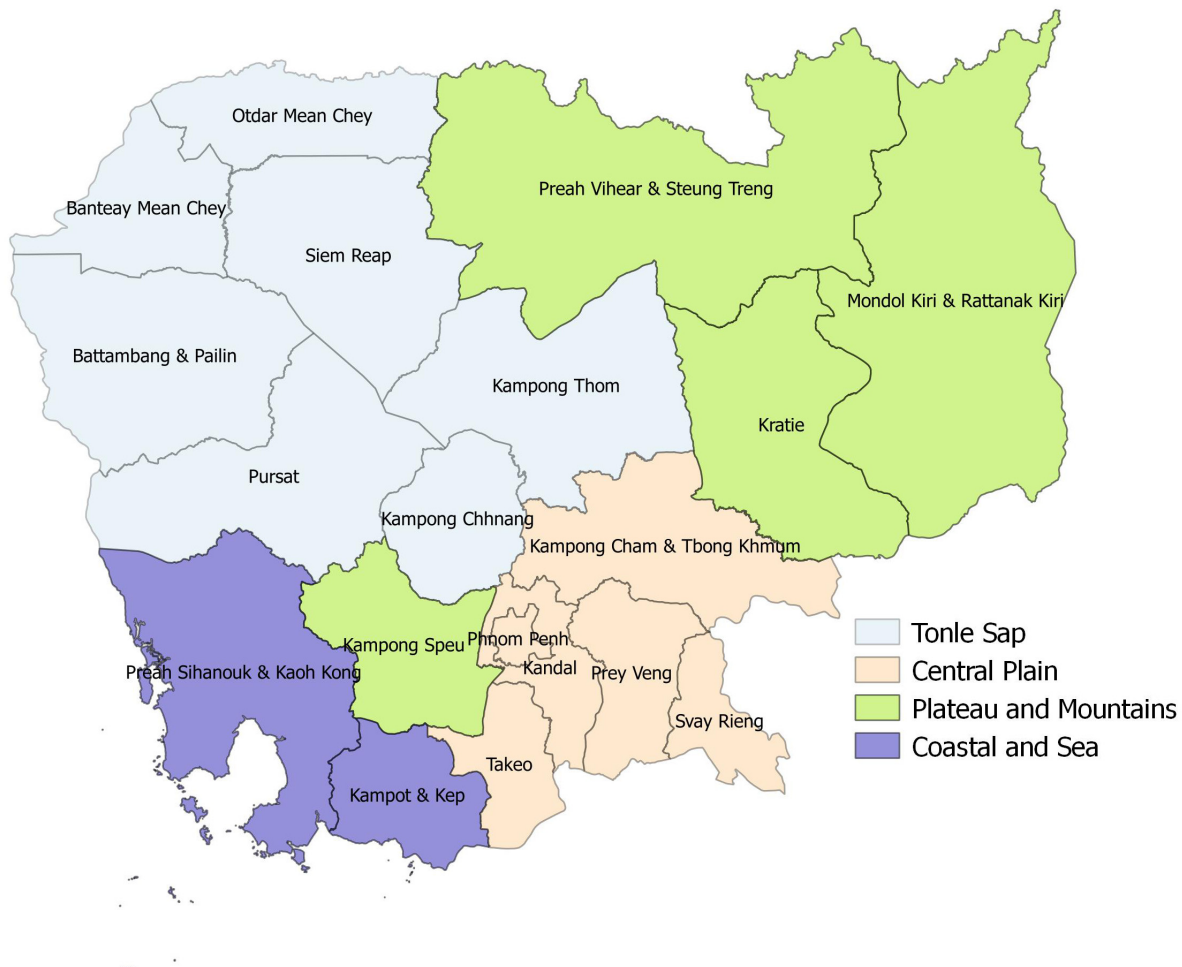


Figure 1. Geographical regions in Cambodia.

**Table 1. Joint Monitoring Programme classification of improved and unimproved water, sanitation and hygiene (WASH)<sup>30</sup>.** Please note this table has been reproduced with permission from UNICEF

Service	Improved	Unimproved
Drinking water	Piped water, boreholes or tube wells, protected dug wells, protected springs, rainwater, and packaged or delivered water, and provided collection time is not more than 30 minutes for a round trip, including queuing	Unprotected dug well, unprotected spring, surface water (river, reservoirs, lakes, ponds, streams, canals, and irrigation channels).
Sanitation	Flush and pour flush connected to piped sewer, septic tanks or pit latrines; ventilated improved pit (VIP) latrine, composting toilets or pit latrines with slabs, and that are not shared with other households	Flush and pour flush not to sewer/septic tank/pit latrine, pit latrine without slab/open pit, bucket, hanging toilet/hanging latrine, no facility/bush/field
Hygiene	Availability of a handwashing facility on premises with soap and water	No handwashing facility on premises

**Table 2. Joint Monitoring Programme classification of sanitary and unsanitary disposal of children stool<sup>31</sup>.** Please note this table has been reproduced with permission from UNICEF

Sanitary	Unsanitary
Child used toilet or latrine	Put or rinsed into drain or ditch
Put or rinsed in the toilet or latrine	Throw into the garbage
Buried	Left in the open or not disposed of
	Other

variables was performed by excluding those with a variance inflation factor (VIF) greater than four<sup>36</sup>. Finally, a multivariable analysis was performed using a generalized mixed linear model with four regions picked as 'random effects' corresponding to the various clusters in the sampling design<sup>37</sup>. The backward stepwise procedure was applied as the model fitting strategy. Statistical significance was considered at a threshold of  $p < 0.05$  and the adjusted odds ratio (AOR) with 95% confidence intervals (CI) was considered as the magnitude of the effect.

The result was used to map geographical regions in Cambodia, applied using the free and open source geographic information system, QGIS V 2.18.4.

## Results

The majority of the children (84.12%) lived in rural areas. Nearly half (44.03%) lived in Central Plain and one third (33.32%) lived in Tonle Sap. The mean maternal age was 28.27 years (standard deviation, SD = 5.89). More than half the mothers (51.08%) attended primary school. Three quarters (75.10%) of the mothers were employed and the average number of household members was five. More than half (51.18%) of the children were male and the mean age was 23.33 months (SD = 6.79). Almost all (96.17%) children had been breast-fed; 59.60% had received deworming treatment. Out of 2,828 households, more than half (54.07%) always had treated water to drink; 57.97% had an unimproved toilet facility; while 68.01% used adequate hygiene; and 70.25% used sanitary disposal of children's stool (Table 3).

## Bivariate analysis of factors associated with childhood diarrhea in Cambodia

The result from the bivariable analyses revealed that as maternal age increased by a year, the odds of the child suffering from diarrhea decreased 18% (COR = 0.82; 95%CI: 0.73– 0.92;  $p < 0.001$ ). The odds of suffering from diarrhea were 49% higher (COR = 1.49; 95% CI: 1.11-1.98;  $p = 0.007$ ) in children whose mother was unemployed compared to employed. As the child's age increased by a month, the odds of the child suffering from diarrhea decreased 17% (COR = 0.83; 95%CI: 0.75-0.92;  $p < 0.001$ ). The odds of suffering from diarrhea was 20% higher (COR = 1.20; 95%CI: 1.04-1.39;  $p = 0.013$ ) in children living in a household with unimproved toilet facilities compared with those with improved toilet facilities. The odds of suffering from diarrhea was 40% higher (COR = 1.40; 95%CI: 1.05-1.87;  $p = 0.020$ ) in children whose stools were disposed of unhygienically compared to children whose stools were disposed of hygienically (Table 4). Further, the child's sex, the number of household members, wealth index, source of drinking water during dry season, whether or not the same source of drinking water was used during wet and dry seasons, and the treatment/non-treatment of drinking water did not reach significance but did meet the pre-determined threshold of  $p < 0.25$  for inclusion in the multivariable model. Finally, region ( $p < 0.25$ ) also met the criteria for inclusion in the multivariable model and was used as a random effect. As such, the multivariable analysis was conducted using a generalized mixed linear model with each of the four regions of Cambodia treated as random effects.

**Table 3. Socio-demographic and environmental characteristics of households in Cambodia, 2014 (n=2,828).**

Variables	Frequency	Percentage
<b>Maternal characteristics</b>		
<b>Age (years)</b>		
16–24	397	14.04
25–34	1591	56.26
35–49	840	29.70
Mean±SD	28.27±5.89	
Range	16 to 49	
<b>Education</b>		
No education	366	12.96
Primary	1445	51.08
Secondary	921	32.58
Higher	96	3.38
<b>Occupation</b>		
Employed	2124	75.10
Unemployed	704	24.90
<b>Knowledge of oral rehydration salts</b>		
Good	2717	96.05
Poor	111	3.95
<b>Exposure to media</b>		
Yes	1808	63.92
No	1020	36.08
<b>Children's characteristics</b>		
<b>Age (months)</b>		
12–23	1460	51.64
24–35	1368	48.36
Mean±SD	23.33±6.79	
Range	12 to 35	
<b>Sex</b>		
Male	1448	51.18
Female	1381	48.82
<b>Breastfeeding status</b>		
Ever	2720	96.17
Never	108	3.83
<b>Deworming</b>		
Yes	1686	59.60
No	1142	40.40
<b>Household characteristics</b>		
<b>Residence</b>		
Urban	449	15.88

Variables	Frequency	Percentage
Rural	2379	84.12
<b>Region</b>		
Coastal and Sea	169	5.98
Tonle Sap	942	33.32
Central Plain	1245	44.03
Plateau and Mountains	472	16.67
<b>Number of household members</b>		
1–4	969	34.28
>4	1859	65.72
Mean±SD	5.73±2.31	
Range	1 to 22	
<b>Wealth index</b>		
Poorest	672	23.76
Poorer	523	18.49
Middle	550	19.44
Richer	493	17.45
Richest	590	20.86
<b>Environmental characteristics</b>		
<b>Drinking water during dry season</b>		
Improved	1745	61.71
Unimproved	1083	38.29
<b>Drinking water during wet season</b>		
Improved	2320	82.02
Unimproved	508	17.98
<b>Same source of drinking water during wet and dry season</b>		
Same	1955	69.11
Different	873	30.89
<b>Treating water to drink</b>		
Yes, always	1529	54.07
No	1299	45.93
<b>Toilet facility</b>		
Improved	1189	42.03
Unimproved	1640	57.97
<b>Hygiene</b>		
Adequate	1923	68.01
Inadequate	905	31.99
<b>Disposal of children's stool</b>		
Sanitary	1987	70.25
Unsanitary	841	29.75

SD, standard deviation.

**Table 4. Bivariate analysis of factors associated with childhood diarrhea in Cambodia, 2014 (n=2,828).**

Variables	Number	Diarrhea %	COR	95% CI	p-value
<b>Overall</b>	2828	16.44		14.72-18.31	
<b>Maternal age (years)</b>	2828	N/A	0.82	0.73-0.92	<0.001
<b>Maternal education</b>					0.681
Literate	2462	16.29	1		
Illiterate	366	17.46	1.09	0.73-1.62	
<b>Maternal occupation</b>					0.007
Employed	2124	15.00	1		
Unemployed	704	20.78	1.49	1.11-1.98	
<b>Mother's knowledge of oral rehydration salts</b>					0.481
Good	2717	16.61	1		
Poor	111	12.21	0.69	0.25-1.90	
<b>Mother's exposure to media</b>					0.502
Yes	1808	15.99	1		
No	1020	17.23	1.09	0.84-1.42	
<b>Child's age (months)</b>	2828	N/A	0.83	0.75-0.92	<0.001
<b>Child's sex</b>					0.075
Female	1381	14.86	1		
Male	1448	17.94	1.25	0.97-1.61	
<b>Breastfeeding status</b>					0.268
Ever	2720	16.64	1		
Never	108	11.42	0.64	0.29-1.40	
<b>Deworming</b>					0.504
Yes	1686	16.91	1		
No	1142	15.75	0.91	0.71-1.17	
<b>Residence</b>					0.561
Urban	449	15.39	1		
Rural	2379	16.64	1.10	0.80-1.50	
<b>Region</b>					0.203
Coastal and Sea	169	12.36	1		
Tonle Sap	942	15.55	1.31	0.82-2.07	
Central Plain	1245	16.92	1.44	0.92-2.25	
Plateau and Mountains	472	18.40	1.60	1.02-2.51	
<b>Number of household members</b>					0.095
>4	1859	15.38	1		

Variables	Number	Diarrhea %	COR	95% CI	p-value
1-4	969	18.47	1.25	0.96-1.62	
<b>Wealth index</b>					0.128
Richest	590	14.44	1		
Richer	493	17.40	1.25	0.82-1.90	
Middle	550	14.65	1.02	0.67-1.55	
Poorer	523	14.50	1.00	0.67-1.50	
Poorest	672	20.46	1.52	1.03-2.26	
<b>Drinking water during dry season</b>					0.065
Improved	1745	15.12	1		
Unimproved	1083	18.56	1.28	0.98-1.66	
<b>Drinking water during wet season</b>					0.676
Improved	2320	16.27	1		
Unimproved	508	17.22	1.07	0.78-1.48	
<b>Same source of drinking water during wet and dry season</b>					0.161
Same	1955	15.56	1		
Different	873	18.40	1.22	0.92-1.62	
<b>Treating water to drink</b>					0.139
Yes, always	1529	15.28	1		
No	1299	17.81	1.20	0.94-1.53	
<b>Toilet facility</b>					0.013
Improved	1189	13.61	1		
Unimproved	1640	18.49	1.20	1.04-1.39	
<b>Hygiene</b>					0.995
Adequate	1923	16.44	1		
Inadequate	905	16.43	0.99	0.74-1.34	
<b>Disposal of children's stool</b>					0.020
Sanitary	1987	14.99	1		
Unsanitary	841	19.85	1.40	1.05-1.87	

COR, crude odds ratio; CI, confidence interval.

### Multivariable analysis of factors associated with childhood diarrhea in Cambodia

The multivariable analysis (Table 5) showed that as maternal age increased by a year, the odds of the child suffering from diarrhea decreased 15% (AOR = 0.85; 95%CI: 0.78– 0.93; p=0.001). The odds of suffering from diarrhea was 43% higher (AOR = 1.43; 95% CI: 1.14-1.78; p=0.002) in children whose mother was unemployed compared to employed. As the child's

age increased by a month, the odds of the child suffering from diarrhea decreased 14% (AOR = 0.86; 95%CI: 0.78-0.94; p=0.001). The odds of suffering from diarrhea was 25% higher (AOR = 1.25; 95%CI: 1.02-1.53; p=0.031) in males compared to females. The odds of suffering from diarrhea was 17% higher (AOR = 1.17; 95%CI: 1.05-1.31; p=0.004) in children living in a household with unimproved toilet facilities compared with those with improved toilet facilities. The odds of



**Table 5. Multivariable analysis of factors associated with childhood diarrhea in Cambodia, 2014 using generalized mixed linear model (n=2,828).**

Variables	Number	Diarrhea %	AOR	95% CI	p-value
<b>Maternal age (years)</b>	2828	N/A	0.85	0.78-0.93	0.001
<b>Maternal occupation</b>					0.002
Employed	2124	15.00	1		
Unemployed	704	20.78	1.43	1.14-1.78	
<b>Child's age (months)</b>	2828	N/A	0.86	0.78-0.94	0.001
<b>Child's sex</b>					0.031
Female	1381	14.86	1		
Male	1448	17.94	1.25	1.02-1.53	
<b>Toilet facility</b>					0.004
Improved	1189	13.61	1		
Unimproved	1640	18.49	1.17	1.05-1.31	
<b>Disposal of children's stool</b>					0.011
Sanitary	1987	14.99	1		
Unsanitary	841	19.85	1.32	1.06-1.64	

AOR, adjusted odds ratio; CI, confidence interval.

suffering from diarrhea was 32% higher (AOR = 1.32; 95%CI: 1.06-1.64; p=0.011) in children whose stools were disposed of unhygienically compared to children whose stools were disposed of hygienically.

## Discussion

This is the first study to report factors associated with diarrhea in children aged 12 to 35 months at the national level in Cambodia. Younger maternal age, maternal unemployment, younger child age, being male, lack of unimprovement to toilet facilities, and unhygienic disposal of children's stools were found to be associated with childhood diarrhea.

Socio-demographic characteristics such as maternal age were significantly associated with reduced incidence of diarrhea, in line with studies conducted in Brazil that found younger mothers to be associated with a higher prevalence of diarrhea among their children<sup>18</sup>. It is likely that older mothers have more experience in childcare and feeding. The association of maternal unemployment with the incidence of diarrhea is consistent with a study in Senegal that found children of housewives to have a higher risk of diarrhea compared to children of women who worked in the public or private sector<sup>9</sup>. It is likely that the employment status of the mother will improve a child's quality of living standards and as well as improving hygienic practice and sanitation in the home during feeding and childcare. The child's age had a significant, negative association with the incidence of diarrhea, in line with many studies in

Ethiopia and Tanzania<sup>4,14,16</sup>. This might be due to the development of the immune system throughout childhood. Males were more likely to suffer from diarrhea than females, which may simply reflect a natural predisposition of males to develop diarrhea more frequently than females<sup>38</sup>, and is also supported by a previous study conducted in India<sup>13</sup>.

Environmental characteristics such as the lack of improvements to toilet facilities were significantly associated with the incidence of diarrhea, consistent with many studies including a systematic review<sup>4,6,8,11</sup>. Finally, disposal of children's stools was significantly associated with the incidence of diarrhea, consistent with previous studies in Ethiopia, India, and Tanzania<sup>12-14</sup>. The present findings demonstrate that the quality of sanitation facilities strongly influences the prevalence of childhood diarrhea. Increasing the number of toilet facilities that receive improvements is likely to reduce direct contact with children's stools, and consequently reduce the occurrence of childhood diarrhea in Cambodia.

A limitation of this research study was that it used a cross-sectional design with just one outcome measure (diarrhea prevalence) taken as a snapshot at a given point in time and cannot be used to infer a causal relationship. Future longitudinal studies may improve on this. The CDHS 2014 was not fully comprehensive in that it did not cover the WASH factors of hand washing before preparing meals and after defecating. The inclusion of these questions in the survey would give a more comprehensive

analysis of hygiene practices in the population. Despite all efforts to prevent bias in the data collection process, the use of self-reporting measures and recall bias may have had an effect on the study findings. Further, the CDHS 2014 captured data by household, rather than by individual person, which may introduce a confound in that it has a tendency to under-estimate the quality of both drinking water source and sanitation facility available.

## Conclusion and recommendations

Diarrhea still remains a public health concern among children in Cambodia. The probability of developing diarrhea is strongly associated with maternal unemployment, being male, not having access to improved toilet facilities, or practicing hygienic disposal of children's stools. Conversely, increasing maternal and child age is associated with a reduction in the probability of developing diarrhea.

"Based on these findings, the authors provide the following recommendations.

**National:** The WASH program should prioritize their efforts in reaching out to younger mothers, mothers of younger children, boys, and unemployed mothers. Guidance should include the use of sanitary methods for disposing of children's stool, as well as water treatment methods, the importance of practicing good sanitation, and maintaining one's health. Intervention programs should focus on the construction of new sanitary toilet facilities, making improvements to existing toilet facilities, and promoting hygienic behaviors.

**Local:** Younger mothers should be encouraged to enroll in health education programs. Additional community sanitation facilities should be constructed, and existing facilities should be improved and properly maintained to ensure continued access to sanitation.

**Future study:** Longitudinal studies are needed to measure the impact of these interventions on multiple aspects of public health, not necessarily limited to the incidence of diarrhea in children.

## Data availability

Our study used raw children's and household data from the **DHS, Cambodia 2014**. Data are free to access for research purposes and can be obtained through the DHS Program after registering and obtaining an approval letter from the Inner City Fund (ICF) (<https://dhsprogram.com/data/Access-Instructions.cfm>).

## Acknowledgements

The authors would like to express sincere thanks and appreciation to:

Dr. Kavin Thinkhamrop, Health and Epidemiology Geoinformatics Research (HEGER), Faculty of Public Health, Khon Kaen University; Dr. Wilaiphorn Thinkhamrop, Data Management and Statistical Analysis Center (DAMASAC), Faculty of Public Health, Khon Kaen University for their statistical support; and Rebecca S Dewey, University of Nottingham for language editing.

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# Open Peer Review

Current Peer Review Status:  

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Version 5

Reviewer Report 07 October 2021

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Siyan Yi 

<sup>1</sup> Saw Swee Hock School of Public Health, National University of Singapore, Singapore, Singapore

<sup>2</sup> KHANA Center for Population Health Research, Phnom Penh, Cambodia

<sup>3</sup> Center for Global Health Research, Touro University California, Vallejo, CA, USA

The authors have addressed all the critical points. I have no further comments.

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Epidemiology, community-based intervention and evaluation, infectious diseases

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

Reviewer Report 07 October 2021

<https://doi.org/10.5256/f1000research.77795.r95138>

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Okechukwu S. Chukwudeh

North-West University, Mahikeng, South Africa

The article is a topical issue especially in less developed countries. It is presumed it will make meaningful impact to scholars and policy makers.

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Sociology (Demography and Population Studies)

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

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Version 4

Reviewer Report 26 August 2021

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**Okechukwu S. Chukwudeh**

North-West University, Mahikeng, South Africa

**Report on the manuscript titled “The association of socio-demographic and environmental factors on childhood diarrhea in Cambodia”**

### Abstract

The abstract should be filtered to avoid repetition of points

### Methods

- 1. Study design and setting:** The design, settings, location and relevant dates was not clearly stated. This should be stated in the methodology section. Where is Central Plain, and Tonle Sap? These were not described in the methodology. Are they cities or communities in rural or urban clusters?
- 2. Participants:** Eligibility criteria was totally missing in this study. Kindly fulfil this requirement. The Author should provide the population size. What is the total number of under-five children (0-5 years) in the country? What is the total number of children 12 to 35 months in the country? What is significant about 12 to 35 months in Cambodia?
- 3. Variables:** The variables, indicators, predictors and confounders for the study are not clearly outline. Kindly outline this in alignment with recent WASH analyses pattern e.g Water ladder scale, and Sanitation ladder services (this should be added to what author have on the work).
- 4. Data:** The data for each variable of measurement is entirely missing. Kindly provide sources of data for each variables and indicators.

5. **Bias:** Kindly provide efforts to address potential bias
6. **Study size:** kindly explain how the sample size was arrived at. How did you arrive at the sample of 2,828? You selected 2,828 sample which represent 565 households based on five persons per household. Recall that you stated that the total number of households was 15,825. This means you selected 4% of the entire household in the study location. This is small and this affects the generalization of the study. Kindly review this along side the eligibility criteria. Also, how were 15,825 households, 17,578 women, and 5,190 men interviewed? What is the significant of interviewing men? The study sample size is clumsy. Kindly review.
7. **Statistical method:** How were variables handled in the analyses. The statistical method was not well explained. What is the meaning of improve and unimproved sanitation? Describe the statistical method and sampling strategy used for the study. How were data handled? What kind of technique was used to calculate the prevalence of diarrhea (see abstract)?

**Conclusion:** The method for the study is not sufficiently detailed to understand the approach. The author is advised to provide detailed approach and statistical techniques applied.

### Results

1. The demographics of the respondents was not sufficiently reported.
2. Descriptive statistics was used for the study. Recall in the methodology, under the 2<sup>nd</sup> stage of the sampling technique, 24 and 28 households were picked from urban and rural clusters, respectively using equal probability weighting. However, result shows that 84% of the children live in rural areas. Kindly align this narrative.
3. Kindly explain the result succinctly.

**Conclusion:** The result should be aligned with the methodology and conclusion

### Interpretations/Discussion

1. Contextually, why are male more susceptible to diarrhea when other studies such as Nwokocha, Chukwudeh, and Damian (2020) have found otherwise. Kindly justify this contextually, this makes the work unique.
2. If male gender is uniquely susceptible to diarrhea as stated in this study, why was it not included in the conclusion and its implications reflected in the recommendation. However, gender status and disease prevalence are contextual and highly contested in literature.
3. Validity of the results was not included.
4. The results were not engaged with other studies to know the gap that was filled in this study.
5. The contribution to knowledge of the study is not clearly outline in the body of the work.
6. The implication and contribution of findings to the body of knowledge is missing.

**Conclusion:** Author should derive conclusion from the results

**Recommendation:** Invitation to revise (more work is required to satisfy all criteria)

### References

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**Is the work clearly and accurately presented and does it cite the current literature?**

Partly

**Is the study design appropriate and is the work technically sound?**

Partly

**Are sufficient details of methods and analysis provided to allow replication by others?**

No

**If applicable, is the statistical analysis and its interpretation appropriate?**

Partly

**Are all the source data underlying the results available to ensure full reproducibility?**

No

**Are the conclusions drawn adequately supported by the results?**

No

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Sociology (Demography and Population Studies)

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.**

Author Response 18 Sep 2021

**PISEY VONG**, Khon Kaen University, Khon Kaen, Thailand

[Thank you for your valuable comments to improve the quality of our paper.](#)

[#Response to reviewer: Okechukwu S. Chukwudeh](#)

### Abstract

The abstract should be filtered to avoid repetition of points

[Reply: Taken care.](#)

## Methods

**1. Study design and setting:** The design, settings, location and relevant dates was not clearly stated. This should be stated in the methodology section. Where is Central Plain, and Tonle Sap? These were not described in the methodology. Are they cities or communities in rural or urban clusters?

Reply: Taken care. Please, see Figure 1 as well as please, kindly see the CDHS 2014 and Data use.

**2. Participants:** Eligibility criteria was totally missing in this study. Kindly fulfil this requirement. The Author should provide the population size. What is the total number of under-five children (0-5 years) in the country? What is the total number of children 12 to 35 months in the country? What is significant about 12 to 35 months in Cambodia?

Reply: Taken care.

**3. Variables:** The variables, indicators, predictors and confounders for the study are not clearly outline. Kindly outline this in alignment with recent WASH analyses pattern e.g Water ladder scale, and Sanitation ladder services (this should be added to what author have on the work).

Reply: The authors have retained our originals. Please feel free to check it in limitation.

**4. Data:** The data for each variable of measurement is entirely missing. Kindly provide sources of data for each variables and indicators.

Reply: Some of the variable is not provided the sources because it is the secondary data which has been grouped or categorized already. i.e. source of drinking water during wet and dry seasons (same/different), residence (urban/rural), etc.

**5. Bias:** Kindly provide efforts to address potential bias

Reply: The authors have retained our originals. Please feel free to check it in limitation.

**6. Study size:** kindly explain how the sample size was arrived at. How did you arrive at the sample of 2,828? You selected 2,828 sample which represent 565 households based on five persons per household. Recall that you stated that the total number of households was 15,825. This means you selected 4% of the entire household in the study location. This is small and this affects the generalization of the study. Kindly review this along side the eligibility criteria. Also, how were 15,825 households, 17,578 women, and 5,190 men interviewed? What is the significant of interviewing men? The study sample size is clumsy. Kindly review.

Reply: DHS used large survey which is not only interviewing for only one outcome. It provides information related to fertility, family planning, maternal and child health, gender, HIV/AIDS, malaria, and nutrition. Therefore, you will get the answer. Please, kindly understand the DHS/CDHS report.

**7. Statistical method:** How were variables handled in the analyses. The statistical method was not well explained. What is the meaning of improve and unimproved sanitation? Describe the statistical method and sampling strategy used for the study. How were data handled? What kind of technique was used to calculate the prevalence of diarrhea (see



abstract)?

Reply: Our statistical method is already explained. The meaning of improved and unimproved sanitation was outlined in Table 1 and Table 2. Please, kindly see. Our outcome calculation was also outline there. Please, see it carefully.

**Conclusion:** The method for the study is not sufficiently detailed to understand the approach. The author is advised to provide detailed approach and statistical techniques applied.

Reply: As we explain above in statistical method, the authors have retained our originals in this point.

### **Interpretations/Discussion**

1. Contextually, why are male more susceptible to diarrhea when other studies such as Nwokocha, Chukwudeh, and Damian (2020) have found otherwise. Kindly justify this contextually, this makes the work unique.

Reply: The authors confirm that our analysis is correct. We also outline in Discussion that “... may simply reflect a natural predisposition of males to develop diarrhea more frequently than females<sup>37)</sup>” as well as a study published in PMC Public Health by Bawankule, R., Singh, A., Kumar, K. *et al.* found the same as our study.

2. If male gender is uniquely susceptible to diarrhea as stated in this study, why was it not included in the conclusion and its implications reflected in the recommendation. However, gender status and disease prevalence are contextual and highly contested in literature.

Reply: Taken care.

3. Validity of the results was not included.

Reply: Please, feel free to check it carefully.

4. The results were not engaged with other studies to know the gap that was filled in this study.

Reply: Please, feel free to check it carefully.

5. The contribution to knowledge of the study is not clearly outline in the body of the work.

Reply: Please, feel free to check it carefully.

6. The implication and contribution of findings to the body of knowledge is missing.

Reply: Please, feel free to check it carefully.

**Conclusion:** Author should derive conclusion from the results.

Reply: Please, feel free to check it carefully.

**Recommendation:** Invitation to revise (more work is required to satisfy all criteria)

Reply: Taken care.

**Competing Interests:** No competing interests were disclosed.

Reviewer Report 13 August 2021

<https://doi.org/10.5256/f1000research.59156.r91191>

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? **Siyan Yi** 

<sup>1</sup> Saw Swee Hock School of Public Health, National University of Singapore, Singapore, Singapore

<sup>2</sup> KHANA Center for Population Health Research, Phnom Penh, Cambodia

<sup>3</sup> Center for Global Health Research, Touro University California, Vallejo, CA, USA

### General comments:

This is an interesting study of an important health topic in low-income countries using large datasets from the Cambodia Demographic and Health Survey (CDHS) 2014. These data are often under use in many resource-limited countries, despite their large scope and scale with standardized methods. Despite its significant contribution to the literature, the manuscript requires substantial improvement in the writing quality and careful proofreading to eliminate several grammatical errors, misuse of punctuations, and complex sentences easily found throughout the text for improving its accuracy and readability. Below are some suggestions that are not exhaustive.

### Abstract

1. When talking about health-related issues in children, please be specific about age groups. The term 'childhood diarrhea' is too broad, while diarrheal diseases commonly affect younger children.
2. The first sentence in background is not very accurate and can be simplified as follows: "Diarrheal diseases remain the leading cause of death among under-five children in lower- and lower-middle-income countries."
3. Methods: "We analyzed cross-sectional data from the Cambodia Demographic and Health Survey 2014 using combined household and children's datasets."
4. Results: The 1<sup>st</sup> sentence: "The survey included 2,828 children aged 12 to 35 months." and the 3<sup>rd</sup> sentence: "Factors significantly associated with childhood diarrhea were..." - Please correct the misuse and inconsistent use of punctuation.
5. Conclusions: The 2<sup>nd</sup> sentence only repeats the results. Please summarize the key findings without redundancies. Recommendations can be simplified, avoiding unnecessary wording: "Intervention programs should focus on reducing diarrheal diseases by constructing improved toilet facilities and promoting behavior to improve hygiene, specifically targeting younger mothers."
6. Keywords can also be improved.

### Introduction

The writing quality of the introduction needs substantial improvement. I am trying to help, but it is difficult and time-consuming. Here are some examples:

1. The 1<sup>st</sup> sentence: the definition of diarrhea is not very important in the background as everyone is familiar with the basic definitions, and it takes unnecessary space. However, the authors should provide its operational definition specific to this study in methods. This would ensure the reader that the measurement of the outcome variable was valid.
2. The 2<sup>nd</sup> and 3<sup>rd</sup> sentences, paragraph 1, tell almost the same thing and should be combined.
3. The 5<sup>th</sup> sentence, paragraph 1: consider, "Childhood diarrhea is associated with multiple factors, including..."
4. The writing quality makes the background very confusing. For example, the authors stated that, in 2016, 20/5,947 (0.34%) total neonatal deaths were due to diarrhea; 672/5,248 post-neonatal deaths were due to diarrhea (13%); and 692 deaths of children under five due to diarrhea (6%). These are hard to understand – how were 'neonatal deaths, post-neonatal deaths, and under-five child deaths' defined? Was it possible that the age groups can be overlapping? The authors continued by stating that "High rates of diarrhea alone account for one fifth of the deaths of children under the age of five in Cambodia, and an estimated 10,000 deaths overall each year." One-fifth means 20%, which is much higher than any percentages mentioned above.
5. The rationale of study is also relatively weak. For example, the authors stated that, "It is of great importance to understand the factors related to the prevalence of diarrhea among children aged 12 to 35 months." Please elaborate why it is important to study diarrhea among children in this age group. This should also be explained in the methods (study population).
6. The study's objective is missing. Please provide a clear objective at the end of the introduction.

## Methods

1. Sampling procedures: it is great that the authors described the CDHS-2014's sampling methods. However, the reader needs the information on how the research team reached children aged 12 to 35 months, this study's population.
2. Please provide operational definition of diarrhea used in the CDHS 2014. This would ensure the reader that the measurement of the outcome variable was valid.
3. I understand that the sample size was sufficiently large to address the research question. However, it would make more sense to mention minimum required sample size calculation, rather than saying that "The final sample size comprised 2,828 children aged 12 to 35 months, providing a suitable degree of power (0.9627, 0.9682)," which was not understandable.
4. Statistical analyses: The sentence, "Any independent variables significant at  $p < 0.25$  were entered into the initial model" is inaccurate and incomplete. Consider: "Variables associated with diarrhea in bivariate analyses at a level of  $p < 0.25$  were included in the initial model."

Also, what did 'the initial model mean?'

Later, the authors mentioned, "Finally, a multivariable analysis was performed using..." This confused the reader – was the earlier-mentioned model different from the multivariable analysis (model)?

### Results

1. The 1<sup>st</sup> sentence is redundant with that in methods (CDHS 2014 description).
2. The result presentation style (mean  $\pm$  SD) has not been recommended for use since long ago. Please use 'mean (SD xx)' format.
3. Much of the bivariate results presentation only repeated the data analysis methods. The authors better keep the space to clarify the direction of the bivariate associations.
4. The way p-values are presented in tables does not follow a standardized format in scientific/academic papers.

### Discussion

1. The discussion section is superficial, mostly only compared this study's findings to those from the literature without in-depth discussions of the key findings and their policy implication.
2. Conclusions and recommendations should be combined. The recommendations can be summarized to the extent to which this study's findings can support.

**Is the work clearly and accurately presented and does it cite the current literature?**

No

**Is the study design appropriate and is the work technically sound?**

No

**Are sufficient details of methods and analysis provided to allow replication by others?**

No

**If applicable, is the statistical analysis and its interpretation appropriate?**

No

**Are all the source data underlying the results available to ensure full reproducibility?**

No

**Are the conclusions drawn adequately supported by the results?**

No

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Epidemiology, community-based intervention and evaluation, infectious diseases

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.**

Author Response 18 Sep 2021

**PISEY VONG**, Khon Kaen University, Khon Kaen, Thailand

Thank you so much for your valuable comments to improve the quality of our paper.  
#Response to reviewer: Siyan Yi

### **Abstract**

1. When talking about health-related issues in children, please be specific about age groups. The term 'childhood diarrhea' is too broad, while diarrheal diseases commonly affect younger children.

Reply: Taken care

2. The first sentence in background is not very accurate and can be simplified as follows: "Diarrheal diseases remain the leading cause of death among under-five children in lower and lower-middle-income countries."

Reply: Taken care

3. Methods: "We analyzed cross-sectional data from the Cambodia Demographic and Health Survey 2014 using combined household and children's datasets."

Reply: Taken care

4. Results: The 1st sentence: "The survey included 2,828 children aged 12 to 35 months." and the 3rd sentence: "Factors significantly associated with childhood diarrhea were..." - Please correct the misuse and inconsistent use of punctuation.

Reply: Taken care

5. Conclusions: The 2<sup>nd</sup> sentence only repeats the results. Please summarize the key findings without redundancies. Recommendations can be simplified, avoiding unnecessary wording: "Intervention programs should focus on reducing diarrheal diseases by constructing improved toilet facilities and promoting behavior to improve hygiene, specifically targeting younger mothers."

Reply: Taken care

6. Keywords can also be improved.

Reply: Taken care: Prevalence, Child, Diarrhea, Cross-Sectional Study, Cambodia

### Introduction

The writing quality of the introduction needs substantial improvement. I am trying to help, but it is difficult and time-consuming. Here are some examples:

1. The 1<sup>st</sup> sentence: the definition of diarrhea is not very important in the background as everyone is familiar with the basic definitions, and it takes unnecessary space. However, the

authors should provide its operational definition specific to this study in methods. This would ensure the reader that the measurement of the outcome variable was valid.

Reply: Taken care.

2. The 2<sup>nd</sup> and 3<sup>rd</sup> sentences, paragraph 1, tell almost the same thing and should be combined.

A: Taken care

3. The 5<sup>th</sup> sentence, paragraph 1: consider, "Childhood diarrhea is associated with multiple factors, including..."

Reply: Taken care

4. The writing quality makes the background very confusing. For example, the authors stated that, in 2016, 20/5,947 (0.34%) total neonatal deaths were due to diarrhea; 672/5,248 postneonatal deaths were due to diarrhea (13%); and 692 deaths of children under five due to diarrhea (6%). These are hard to understand – how were 'neonatal deaths, post-neonatal deaths, and under-five child deaths' defined? Was it possible that the age groups can be overlapping? The authors continued by stating that "High rates of diarrhea alone account for one fifth of the deaths of children under the age of five in Cambodia, and an estimated 10,000 deaths overall each year." One-fifth means 20%, which is much higher than any percentages mentioned above.

Reply: Taken care

4.1. Neonatal death: Probability of dying during the first 28 days of life

Post-neonatal deaths: Probability of dying between 28 and 364 days of age

Under-five death: Probability of dying between birth and exactly 5 years of age

Sources: <https://data.unicef.org/topic/child-survival/neonatal-mortality/> and <https://www-doh.state.nj.us/doh-shad/view/sharedstatic/PostneonatalMortalityRate.pdf>

4.2. The authors can confirm that the age groups cannot be overlapping.

4.3. "High rates of diarrhea alone account for one fifth of the deaths of children under the age of five in Cambodia, and an estimated 10,000 deaths overall each year." is the report from UNICEF year 2014; however, "in 2016, 20/5,947 (0.34%) total neonatal deaths..." is the report from UNICEF year 2018. Therefore, the authors would like to reverse the sentence as following:

"According to report from UNICEF Cambodia year 2014, high rates of diarrhea alone account for one fifth of the deaths of children under the age of five in Cambodia, and an estimated 10,000 deaths overall each year. However, according to report from UNICEF year 2018, by year 2016 Cambodia had 5,947 total neonatal deaths, of which 20 were due to diarrhea; 5,248 post-neonatal deaths, of which 672 were due to diarrhea (13%); and 692 deaths of children under five due to diarrhea (6%)."

5. The rationale of study is also relatively weak. For example, the authors stated that, "It is of great importance to understand the factors related to the prevalence of diarrhea among children aged 12 to 35 months." Please elaborate why it is important to study diarrhea

among children in this age group. This should also be explained in the methods (study population).

Reply: Taken care

6. The study's objective is missing. Please provide a clear objective at the end of the introduction.

Reply: Taken care

### **Methods**

1. Sampling procedures: it is great that the authors described the CDHS-2014's sampling methods. However, the reader needs the information on how the research team reached children aged 12 to 35 months, this study's population.

Reply: Taken care: In our analysis, we included only children aged 12 to 35 months (n=2,828) due to the high prevalence of diarrhea among this aged group while comparing with other age groups and this age period is known to affect for child development and growth."

2. Please provide operational definition of diarrhea used in the CDHS 2014. This would ensure the reader that the measurement of the outcome variable was valid.

Reply: Taken care.

3. I understand that the sample size was sufficiently large to address the research question. However, it would make more sense to mention minimum required sample size calculation, rather than saying that "The final sample size comprised 2,828 children aged 12 to 35 months, providing a suitable degree of power (0.9627, 0.9682)," which was not understandable.

Reply: The authors used secondary data for this study; so, authors should test for the power of its sample size whether it is sufficient for this study analysis. This following paper is also performed <https://bmjpaedsopen.bmj.com/content/5/1/e000992> the power to clarify its sufficiency. According to our analysis it is unable to show how minimum the sample size is.

4. Statistical analyses: The sentence, "Any independent variables significant at  $p < 0.25$  were entered into the initial model" is inaccurate and incomplete. Consider: "Variables associated with diarrhea in bivariate analyses at a level of  $p < 0.25$  were included in the initial model."

Reply: Taken care

Also, what did 'the initial model mean'?

Reply: Taken care. Multivariable model

Later, the authors mentioned, "Finally, a multivariable analysis was performed using..." This confused the reader – was the earlier-mentioned model different from the multivariable analysis (model)?

Reply: Taken care. It is the same

### **Results**

1. The 1<sup>st</sup> sentence is redundant with that in methods (CDHS 2014 description).

Reply: Taken care

2. The result presentation style (mean  $\pm$  SD) has not been recommended for use since long ago. Please use 'mean (SD xx)' format.

Reply: Taken care

3. Much of the bivariate results presentation only repeated the data analysis methods. The authors better keep the space to clarify the direction of the bivariate associations.

Reply: Taken care

4. The way p-values are presented in tables does not follow a standardized format in scientific/academic papers.

Reply: We think reviewer suggest to present p-value in each group. We agree with the reviewer if our research question in which the variable has stratified group i.e. Whether age group of each gender associated on Outcome (Y) or not. Then, we must stratify group of each age group and gender; after that we will present each p-value in each group. In our research question, we better to present p-value of each factor because we would like to know each factor. Therefore, the authors have retained our originals.

### Discussion

1. The discussion section is superficial, mostly only compared this study's findings to those from the literature without in-depth discussions of the key findings and their policy implication.

Reply: Taken care

2. Conclusions and recommendations should be combined. The recommendations can be summarized to the extent to which this study's findings can support.

Reply: Taken care

**Competing Interests:** No competing interests were disclosed.

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## Version 1

Reviewer Report 15 June 2020

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**Siyan Yi**

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General comments: This study used data from Cambodia Demographic and Health Surveys to



identify risk factors associated with diarrhea in children aged 12 to 35 months. Overall, the study findings are interesting and may contribute to the literature in this area given the scarcity of data in low- and middle-income countries. The analyses appeared appropriate. The quality of the writing is acceptable, although more careful proofreading is required before the paper can be published.

Here are my specific comments:

**Title:**

1. The term 'influence' may not be appropriate for this study as it can only tell the associations of variables, not causal relationships.

**Abstract:**

1. Methods: The first sentence "A cross-sectional study was conducted using the combination of two datasets from the Cambodia Demographic and Health Survey 2014" is hard to understand. The authors may want to make it clear that this study used secondary data from CDHS. What are the two data sets?
2. What was the time frame for the prevalence of diarrhea - past month or lifetime?

**Introduction:**

1. Please provide a reference for the statement in the second sentence, paragraph 1.
2. Avoid starting sentences with numbers.
3. It would be helpful for readers if authors could define some terminology; e.g., neonatal deaths, post-neonatal deaths, under-five deaths, etc.
4. Paragraph 2:
  - "...and 692 deaths of children under five due to diarrhea (6%)." What is the denominator of the 6%? In the following sentence, the authors stated that 'diarrhea alone account for one fifth of the deaths of children under the age of five in Cambodia.' Please clarify these.
  - "High rates of diarrhea alone account for..." Diarrhea alone?
  - It is confusing that this study used data from CDHS 2014, but also cited the prevalence of diarrhea in the same population and from the same data, while claiming that no national studies on childhood diarrhea in Cambodia have yet been published. - The rationale of the study needs improvement.

**Methods:**

1. What 'province domains' mean?
2. What does this mean: '...,which comprised the 2008 Cambodian General Population Census (GPC)?'
3. 'The sample considered any domain...' is not understandable.
4. Although the CDHS 2014 was referred to, some variables require a clear definition; e.g., improved/unimproved water sources, toilet facilities, adequate/inadequate hygiene,

sanitary/unsanitary disposal of children's stools, etc.

5. Data analyses:

- It is not accurate to state this "Continuous data were treated as means, standard deviations, and ranges for analysis." Perhaps something like "For continuous variables, mean and standard deviations were calculated..."
- I am not sure what authors wanted to tell by this "A weighting variable was used in the form of the woman's individual sample weighting."
- Any independent variables significant at  $p < 0.25$  in bivariate analyses were entered into the initial model.
- Multicollinearity assessment was performed...

**Results:**

1. ...and one third (33.32%) in Tonle Sap region?
2. It should be mean (SD xx).
3. "More than half the mothers (51.08%) attended primary school." Did this include mothers who had no education?
4. Any details to define the breastfeeding - duration, exclusivity...?
5. Please check this data: "...and 77.97% of them had never been vaccinated." This could be very wrong as the immunization coverage in Cambodia has been globally recognized as very high.

**Discussion:**

1. This section can be improved by extending more in-depth literature in this area and link to the policy implication of the findings.
2. Further limitations of the study should also be included (e.g., self-reporting measures, recall bias...).
3. Conclusions and recommendations can be combined.
4. Recommendations can be summarized.

**Is the work clearly and accurately presented and does it cite the current literature?**

Partly

**Is the study design appropriate and is the work technically sound?**

Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**

Partly

**If applicable, is the statistical analysis and its interpretation appropriate?**

Yes

**Are all the source data underlying the results available to ensure full reproducibility?**

Yes

**Are the conclusions drawn adequately supported by the results?**

Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Epidemiology, community-based intervention and evaluation, infectious diseases

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.**

Author Response 29 Jun 2020

**PISEY VONG**, Khon Kaen University, Khon Kaen, Thailand

Review1

**Title:**

The term 'influence' may not be appropriate for this study as it can only tell the associations of variables, not causal relationships.

A: Agree with the reviewer. As suggested, we have revised the term to "The association". See title, para 1 on page 1

**Abstract:**

1. Methods: The first sentence "A cross-sectional study was conducted using the combination of two datasets from the Cambodia Demographic and Health Survey 2014" is hard to understand. The authors may want to make it clear that this study used secondary data from CDHS. What are the two data sets?

A: Taken care. "A cross-sectional study of the secondary data from the Cambodia Demographic and Health Survey (CDHS) 2014 was conducted using the combination of household data and children's data. See Abstract, 1<sup>st</sup> sentence, para 2 on page 1

2. What was the time frame for the prevalence of diarrhea - past month or lifetime?

A: Taken care. The authors added the text "in the last 2 weeks". See Abstract, 2<sup>nd</sup> sentence, para 3 on page 1

**Introduction:**

1. Please provide a reference for the statement in the second sentence, paragraph

A: Taken care. "1,2". See 2<sup>nd</sup> sentence, para 1 on page 3.

2. Avoid starting sentences with numbers.

A: Taken care. Globally, 88% of diarrhea cases are attributable..... See 4<sup>th</sup> sentence, para 1 on page 3.

3. It would be helpful for readers if authors could define some terminology; e.g., neonatal

deaths, post-neonatal deaths, under-five deaths, etc.

A: We are sorry, we do not agree with the peer reviewer on this. Authors have retained our original because we think it is not much helpful to add terminology of neonatal deaths, post-neonatal deaths, under-five deaths.

4. Paragraph 2:

- "...and 692 deaths of children under five due to diarrhea (6%)." What is the denominator of the 6%? In the following sentence, the authors stated that 'diarrhea alone account for one fifth of the deaths of children under the age of five in Cambodia.' Please clarify these.

- "High rates of diarrhea alone account for..."Diarrhea alone?

- It is confusing that this study used data from CDHS 2014, but also cited the prevalence of diarrhea in the same population and from the same data, while claiming that no national studies on childhood diarrhea in Cambodia have yet been published. - The rationale of the study needs improvement.

A: The denominator of the 6% is the "number of under five children", however in the data from UNICEF, they do not put it. They just put only "under five deaths due to diarrhea: 692"; and "% underfive deaths due to diarrhoea: (6%)". According to calculation by the authors, denominator of (6%) is about 11,533.

A: Please, see the reference on number 26 which mentioned as "High incidences of diarrhoeal diseases alone account for one fifth of the deaths of children age five and under in Cambodia, and an estimated 10,000 overall deaths annually, largely owing to lack of sanitation and poor hygiene practices".

A: Agree with the reviewer. As suggested, we have revised the text to "There are no existing studies on the association in this age group, and no national studies on the associated factors with childhood diarrhea in Cambodia have yet been published". See 2<sup>nd</sup> sentence, para 3 on page 3.

#### **Methods:**

1. What 'province domains' mean?

A. Province domains means the 19 sampling domains of provinces. There are 24 provinces in Cambodia in CDHS 2014, of which fourteen individual provinces (Banteay Meanchey, Kampong Cham, Kampong Chhnang, Kampong Speu, Kampong Thom, Kandal, Kratie, Phnom Penh, Prey Veng, Pursat, Siem Reap, Svay Rieng, Takeo, and Otdar Meanchey); and five groups of provinces (Battambang and Pailin, Kampot and Kep, Preah Sihanouk and Koh Kong, Preah Vihear and Stung Treng, and Mondul Kiri and Ratanak Kiri)

2. What does this mean: '..., which comprised the 2008 Cambodian General Population Census (GPC)?'

A. It means "which used the 2008 Cambodian General Population Census"

That has been mentioned in CDHS 2014 as "The sampling frame used for the 2014 CDHS was derived from the list of all enumeration areas (EAs) created for the 2008 Cambodia General Population Census (GPC), provided by NIS

3. The sample considered any domain...' is not understandable.

A: Taken care. We have revised the text to "The sample was allocated into urban and rural in each domain with a power allocation preventing oversample urban, and can represent Cambodia is mainly rural. See 3<sup>rd</sup> sentence, para 3 on page 3.

4. Although the CDHS 2014 was referred to, some variables require a clear definition; e.g.,

improved/unimproved water sources, toilet facilities, adequate/inadequate hygiene, sanitary/unsanitary disposal of children's stools, etc.

A: Agree with the reviewer. As suggested, we have added the text "World Health Organization (WHO) guidelines on water, sanitation and hygiene (WASH) were used to classify WASH as either improved or unimproved according to the WHO/UNICEF Joint Monitoring Programme (Table 1 and Table 2). See 3<sup>rd</sup> sentence, para 2 on page 4; and we also added the Table 1 and Table 2. See on page 11 and 12.

5. Data analyses:

- It is not accurate to state this "Continuous data were treated as means, standard deviations, and ranges for analysis." Perhaps something like "For continuous variables, mean and standard deviations were calculated..."
- I am not sure what authors wanted to tell by this "A weighting variable was used in the form of the woman's individual sample weighting."
- Any independent variables significant at  $p < 0.25$  in bivariate analyses were entered into the initial model.
- Multicollinearity assessment was performed...

A: Agree with the reviewer. As suggested, we have revised the text "Categorical variable were analyzed to provide frequency and percentage. Continuous variable were calculated as means, standard deviations, and ranges". See 1<sup>st</sup> sentence, para 3 on page 4.

A: Because it is survey data, by providing national representative, we used Woman's individual weighting because child data was accessed by asking for their mother.

A: Yes, please see in the "Result" on 2<sup>nd</sup> sentence, para 2 on page 6.

A: Taken care "Multicollinearity assessment was performed..."

**Results:**

...and one third (33.32%) in Tonle Sap region?

A: Taken care. We have revised by adding "lived". See on 2<sup>nd</sup> sentence, para 1 page 5  
2. It should be mean (SD xx).

A: Taken care.

3. "More than half the mothers (51.08%) attended primary school." Did this include mothers who had no education?

A: No, It did not include mothers who had no education

4. Any details to define the breastfeeding - duration, exclusivity...?

A: No, in the data showing only "ever breastfed (not currently breastfeed, never breastfed, still breastfeeding"; so we group as "ever and never".

5. Please check this data: "...and 77.97% of them had never been vaccinated." This could be very wrong as the immunization coverage in Cambodia has been globally recognized as very high.

A: Agree with the reviewer. As in the data of 2828 showed that 2.15% was *no*, 22.03% was *yes*, 0.27% was *don't know*, and 75.55 was *missing*. The authors request to delete this variable since it is too much missing, moreover according to literature review this variable is not related with childhood diarrhea, only rotavirus vaccination is associated.

Discussion:

1. This section can be improved by extending more in-depth literature in this area and link to the policy implication of the findings.

A: Agree with the reviewer. However, we do not extending more in-depth literature. We have retained our original.

2. Further limitations of the study should also be included (e.g., self-reporting measures, recall bias...).

A: Taken care. See 4th sentence, para 3 on page 7.

3. Conclusions and recommendations can be combined.

A: Authors have retained our original because it will be a good idea to separate the limitation, recommendations and conclusion. Moreover, conclusion is an important part of the paper.

4. Recommendations can be summarized.

A: Taken care. As suggested, the authors have summarized the text in Recommendations part. See page 8.

**Competing Interests:** No competing interests

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