Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 10, Issue, 02, pp.65187-65192, February, 2018

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

ASSESSING WATER, SANITATION AND HYGIENE PRACTICES ASSOCIATED WITH DIARRHEA PREVALENCE AMONG HOUSEHOLDS' MEMBERS IN FLOOD PRONE AREAS ALONG KILOMBERO VALLEY

***Robert O. Kibongolo and Larama M.B. Rongo**

School of Public Health and Social Sciences, Muhimbili University of Health and Allied Sciences, P.O Box 65015, Dar es Salaam

ARTICLE INFO

Article History:
Received 12th November, 2017
Received in revised form
23rd December, 2017
Accepted 06th January, 2018
Published online 18th February, 2018

Key words:

Water supply,
Sanitation, Hygiene,
Diarrhea,
Flood Prone Areas.

ABSTRACT

Introduction: Increased diarrhea incidences is mainly associated with inadequate or poor household water, sanitation, and hygiene (WaSH) practices in flood prone areas. This study aimed at assessing water, sanitation and hygiene practices associated with diarrhea prevalence among households' members in flood prone areas of Kilombero Valley.

Methods: Cross sectional study was carried out in the early August 2017. A total of 384 heads of households were interviewed from 16 Villages within five wards situated in flood prone areas along Kilombero Valley to determine the prevalence of diarrhea and their associated WASH practices.

Results: The prevalence of diarrhea was 30.6%. WaSH characteristics among households interviewed shows that, 56.8% reported to use improved water sources, 35.2% treated their drinking water, 48.7% used improved sanitation facilities, 3.6% practiced open defecation and 6.3 have good hygiene conditions. Treating drinking water (AOR=2.729, 95%CI 1.169-6.370, p=0.020), Sanitation status (AOR=6.749, 95%CI 1.602-28.434, p=0.009) and use of pit latrine without slab (AOR=8.213, 95%CI 2.070-32.587, p=0.003) increased the risk of diarrhea. Also, use of good storage facilities (AOR=0.272, 95% CI 0.099-0.742, p=0.011), and handwashing after using toilet (AOR=0.513, 95% CI 0.229-0.881, p=0.015) were associated with reduced risk of diarrhea.

Conclusion: The study reveals that, households' members in the flood prone areas are more susceptible to diarrhea incidences associated with poor WaSH practices. The Local Government Authority and NGOs should set an integrated intervention towards improving household water treatment and storage (HWTS), sanitation facilities and hygienic conditions in the flood prone areas along Kilombero Valley in order to reduce the burden of diarrhea.

Citation: Robert O. Kibongolo and Larama M.B. Rongo. 2018. "Assessing water, sanitation and hygiene practices associated with diarrhea prevalence among households' members in flood prone areas along kilombero valley", *International Journal of Current Research*, 10, (02), 65187-65192.

INTRODUCTION

Diarrhea remains one of the leading causes of morbidity and mortality worldwide despite of the improved health technologies, management and increased use of Oral rehydration therapy (ORT). Globally diarrheal disease kills an estimated 1.5 million people each year (World Meteorological Organization, 2015). Studies (Joanna Esteves Mills, 2016) revealed that most of diarrheal diseases in Low and middle income countries (LMIC) are associated with inadequate WASH which account about 842,000 deaths per year were caused by inadequate WASH. This represent over half (58%) of diarrhea disease or an estimated 1.5% of the total disease burden. Diarrheal deaths among children under-five have more than halved from 1.5 million in 1990 to 622 000 in 2012. Inadequate WASH accounts for 361 000 of these deaths, or over 1000 child deaths per day (Joanna Esteves Mills, 2016; Prüss-Ustün, 2014). The infectious agents associated with diarrhea disease are transmitted mainly through the fecal oral route (Trærup, 2010). Studies (Corvalán, 2016; Agustina, 2013) shown the shown that, the increased diarrhea burden associated with WaSH practices is mainly attributable by unhygienic handling and storage of foods, lack of household water treatment and storage practice of drinking water, poor handwashing practices, poor disposal of wastes, open defecation as well as lack of safe water sources for domestic purposes. However, the control of diarrhea may be done through improved water quality, hand washing and other hygiene practices within domestic and community settings (7 World Bank, 1992; Taylor, 1989; CDC, 2015). Tanzania is one of the developing countries which did not reach both National and International targets particularly National Strategy for Growth and the Reduction of Poverty II (Popularly abbreviated

Corresponding author:* **Robert O. Kibongolo,
School of Public Health and Social Sciences, Muhimbili University of Health and Allied Sciences, P.O Box 65015, Dar es Salaam.

in Kiswahili as MKUKUTA) and Millennium Development Goals (MDGs, despite of the National WASH campaigns such as Community Led Total Sanitation (CLTS) and Maji Safi kwa Afya Bora Ifakara (MSABI) in Kilombero District focusing on the raised awareness on the use of improved water sources, sanitation facilities and hand washing with soap, yet still majority especially in rural areas use unimproved water sources, sanitary facilities and practice open defecation even close or within the water sources such as rivers, lakes and oceans. Currently, more than a half (61.4%) of Tanzania population has access to improved water sources and only 10% practice open defecation. Also, water supply coverage is estimated at 86% for urban Tanzania mainland areas and 47.8% for rural mainland areas and the sustained sanitation coverage for Tanzania is 35.5%. Diarrhea remains to be the major cause of morbidity and mortality among young children in Tanzania especially for children under 5 years which was about 12% in the 2 weeks before the survey (URT, 2015).

Diarrhea associated with WaSH are endemic in the flood prone areas due to the fact that flooding has tendency of destroying the existing water and sanitation systems which eventually alters the hygienic practices and increasing the vulnerability to health problems particularly diarrhea incidences in most developing countries (Guzman Herrador *et al*., 2011; WaterAid, 2012). Most people in rural areas especially along the river system depend on open water sources for various domestic purposes which present serious health risk (URT, 2015; MSABI, 2012; Plan, 2010). In this case, the proven cost effective measures at household level in the flood prone areas include proper household water treatment and storage (HWTS), improved sanitation infrastructures as well as hygiene status such as hand washing practices which will reduce the vulnerability to emerging flood health problems (Joanna Esteves Mills, 2016; Carlton *et al*., 2014; PATH, 2015). Several studies have reported the relationship of WASH practices and diarrhea prevalence. But there is no information that depicts the extent of WASH practices that influence the prevalence of diarrhea among households' members in the rural flood prone areas of Tanzania. Hence, this study entails to assess water, sanitation and hygiene practices associated with diarrhea prevalence among households' members in the flood prone areas along Kilombero Valley. The study will help community, households and local authority to develop sustainable strategies that will reduce health impacts of households' members in flood prone areas of Kilombero Valley.

MATERIALS AND METHODS

Study area

The study was conducted in flood prone areas along Kilombero Valley in Kilombero District, Morogoro Region in the Southern part of Tanzania which forms one of the four principal sub-basins of the Rufiji River Basin. It covers an area of approximately 39,990 km². The Kilombero River basin is oriented from SW to NE and situated between Longitudes 34°33''E and 37°20''E and between Latitudes 7°39''S and 10°01''S as shown in figure 1. According to National Census of 2012, Kilombero District has a population of 407,880 with household size of 4.3 and is divided into 19 wards (URT, 2012). The Valley has attracted different ethnic groups to engage approximately 80% in agricultural activities due to its potential land fertility and availability of both permanent and temporary rivers, while few are involved in livestock keeping and fishing activities (Nindi *et al*., 2014).

Study design and tools

The research employed cross-sectional study design using quantitative methods for addressing the objectives. Structured questionnaire adopted from the UNICEF Survey on Monitoring WASH practices at household level in Gaza in 2009 which was modified to fit the households resides in flood prone areas and then used to interview 384 heads of households or adults over 18 years. The questionnaire addressed the demographic characteristics of respondents, household characteristics that are size of household, water sources, household water treatment and storage (HWTS) practices of drinking water as well as hygiene and sanitation practices like hand washing and toilet use. Also, the episode of three months recall period for diarrhea incidences in the households was reported during the study. If households were observed to have the disease, then specific questions about diarrhea characteristics were asked about presence of mucus, blood and/or worms and the use of health care practices to treat diarrhea including administration of Oral rehydration solution and whether doctor was consulted. English version interview questions were translated into Kiswahili to obtain data from the study participants and to ensure that they understand the contents properly. Field observation was also done for collecting data regarding cleanliness of households' premises, water and sanitation facilities, e.g. cracks, dampness, etc.

Sampling and sample size

A multistage sampling technique was employed whereby Kilombero District was purposively selected for this study. Sixteen (PATH, 2015) Villages were randomly selected within five (5) Wards that are situated in the flood prone areas constitute both urban and rural characteristics. From each Village, 24 households were selected by using simple random. The first household was identified with the assistance from Village Chairperson after counting the households that frequently affected by flood incidences and one household was selected randomly from total counted. Other households were obtained after having sampling interval from the total number of households and the sample size. Simple random sampling was also used for the households with more than one heads of households' inorder to determine the head of household who will be included in the study. Sample size was calculated based on the following formula; $n = z^2p\ (1\text{-}p)/\ \varepsilon^2$; *n* is the number of households; *p* is proportion of households with diarrhea prevalence in flood prone areas which was 50%; *Z* is the level of significant set up at the level of 95% confidence interval and Ɛ is the maximum likely error between the means which was 5%. A total of 384 heads of households were determined in the study area.

Variables

The variables considered in the study was three months reported Diarrhea incidence; Socio-demographic (age, sex, monthly income, education, presence of children under 5 years, type of housing, family size); and the Environmental factors were Water supply: - (drinking water sources, water purification practices, drinking water storage utensils); Sanitation: - presence or absence of improved sanitary

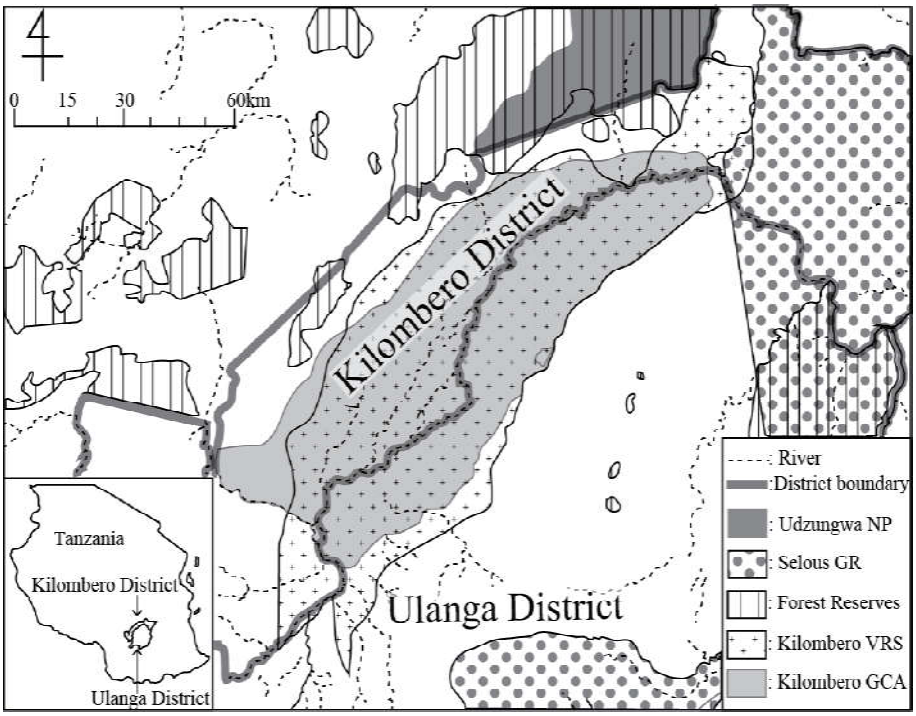

Figure 1. Map of Tanzania showing location of the Kilombero Valley Floodplain

facilities, sharing of sanitary facilities, location of sanitary facilities in the household, Waste disposal; Hygiene status which include availability of soap, presence or absence of functional handwashing station as well as awareness of handwashing practice.

Data processing and analysis

The collected data were checked, coded entered using Epi Info Version 3.5.1 and exported into SPSS computer software version 20 for analysis. Univariate analysis and multivariate analysis using logistic regression were conducted to determine the relationship WASH practices and reported diarrhea incidences. Also, $p<0.05$ was used to interpret the significance of the statistical test.

Ethical clearance

Ethical clearance was obtained from Muhimbili University of Health and Allied Sciences directorate of Research and Publications Committee in Tanzania. Informed written consent was sought from heads of households under study prior to administration of the questionnaire. Confidentiality regarding the information collected from the survey was ensured.

Operational definition of terms

Diarrhea refers to loss of watery stool at least three times a day. Water sources are places from which water for domestic purposes can be obtained. Therefore, an unimproved (poor) water source is water from dam or pond, or stagnant water from a river, stream or rainwater tank. An improved water source is defined by the WHO/UNICEF Joint Monitoring Program to be water piped into the residence, from human powered drills or from water tower. Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and feces.

The UNESCO defines sanitation as 'Maintaining clean, hygienic circumstances that help avoid disease through services such as waste collection and waste water removal'. In this context the households with unimproved (poor) sanitation status have no latrine or toilet facilities. Households with (good) sanitation status have pour/ flush latrine, or ventilated improved pit latrine. Hygiene is the practice of keeping oneself and one's surroundings clean in order to prevent illness or the spread of disease. Poor hygiene practice includes having no handwashing and bathing facilities or detergents in the house, or washing hands with water but no soap or other detergents. Good hygiene practice includes the use of hand washing and bathing facilities, with the availability of soap and the detergents in the house. Flood prone areas refer to areas in which a large amount of water is likely to temporarily cover an area of land that is usually dry.

RESULTS

Socio-demographic characteristics of respondents

As shown in Table 1, more than a half (54.7%) of the respondents was females while 45.3% were males. About (19.8%) of respondents were aged below 30 years; while almost more than half (54.4%) were between 31 and 50 years and 99 (25.8%) of respondents were above 51 years. Only 6.3% earned Tsh. 200,000/= and above while majority (93.8) were earning less than 200,000/= Tsh. per month. About 11.5% of the total respondents did not have formal education. Majority had attained primary (78.6%) and 9.9% attained Secondary education and above. It was also found that about 68.8% of their houses are built with temporally building materials.

Reported diarrhea prevalence

Table 2 depicts that the households reported diarrhea incidences in flood prone areas along Kilombero Valley in

three months prior to data collection was 30.6%. Also, with respect to age distribution, about 22.5% were children below five (5) years while 38.6% were within and above five (5) years.

Table 1. Demographic and socio-economic characteristics of respondents

Variable	Categories	Frequency (n)	Percentage (%)
Age group	30 and below	76	19.8
	31-40	110	28.6
	41-50	99	25.8
	51 and above	99	25.8
Sex	Female	210	54.7
	Male	174	45.3
Education level:	None	44	11.5
	Primary	302	78.6
	Secondary and above	38	9.9
Marital status	Single	35	9.1
	Married	295	76.8
	Divorced	15	3.9
	Widowed/widower	39	10.1
Family size	1-4	177	46.1
	> 4	207	53.9
Monthly income (Tsh.)	< 200,000	360	93.8
	≥ 200,000	24	6.3
Housing structure	Temporary	264	68.8
	Permanent	120	31.3

Table 2. Prevalence of reported diarrhoea in flood prone areas along Kilombero Valley

Diarrhoea prevalence	Frequency (n)	Percentage (%)
Below 5 years (n= 182)	41	22.5
5 and above years (n= 202)	78	38.6
Total (n=384)	119	30.6

WASH Practices in the flood prone areas along Kilombero Valley

Household water sources, storage and treatment: About (35.2%) responded that they treat their drinking water at point of use. Among those who reported treating their drinking water, boiling is the most treatment method used method which accounted to be 15.9%. The drinking water storage facilities were also assessed during the study period.

The most widely used storage facility was bucket covered with a lid which accounts 68% of all facilities in the study area. Regarding on the separation of drinking water storage facilities from other domestic uses, about 90.4% reported that, they were always had specific storage facilities while others did not separate drinking water with water for another household uses.

Sanitation practice: Majority (51.3%) of households in the study have access to unimproved toilet facilities. The most dominant toilet facility used by households include Pit latrine without slab (47.7%). The results depict that most (96.1%) of the toilet facilities are situated within 50m from the houses. A distribution of households by their types of latrine shows that more than half, (77.3%), shared sanitation facilities that are they were used by more than one household while the remaining that is (19%) toilets was used by only one household. About 3.6% still practice open defecation. With regards to households' waste disposal practices it has been observed that most of them (42.7%) tend to collect their refusal and then burnt immediately in the household's premise. Liquid wastes are mainly (54.9%) thrown into the households' yards purposely for reducing dust into the surrounding or discharged directly into the garden.

Hygiene practice: The most critical times to wash one's hand according to respondents are; before eating (91.1%), before cooking/preparing meals (10.7%), after using latrines (65.6%). About 41.7% of respondents regardless of gender, education level or whether they have latrines or not, reported that they have the habit of washing hands with water and soap. Only 6.3% of households had hand washing station/places. About 6.3% showed that there is soap in the handwashing station.

Relationship between WASH practice and reported diarrhea

The study assessed the relationship between the current WASH practices and the three (3) months diarrhea prevalence (Table 3). Drinking water treatment were significantly associated with diarrhea (AOR=2.729, 95%CI 1.169-6.370, p=0.020). Good storage facilities were significantly protective by 60% against diarrhea (AOR=0.272, 95% CI 0.099-0.742). Improved sanitation status (AOR=6.749, 95%CI 1.602-28.434) and use of pit latrine without slab (AOR=8.213, 95%CI 2.070-32.587) were associated with diarrhea prevalence in the study area. Handwashing practice at critical conditions especially after using toilet was significantly protective by 40% against diarrhea. With regards to liquid waste disposal practice it was found that the throw of liquid wastes in household premises was significantly associated with diarrhea in the study area.

Table 3. Relationship between WASH practices and diarrhoea in flood prone areas along Kilombero Valley

Variable	Category	n	COR (95%CI)	p-value	AOR(95%CI)	p-value
Treating drinking water	Yes No	135 249	3.11(1.89-5.21) 1	0.000	2.73(1.17-6.37) 1	0.020*
Boiling drinking water	Yes No	59 325	2.51(1.22-5.14) 1	0.012	1.34(0.47-3.82) 1	0.589
Let it stand and settle	Yes No	41 343	2.90(1.19-7.11) 1	0.020	1.31(0.41-4.23) 1	0.647
Drinking water storage facility	Good Bad	336 48	0.40(0.18-0.88) 1	0.023	0.27(0.09-0.74) 1	0.011*
Sanitation status	Improved Unimproved	187 197	0.57(0.37-0.88) 1	0.011	6.75(1.60-28.43) 1	0.009*
Ventilated improved pit latrine	Yes No	81 303	0.51(0.31-0.85) 1	0.010	0.72(0.37-1.39) 1	0.328
Pit latrine without slab	Yes No	183 201	1.92(1.23-2.99) 1	0.004	8.21(2.07-32.59) 1	0.003*
Handwashing after using toilet	Yes No	252 132	0.59(0.37-0.96) 1	0.033	0.51(0.29-0.88) 1	0.015*
Throw on garden/yard	Yes No	211 173	1.79(1.16-2.77) 1	0.009	1.38(0.64-2.96) 1	0.416
Discharge liquid waste in pit	Yes No	131 253	0.59(0.38-0.92) 1	0.020	0.81(0.374-1.76) 1	0.596

P < 0.05; n: frequency; COR: crude odds ratio; AOR: adjusted odds ratio; CI: Confidence intervals.

Also, it was found that the discharge of liquid waste into septic pit was protective by the protective factor of 41% to diarrhea. Other Water, Sanitation and Hygiene Practices did not show any significant association toward diarrhoea diseases to residents in flood prone areas of Kilombero District.

DISCUSSION

This study documents WASH practices in flood prone areas and their association with diarrhea prevalence. The results particularly involved household drinking water treating and storage, sanitation status, liquid waste and solid waste disposal methods as well as handwashing practices. The most emerging communicable diseases in flood prone areas is mainly through contaminated water, mud and dust which contaminated due to poor sanitation and lack of hygiene practices as well as insufficient facilities to protect them from epidemic threats (Jan *et al*., 2015). Despite of the fact that there is an increased use of improved water sources as compared to National Rural Mainland settings, there is no association with improved water sources for domestic purposes in flood prone areas of Kilombero Valley. This indicates that the transport of water from the source increases the risk. Ensuring safe water for domestic purposes, through water treatment at the point of use may reduce incidences of diarrhea (Mlenga, 2016). Water quality interventions particularly at the point of use (POU) treatment has been found to be the most effective in the control of diarrhea disease at household level (Dis, 2005). Boiling of water for drinking purposes could also minimize the problem of diarrhea although water may be recontaminated during cooling and also the practice may be economically and environmentally unsustainable to the communities under study (The Texas Department of Insurance, 2007). Generally, the treatment of drinking water is not mainly practiced in flood prone areas and even practiced inappropriately which may results into increased diarrhea incidence during and after flood occurrence as revealed in the results that there is association drinking water treatment and diarrhea incidence. The findings of drinking water storage facilities are in line with other studies that unhygienic storage conditions may have possibly led to further decline of water quality in households and eventually increases the risk of diarrhea disease (Tubatsi, 2015). Regardless of the water sources the manner in which the water is managed/ stored in the household remains critical if the contamination is to remain minimal (Mlenga, 2016). Thus, the improved household water storage vessels coupled with point of use water treatment before storage can reduce this risk (Mintz, 1990; Lorna Fewtrell, 2004). However, proper storage of already prepared drinking water through washing of storage containers and safe clean drinking water may reduce risks of diarrhea in the population under study.

Due to economic constraints, majority of households in rural settings do not have improved sanitation facilities which in turn drive them to use unimproved sanitation facilities such as pit latrine without slab. Findings from this study showed that majority of households with pit latrine without slab were at higher risk of developing diarrhea compared to those used improved latrines such as Ventilated Improved Pit latrines. This may be due to the fact that, these toilet facilities can be easily destructed during flood incidences and eventually tend to increase transmission of pathogens. Findings from the present study are similar to findings from other studies which reported an association between diarrhea and use of unimproved sanitation facilities (Danquah, 2014). In addition, it has been reported by other studies that, about 15% to 70% of diarrhea worldwide could be reduced by ensuring hygienic sanitary facilities (Mlenga, 2016). Also findings from this study and other study found no significance association with the overflowed toilet and diarrhea disease (Denslow *et al*., 2016).

Poor waste disposal methods may contribute to diarrhea prevalence in flood prone areas. The throwing of wastewater in yards/ gardens found to have significance associated with diarrhea while discharge of wastewater into the pit played great role in the control diarrhea. According to WHO (WHO, 2015), about a tremendous adverse impact of unsafe water in India despite of increased access and also that regardless of the initial water quality, widespread unhygienic practices during collection and limited access to sanitation facilities perpetuated transmission of diarrhoea. This study found that, the flood prone areas along Kilombero Valley have unhygienic status of about 93.8% which may contribute to a great extent on the prevalence of diarrhea disease in flood prone areas. Handwashing with soap during critical conditions may play a great role in the control of diarrhea in flood prone areas. Findings from this study and other studies revealed that sustainable practice of hand washing after defecation and before handling food is an easy but effective measure in preventing transmission of pathogens to humans (Mlenga, 2016; Bizuneh *et al*., 2017; Patrick Kelly , 1999).

Conclusion

WASH practices found to be at low level which in turn results into diarrhea incidences in flood prone areas of Kilombero Valley in Kilombero District. There should be integrated programs encompasses the improved use of proper drinking water treatment methods, good water storage, improving sanitation, handwashing practice, proper disposal liquid and solid wastes inorder to reduce the diarrhea

Study Limitations

The cross-sectional design of the study could not allow for determination of a cause-effect relationship between diarrhea and WASH practices. Also some of the information obtained through questionnaire relied on heads of household self-reporting which might have involved recall bias. The findings cannot be generalized to all communities in flood prone areas due to limited sample size.

Acknowledgements

Sincerely, we are sending our gratitude to Muhimbili University of Health and Allied Sciences as well as Water and Land Centre Consult Ltd for their Material and financial support. Our thanks also extended to Kilombero District Council and Ifakara Town Council administrative bodies and Health Extension workers, data collectors, and heads of households for their cooperation in the study.

Conflicts of Interest

No potential conflicts of interest to disclose.

REFERENCES

Agustina R, Sari TP, Satroamidjojo S, Bovee-oudenhoven IMJ, Feskens EJM, Kok FJ. 2013. Association of food-hygiene practices and diarrhea prevalence among Indonesian young children from low socioeconomic urban areas.

Bizuneh H, Getnet F, Meressa B, Tegene Y, Worku G. 2017. Factors associated with diarrheal morbidity among under-

five children in Jigjiga town, Somali Regional State, eastern Ethiopia : a cross-sectional study.;1–7.

Carlton EJ, Eisenberg JNS, Goldstick J, Cevallos W, Trostle J, Levy K. 2014. Original Contribution Heavy Rainfall Events and Diarrhea Incidence : The Role of Social and Environmental Factors.179(3):344–52.

CDC. 2015. Global Water, Sanitation and Hygieine Factsheet: Common Illness, Global Killer. Centre for Disease Control:1–4.

Corvalán C. 2006. Preventing Disease Through Towards an estimate of the. World Health [Internet].;12(2):1–106. Available from: http://www.who.int/quantifying_ ehimpacts/ publications/preventingdisease.pdf

Danquah L, Awuah E, Mensah CM, Agyemang S. 2014. Sanitation and hygiene practices in relation to childhood diarrhoea prevalence : The case of households with children under-five years in Ghana. 2(2):119–25.

Denslow SA, Edwards J, Horney J, Peña R, Wurzelmann D, Morgan D. 2010. Improvements to water purification and sanitation infrastructure may reduce the diarrheal burden in a marginalized and flood prone population in remote Nicaragua. BMC Int Health Hum Rights [Internet].;10(1):30. Available from: http://www.biomedcentral.com/1472-698X/10/30

Dis LI. 2005. Water, Sanitation, and hygiene interventions to reduce diarrhoea in less developed countries : a systematic review and meta-analysis.5 (January):42–52.

Guzman Herrador BR, Freiesleben De Blasio B, Macdonald E, Nichols G, Sudre B, Vold L, *et al*. 2011. Analytical studies assessing the association between extreme precipitation or temperature and drinking water-related waterborne infections: a review.

Jan A, Phil M, Afridi A, Phil M, Salam A, Phil M. 2015. An Assessment of Knowledge and Practice of People in Flood Risky areas on Health Education and Hygiene in District Charsadda, Khyber Pukhtoon Khwa. The South Asian Journal of Medicine.1(1):7–16.

Joanna Esteves Mills & Oliver Cumming. The Impact of Water, Sanitation and Hygiene on key Health and Social Outcomes : Review of Evidence. UNICEF. 2016;(June)

Lorna Fewtrell and John M. Colford, Jr. Water, 2004. Sanitation and Hygiene : Interventions and Diarrhoea. A Systematic Review and Meta-analysis. The World Bank 1818 H Street, NW Washington, DC.(July).

Mintz E, Reiff F, Tauxe R.1990. Safe water treatment and storage in the home : A practical new strategy to prevent waterborne disease. JAMA.

Mlenga DH. 2016. Towards Community Resilience, Focus on a Rural Water Supply, Sanitation and Hygiene Project in Swaziland.4(4):85–92.

MSABI. Annual Report 2012. 2012; Available from: http://static.squarespace.com/static/51c88c5fe4b050e44c4707f3/t/51dd82fae4b07aea088d6c1c/1373471482116/MSABI Annual Report 2012.pdf

Nindi SJ, Maliti H, Bakari S, Kija H, Machoke M. 2014. Conflicts Over Land and Water Resources in the Kilombero Valley Floodplain, Tanzania. Conflicts Over L Water Resources Kilombero Valley Floodplain, Tanzania. African Study Monographs, Suppl. 50(October):173–90.

PATH. 2015. Diarrheal disease. Solution to defeat a global killer. Washington DC. (1).

Patrick Kelly *et al*. 1999. Environmental and Behavioral Risk Factors For diarrhea disease in Childhood. Activity report. (79).

Plan SM. 2010. Tanzania rural water supply and sanitation program (RWSSP) II final report.(June).

Prüss-Ustün, A., Bartram, J., Clasen, T., Colford, J. M., Cumming, O., Curtis, V. & Cairncross, S. 2014. Burden of disease from inadequate water, sanitation and hygiene in low-and middle-income settings: a retrospective analysis of data from 145 countries. Tropical Medicine & International Health, 19(8), 894-905.

Taylor CE, Greenough WB. 1989. Control of diarrheal diseases. Annual Review Public Health. 10: 221-44;

The Texas Department of Insurance. 2007. Waterborne Illnesses Prevention FactSheet. The Texas Department of Insurance, Division of Workers' Compensation.

Trærup SLM, Ortiz RA, Markandya A. 2010. The Health Impacts of Climate Change : A Study of Cholera in Tanzania. BC3 Working paper series 1. Basque Centre for Climate Change, Bilbao, Spain.(January).

Tubatsi G, Bonyongo MC, Gondwe M. 2015. Water use practices, water quality, and households' diarrheal encounters in communities along the Boro-Thamalakane-Boteti river system, Northern Botswana. J Heal Popul Nutr [Internet].;33(1):1–12. Available from: http://dx.doi.org/10.11 86/s41043-015-0031-z

URT. 2012. Population and housing census. Population Distribution. 2013.

URT. 2016. Tanzania Demographic and Health Survey and Malaria Indicator Survey 2015-2016. Final Report. Ministry of Health, Community Development, Gender, Elderly and Children Dar es Salaam, Ministry of Health Zanzibar, National Bureau of Statistics Dar es Salaam Office of Chief Government Statistician Zanzibar ICF Rockville, Maryland USA December 2015.

Water Aid. 2012. Handbook on Climate Change and Disaster Resilient Water, Sanitation and Hygiene Practices. WaterAid in Bangladesh.

WHO. 2015. Evidence of the Effectiveness of Household and Community WASH Interventions in Increasing Climate Resilience Environmental Health Unit, WHO.

World Bank. 1992. Sanitation and Water Supply Practical: Lessons from The Decade. Water and sanitation diseases on page 9. Washington DC: WB.

World Meteorological Organization. Health and sanitation aspects of flood management. Intergreted Flood management Tools Series No.23 Version 1. 2015;(23).

****