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Extended Abstract

Introduction

Clinically, diarrhea is defined as the passage of three or more loose or liquid stools per day, or more frequently than is normal for the individual (World Health Organization: WHO, 2013). Diarrhea is responsible for the death of over two million people annually, representing four percent of total worldwide mortality and also known to mostly affect poverty-stricken populations (WHO, 2006). It is one of the principal causes of morbidity and mortality among children in the developing world. Diarrhea causes 1.3 million deaths in children younger than 5 years every year (Black et al, 2010). The distribution of diarrhea mortality and causes of the disease varies globally from one country to another. Diarrhea related deaths among children younger than five years are very high in some countries in south Asia and Africa (Breyette Lorntz et al., 2006). Also, children younger than five years in developing countries have a median of three episodes of diarrhea every year (Kosek, et al., 2003); and increases in environmental problems will increase diarrhea incidence in the future. Even though, the development of oral rehydration solution in the 20th century has served as a remedy for more than 90 percent of dehydration from diarrhea (The Lancet, 1978), it does not lessen diarrhea incidence (Santosham et al., 2010).

Research has shown that diarrhea is correlated with extreme climatic conditions, water and poor sanitation (WHO, 2010; Hashizume et al., 2007; Lipp et al., 2002; Rose et al., 2000; Checkley et al., 2000; Cairncross et al., 1993). The World Health Organization (2010) (2010) estimates that, water and poor sanitation contribute to approximately 94 percent of the four billion cases of diarrhea that occur globally each year. In most developing and middle income countries, the transmission of diarrheal disease occurs mainly through contaminated food or drinking water, bacterial and viral pathogens (Podewils et al, 2004). A study of drinking- water-related outbreaks of acute gastrointestinal illness in the United States by Rose et al., (2000) revealed that 20% and 40% of groundwater and surface water outbreaks, respectively, between 1971 and 1994 were statistically associated with extreme precipitation. Globally floods are the most frequent natural disaster affecting over 2.5 billion people during the last three decades (Centre for Research on the Epidemiology of Disasters, 2007). The most affected countries also have poor water and sanitation infrastructure that increases their vulnerability to diarrheal diseases in the event of flooding. Even though flooding has been a problem for communities living in flood prone areas over the years (Lawford et al., 1995; Dhar and Nadargi, 2002; Schanze et al., 2006), an increased frequency especially during the past two decades is evident and this has been partly attributed to climate change (Easterling et al. 2000; Milly et al. 2002; IPCC, 2007).

Despite these evidences on flood-diarrhea nexus, there is rarely any study on risk perceptions of diarrheal disease people develop as a result of exposure to flood and how this is related to incidence of diarrhea in households. This study uses household risk perceptions of diarrhea as an intermediate variable in examining the flood-diarrhea nexus. Risk perceptions of people are known to influence the way people do things (Cutter et al., 2008; Levy et al., 2006; Price, 1993) and this is expected to play significant role in how people respond to flooding and its associated consequences. The assessment of risk perceptions of population are used in diverse disciplines such as demography, medicine, psychology and environmental science to test models that hypothesize associations between risk perceptions and health behavior (MacCaul et al, 1996; Aiken et al., 1994; Harris et al., 1991; Weinstein et al., 1991) and also identify populations most at risk of certain events and the possible public health interventions required to address the situation (Levy et al, 2006). Examining perceptions of diarrheal disease risk among a population vulnerable to flooding could serve as the basis to develop public health policies to reduce the health effect of flooding on the population

This paper assesses how households' risk perceptions of diarrheal disease explain the flooding and diarrheal disease relationship in two poor urban settings in Accra, Ghana. The two communities provide different environmental context to study flood-diarrhea nexus as the environment of James Town is paved with permanent housing structures while the environment of Agbogbloshie is marshy with make-shift structures. It is conceivable that flooding will pre-dispose the spread of disease in these and other communities. However, it is not known how people in poor urban places perceive their risk of diarrhea as a result of flooding and it is also unknown if different measurements of risk perception of diarrhea trigger different levels of incidence of diarrhea among households in poor urban communities. Addressing these general puzzles will provide useful information to public health practitioners on how to design specific programs to meet the needs of specific populations. Three research questions are addressed: (1) Is there any relationship between flooding and diarrheal disease in poor urban communities in Accra, Ghana? (2) Are there any perception differences in diarrheal disease between households who experienced flooding in poor urban settings and those that do not? (3) Do different risk perception measures trigger differences in incidence of diarrhea in poor urban communities?

Sources of Data, Variables and Method of analysis

Data for the study were collected in James Town and Agbogbloshie in September 2012 which are also field sites of the Regional Institute for Population Studies (RIPS). The study protocol was approved by the Institutional Review Board at the Noguchi Memorial Institute for Medical Research, University of Ghana. A total of five enumeration areas (EA's) from Agbogbloshsie and nine enumeration areas from James Town were chosen for the study. These EA's were used because the RIPS had already established itself in these EA's providing prior knowledge about the geography of the area. These EA's are also representative of the study communities and also represents a balanced characteristic of poor urban settlements in Ghana. The selection of households for the study was based on a simple random sampling from household list used by RIPS in EDULINK research in 2011. Approximately 40 households were targeted for each of the EA's in Agbogbloshie and so a total of 200 households were expected to be interviewed. In James Town on the other hand, a total of 25 households were targeted for each EA and the expectation was to obtain a total of 225 households. In all, 199 households were interviewed in Agbogbloshie and 202 households were interviewed in James Town making a total of 401 households in both communities representing 94.5% response rate. Secondary sources of data on the other hand, are drawn from the Ghana Meteorological Agency (GMA) and the Centre for Health Information Management (CHIM) of the Ministry of Health, Ghana. Daily data on rainfall and diarrheal disease for the period 1985 to 2010 was obtained from the two organizations respectively.

Dependent Variable

The dependent variable that was investigated is experience of diarrheal disease by a household member in the last 4 weeks after the October 26th, 2011 flooding in Accra. In order to measure this variable, two main questions were used. The first question was: Has any member of your household experienced diarrhea over the past 12 months? The responses were (1) Yes, (0) No. The second question was for all those who experienced diarrhea in the last 12 months to indicate when it first happened. All those who experienced diarrhea in the four weeks preceding the flooding were coded as 1 while those who experienced diarrhea afterwards were coded as 0 and added to those who had experienced diarrhea over the past 12 months.

Independent Variables

Risk Perceptions. Risk perception of diarrhea was assessed using the following measures: (i) a numerical measure ["what is the chance of a member of your household being diagnosed of diarrheal disease as a result of flooding? Please choose a number between 0% (no chance of being diagnosed of diarrhea) and 100% (definitely will be diagnosed diarrhea)"], (ii) a verbal measure ("How would you rate the chance of a member of your household being diagnosed of diarrhea? Please check very low, moderately low, neither high nor low, moderately high or very high") and (iii) a comparative measure ("Overall, how do you think is the chance of a member of your household being diagnosed of diarrhea as a result of flooding compared to other people in your neighborhood"? 1, much lower; 5, much higher).

Control Variables

We controlled for age, sex, level of education, household size, wealth quintile, household source of drinking water, type of toilet facility, mode of disposing solid waste, mode of disposing liquid waste, distance of household to nearest refuse collection point, distance to of household nearest public toilet, presence of livestock in household, presence of cockroaches in household, household hygiene practices (wash hand with soap before preparing food, wash hand with soap before eating, wash hand with soap before feeding child, wash hand with soap after visiting wash room) and location of household in community which are known to influence diarrheal disease.

Analytic Approach

To examine the effect of different risk perception measures on diarrheal disease in poor urban communities, a binary logistic regression model was employed to handle the dichotomous dependent variable. Four models were run for the study. The first model examined the relationship between the exposure to flooding and diarrheal disease while model 2 controlled for household socio-demographic characteristics, water and sanitation issues. The third model examined household hygiene practices and other measures taking by households to protect members from diarrhea while the fourth model examined the effect of household risk perception in flood-diarrhea nexus.

Preliminary Findings

Relationship between flooding and diarrheal disease

Tables 1a and 1b present a detailed analysis of the relationship between flooding and diarrheal disease in the Ashiedu Keteke sub-metropolitan area of Accra the two study communities are located. The analyses indicate that there is a correlation between extreme rainfall and diarrhea. In Table 1a for instance, 12% of the variation in incidence of diarrheal disease is explained by extreme rainfall and the F-statistic in the model indicates that the model is a good fit at $p<0.05$. Extreme rainfall events in the Ashiedu-Keteke sub-metropolitan area of Accra granger cause diarrheal disease. An increase in extreme rainfall by 0.001mm increases incidence of diarrheal disease by 0.001 in the Ashiedu Keteke sub-metropolitan area of Accra. In Table 1b, the spearman correlation analysis indicate that monthly extreme rainfall days were positively correlated with monthly cases of diarrhea in the sub-metropolitan area throughout the study period (r^2 ranged from 0.34 to 0.35) with a strong lag effects on the relationship. There was a strong positive lag effect at zero and a month lag compared to two months lag.

Description of variables and the interaction effects of risk perceptions of diarrhea on flood-diarrheal disease relationship

The sampled households for the study are approximately 50 percent each for the two communities. More than half (56.6%) of household heads are males while the remaining 43.4 percent being females. The proportion of household members with some level of education is 0.9 (0.9017 ± 0.1957) with Agbogbloshie and James Town recording almost the same proportions of 0.9 (0.9096 ± 0.1943) and approximately 0.9 (0.8964 ± 0.1975) respectively. In term of households exposure to floods, approximately three quarters (75.4%) of households' in Agbogbloshie and less than two-fifth (15.8%) of households' in James Town experienced the October 26, 2011 flooding in Accra. With regards to diarrheal disease, a little less than half (48.6 percent) of households had members diagnosed of diarrheal disease in the first four weeks after the October 26, 2011 flooding. There were more households who reported diarrhea cases over the period in Agbogbloshie (65.3%) than in James Town (32.2%). About three-quarters (75.3 percent) of households rate their numeric risk of experiencing diarrheal disease 19% probability. In the Agbogbloshie community, 13.6% of the respondents indicated that members of their households had a 40-59 percent chance of being diagnosed of diarrheal disease as a result of heavy rainfall. The risk of diarrhea as indicated by the respondents is higher in Agbogbloshie than in James Town. Also, in terms of both verbal and comparative measure of risk of diarrhea, households in James Town expressed a low risk for their members compared to those in Agbobloshie. Generally, households have the perception that the risk of diarrheal disease is low among their members and this is a common belief among households in the James Town community.

The results from Table 4 (model 4) indicate that household risk perception measures are significant predictors of diarrheal disease. Both numeric and verbal risk measures are positive predictors while comparative measure is a negative predictor of diarrheal disease in poor urban households. Even though all the risk perception measures are predictors of diarrheal disease in poor urban households, the choice of a particular method will depend on the objective of the program being implemented. If the objective of the program is to identify households at high risk of diarrheal disease, then either numeric or verbal measure would be appropriate. However, if the objective is to identify households at low risk of diarrhea, then comparative measure would be appropriate. Addressing the problem of diarrheal disease in poor urban communities would not be successful without understanding and incorporating the risk perceptions of the people into programs.

Table 1a: Granger causality of the relationship between number of extreme rain days

Characteristics	Coefficient		S.E
Number of extreme rainy days	0.0009	*	0.00045
Constant	-0.0005		0.00009
Adjusted R2	0.12000		
F(1, 23)	4.21000	*	

Table 1b: Correlation between monthly extreme rainfall and diarrhea in the Ashiedu Keteke sub-metro in Accra, 1985 – 2010

Monthly climate variables	Lag (months)	r^2	P-value
Monthly extreme rainfall days (≥59.2mm)	0	0.35	0.039
Monthly extreme rainfall days (≥59.2mm)	1	0.35	0.039
Monthly extreme rainfall days (≥59.2mm)	2	0.34	0.044

Table 2: Description of key variables

Variables	Agbogbloshie (N=199)	James Town (N=202)	Total (N=401)
Experience flooding in the last 12 months			
Yes	75.4	15.8	45.4
No	24.6	84.2	54.6
At least one member of household diagnosed of diarrhoea in the last 12 months			
Yes	65.3	32.2	48.6
No	34.7	67.8	51.4
Perceptions of diarrhoeal disease:			
Chance of household members experiencing diarrhoea (%)			
0-19	59.8	90.6	75.3
20-39	20.1	9.4	14.7
40-59	13.6	-	6.7
60-79	3.5	-	1.7
80-100	3.0	-	1.5
Rate of household members experiencing diarrhoea			
Very low	33.7	58.9	46.4
Moderately low	37.2	33.7	35.4
Neither high nor low	18.1	7.4	12.7
Moderately high	10.1	-	5.0
Very high	1.0	-	0.5
Chance of members of household experiencing diarrhoea compared to others			
Much low	26.1	45.5	35.9
Low	40.7	53.0	46.9
About the same	23.1	0.5	11.7
High	9.5	1.0	5.2
Much higher	0.5	-	0.2

Table 3: Coefficients of the relationship between household vulnerability to flooding, household environmental risk factors and diarrheal disease (N=401)

	Model 1			Model 2		
Characteristics	Coef.	Robust S.E		coef.	Robust S.E	
Household exposure to flood (RC=No)						
Yes	1.18	0.21	***	0.738	0.298	**
Average age of household members				-0.011	0.012	
Average education of household members				0.197	0.166	
Sex (Male)						
Female				0.02	0.247	
Wealth quintile (RC=Poorer)						
Poor				0.286	0.358	
Middle				-0.591	0.356	
Rich				-0.079	0.358	
Richest				0.358	0.359	
Total number of persons in household				-0.042	0.057	
Distance to nearest public toilet (RC=<50 metres)						
50 metres and above				0.007	0.261	
Distance to nearest refuse collection point (RC=<50 metres)						
50 metres and above				0.961	0.333	**
Type of toilet facility (RC=**B**ucket pan/pit latrine						
WC/Flush toilet				-0.144	0.942	
KVIP				-0.485	0.821	
Public toilet				-0.279	0.707	
Mode of disposing solid waste (RC=Unimproved)						
Improved				0.091	0.265	
Mode of disposing liquid waste (RC=Unimproved)						
Improved				-0.001	0.318	
Live in part of community that flood anytime it rains (RC=No)						
Yes				0.017	0.334	
Sometimes				0.209	0.416	
Do you have livestocks (RC=No)						
Yes				0.808	0.76	
Number of times seen cockroaches in household in past 7 days (RC=Never)						
1-3 times				0.164	0.333	
4 or more times				0.997	0.305	***
Don't know				0.333	0.883	
Source of drinking water (RC=Piped into dwelling)						
Piped into yard				1.924	0.995	*
Public tap/stand pipe				1.641	0.884	*
Sachet water/bottled water				2.112	0.86	**
Constant	-0.592	0.141	***	-3.580	1.416	**
Psuedo R^2	0.06			0.162		
Wald $\chi 2$	-1	31.67	***	-25	64.19	***

** p<0.05; ** p<0.01; ***P<0.001*

Table 4: Coefficients of the relationship between household exposure to flooding, environmental risk factors, measures of diarrhea risk perception and incidence of diarrheal disease (N=401)

	Model 3			Model 4		
Characteristics	Coef.	Robust S.E		coef.	Robust S.E	
Household exposure to flood (RC=No)						
Yes	0.701	0.298	**	0.677	0.328	*
Average age of household members	-0.010	0.011		-0.005	0.006	
Average education of household members	0.165	0.168		0.188	0.192	
Sex (Male)						
Female	-0.022	0.253		0.167	0.296	
Wealth quintile (RC=Poorer)						
Poor	0.292	0.365		0.476	0.397	
Middle	-0.586	0.364		-0.409	0.446	
Rich	-0.086	0.368		0.149	0.421	
Richest	0.303	0.363		0.574	0.425	
Total number of persons in household	-0.052	0.058		-0.041	0.064	
Distance to nearest public toilet (RC=<50 metres)						
50 metres and above	-0.046	0.265		-0.177	0.313	
Distance to nearest refuse collection point (RC=<50 metres)						
50 metres and above	0.986	0.340	***	0.891	0.404	*
Type of toilet facility (RC=**B**ucket pan/pit latrine						
WC/Flush toilet	-0.129	0.941		-0.309	0.942	
KVIP	-0.417	0.840		-0.712	0.866	
Public toilet	-0.243	0.717		-0.512	0.632	
Mode of disposing solid waste (RC=Unimproved)						
Improved	0.052	0.276		-0.045	0.345	
Mode of disposing liquid waste (RC=Unimproved)						
Improved	0.001	0.323		0.171	0.392	
Live in part of community that flood anytime it rains (RC=No)						
Yes	-0.005	0.344		0.552	0.385	
Sometimes	0.143	0.421		0.779	0.487	
Do you have livestocks (RC=No)						
Yes	0.774	0.751		1.497	0.948	
Number of times seen cockroaches in household in past 7 days (RC=Never)						
1-3 times	0.174	0.333		0.089	0.392	
4 or more times	1.005	0.307	***	0.755	0.355	*

Don't know	0.394	0.910		0.713	0.949	
Source of drinking water (RC=Piped into dwelling)						
Piped into yard	1.838	0.975	*	1.674	1.078	
Public tap/stand pipe	1.558	0.877	*	1.250	0.924	
Sachet water/bottled water	2.068	0.840	**	1.946	0.882	*
Do you purify your water before drinking (Yes)						
No	-0.157	0.476		-0.036	0.582	
wash hand with soap before preparing food (Yes)						
No	0.361	0.472		0.609	0.598	
wash hand with soap before eating (Yes)						
No	-0.221	0.286		-0.445	0.346	
wash hand with soap before feeding child (Yes)						
No	-0.887	0.889		-0.959	1.006	
wash hand with soap after visiting wash room (Yes)						
No	-0.172	0.260		-0.160	0.300	
Chance of any member of household being diagnosed of diarrhea as a result of flood (%) (RC=0-19%)						
20-39				2.121	0.400	***
40-59				2.375	0.750	**
Rate of household member being diagnosed of diarrhea as a result of flood (RC=Very slow)						
Moderately slow				0.222	0.323	
Neither high nor low				2.027	0.476	***
Moderately high				1.516	1.282	
Chance of household member being diagnosed with diarrhea as a result of flood compared to other (RC=Much low)						
Low				-0.561	0.288	*
About the same				-0.413	0.511	
Constant	-2.435	1.803		-4.131	2.044	**
Psuedo R-squared	0.168			0.281		
Wald $\chi 2$	(30)	69.71	***	(37)	111.56	***

** p<0.05; ** p<0.01; ***P<0.001*

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