Water-borne illness from contaminated drinking water sources in close proximity to a dumpsite in Payatas, The Philippines.

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Abstract

Improper solid waste disposal in the Philippines has threatened the environment and public health since it has caused the contamination of adjacent surface and ground waters that are the drinking water sources of many communities. Water pollution has contributed to high incidences of mortality and morbidity. This study assessed the significant factors causing waterborne illnesses among residents living in communities with and without the Payatas dumpsite. A cross-sectional study design was used. Householders in the "with" and "without dumpsite" communities of Payatas, Philippines were randomly selected and interviewed. Through the logit analysis and the use of survey data of confirmed cases from the records of health centers, the factors causing waterborne illnesses were disclosed. Frequent exposure to the dumpsites, and obtaining water from wells in Payatas, Philippines was found to have increased the occurrence of waterborne illnesses in individuals younger than 40 years old, with low educational attainment and in those having big household sizes. This study found that constant exposure of individuals to the dumpsite has led to considerable public health consequences. Considering that water pollution remains a key issue for public health action in the Philippines, the results should guide policymakers' decisions on future environmental health policies.

Keywords: water quality, water-borne illness, landfill, leachate, Philippines

Introduction

Garbage is a major problem in Metro Manila and in other parts of the Philippines. In the Metro Manila area, there are about 10.492 million people generating an average of 6,000 tons of waste daily (Department of Health 2000). The absence of proper garbage disposal and waste management systems forces most communities to use open dumpsites because it is inexpensive (Ministry of Health 1982). Dumpsites are unsightly places that emit obnoxious odors, create risks of instantaneous burning and explosions, and contribute to possible contamination of nearby water sources (Department of Health 2000). Previous studies have confirmed that dumpsite leachate may introduce harmful chemical and bacterial contaminants to drinking water sources of most communities living nearby (Torres et al. 1991; Bacud et al. 1994).

Unrelenting human pressures on the environment has created unprecedented water quality challenges that need to be addressed. There is an emerging consensus among researchers, policy makers and the general public that unsafe drinking water polluted by fecal and chemical pollution directly threatens the health and life of each individual worldwide (Bacud et al. 1994; Lee et al. 2002; Semenza et al. 1998; Torres et al, 1991). Historically, considerations on the effects water pollution on health have focused on waterborne illnesses, especially since the problem of water pollution has contributed to 70 to 80% of the health problems in developing countries (Chabala and Mamo 2001). In the Philippines, the Department of Health (2000) stated that 770,000 cases of waterborne illnesses are reported annually nationwide, making it one of the leading causes of morbidity and mortality in the country.

A review of past studies (Kumar and Harada 2002; Swaddinwudhipong et al. 1995; Tumwine et al. 2002) indicated that waterborne illnesses, particularly diarrhea, occur when people live in conditions where there are poor water and sanitation facilities, poor health promotion, poor personal hygiene practices and lack of safe water sources. Household crowding due to high population density also aggravates the risk of waterborne diseases. The risk of diseases like diarrhea heightens when people continuously drink or use water obtained from wells, live in poor housing conditions, and have low family income and low educational attainment. In addition, water consumption from unsafe and uncertain sources has indicated different health risks such as cancer, nephrotoxicity, central nervous system effects and even cardiovascular diseases. These studies contribute to our current knowledge that the occurrence of waterborne diseases is dependent on numerous factors. This is of great concern because human health hazards associated with contaminated drinking water have been known for a very long time and still the problem remains at the forefront of policy debates today.

This study aimed to determine the impact of an open dumpsite on water sources and on the communities living close to it.

Methods

The Payatas estate in the Philippines was chosen as the study area. Payatas, which is located at the northern district of Quezon City, Philippines comprises 6 communities and is where the open dumpsite is located. Payatas represented the community "with dumpsite" while Holy Spirit, as control, was chosen to represent the community "without dumpsite" (Figure 1). A total of 298 households for Holy Spirit and 249 households for Payatas were randomly selected through the use of rolling identical pieces of paper with the name of each community in it, and then drawing the names after the pieces of paper had been thoroughly mixed. The sampling interval used in this study was the number 5 as determined by drawing a random number between 1 and 10. Interviewers were instructed to select at random one household from the first 5 households, and interview every 5th household thereafter. A total of 547 households living in the communities "with" and "without dumpsite" were interviewed for the survey. The structured interview schedule given was divided into two sections. The first section contained items on demographic characteristics to get a social profile of the respondents, and the second contained questions on the economic and health profiles of the respondents. Their health profiles were based on recall information on being sick with water-borne ailments for the past six months and checked with their medical records in the health center. There were 14 interviewers who were briefed on how to conduct the appropriate survey before they met the householders. The research was conducted in 2003 to 2004 but the actual interview was conducted in 45 days.

The Statistical Package for Social Sciences (SPSS) software was used to record and analyze the data. The Statistical Data program (STATA) was used to estimate the equation and build the model. The logistic regression analysis was used to determine the risk of occurrence of water-borne diseases in the communities "with" and "without the dumpsite" and determine the factors significant to the occurrence of water-borne ailments in the communities "with" and "without the dumpsite". Different exposure variables were collapsed to form dichotomized categories in performing the regression analysis. The regression equation: $Y= \alpha + \beta X$ followed a logistic distribution. The risk was assessed between the dichotomous outcome of Y as either being sick with water-borne ailments or not and with those of its factors, X (age, sex, education, occupation, income per day, household size, exposure to dumpsite, years of stay and water source). The factors X were categorized dichotomously as the other group and the referent group. For age, income per day, household size, year of stay factors, the groups' dichotomous categorization was arbitrarily set based on the distribution of the data. For the sex factor, the groups' dichotomous categorization was arbitrarily set based on gender; for education, on householders with no or elementary education and high school or higher educational attainment, and for occupation, on householders dependent and not dependent on jobs in the Payatas open dumpsite. For exposure to dumpsite factor, the groups' dichotomous categorization was based on householders living in the communities "with" and "without dumpsite." For water source factor, the groups' dichotomous categorization was based on those householders using water from wells and from other sources. In this case, dummy variables of 0 and 1 were used to represent the other group and the referent group as it is highly suspected and no evidence would show that the logit model for the occurrence of water-borne ailments is linear to the covariates X. After comparing the likelihood ratio test (LRT) p-value at each step to a likelihood ratio criterion, the variable selected was included in the model. The criterion used a fixed preset alpha (α) level of significance where the α for "enter" of variable was set at 0.20 and the α for "remove" was set at 0.30. The factors were entered in the model in the descending order of importance, as in the case of the result of significance in the univariate logistic regression analysis. Stepwise regression procedure that involved forward selection followed by backward elimination was used in building the model. Goodness-of-fit test was performed to determine if the model built was a good fit. The log of the odds was estimated using the regression function that the model developed:

$$\beta 0 + \beta 1X1 + \beta 2X2 + \ldots + \beta nXn$$

and the odds were estimated by:

$$\text{Exp}\ (\beta 0 + \beta 1X1 + \beta 2X2 + \ldots + \beta nXn\ )$$

The significance of the estimated coefficients was evaluated using the likelihood ratio test statistic. Results yielding a significant p-value were included in the model and those not significant were excluded.

Results

Socio-demographic, economic and health profile of respondents

Approximately 100% of the 547 systematically random selected householders were interviewed. Of the total householders, 249 were from the community "with dumpsite" and 298 were from the community "without dumpsite." Among those interviewed, only 209 (38.2%) were economically dependent on the Payatas open dumpsites. The 209 householders worked in the Payatas open dumpsite either as scavenger, vendor or junkshop owner. About 338 (61.8%) householders were not economically dependent on the Payatas open dumpsite. Majority of the householders worked as laborers, sales men, and drivers and even as professionals. Most of the householders interviewed (65.6%) were females and married (84.5%) with a mean age of 36 years old for both sexes. About 29.6% said that they have lived in their respective areas for the last one to five years. The average length of residence of respondents in both the "with" and "without dumpsite" communities were nine years (Table 1).

Table 1: Demographic characteristics of respondents

Variables	'With Dumpsite' (N=249)		'Without Dumpsite' (N=298)		Total (N=547)	
	Number	%	Number	%	Number	%
Sex:						
Male	38	15.1	150	50.3	188	34.4
Female	211	84.9	148	49.7	359	65.6
Civil Status:						
Single	26	10.5	15	5.0	41	7.5
Married	201	80.9	261	87.6	462	84.5
Separated	7	2.8	9	3.0	16	3.0
Widowed	13	5.4	12	4.0	25	4.5
No reply	1	0.4	2	0.7	3	0.5
Age:						
≤ 15	1	0.4	0	0	1	0.2
16-30	97	38.8	99	33.2	196	35.9
31-45	108	43.5	128	43.0	236	43.1
46-60	32	12.9	49	16.4	81	14.8
≥ 61	7	3.0	11	3.7	18	3.2
No reply	4	1.4	11	3.7	15	2.8
Mean	36		37		36	

In terms of education, 26.4% of householders were high school graduates and only 0.6% had no formal education. Each household had an average of five members, of which two worked to provide for their household's daily subsistence. The mean daily gross income per household in the "with" and "without dumpsite" communities were PhP296.78 and PhP327.40, respectively. About 94% recalled that they and their family members had been sick for the past six months. The five most common ailments mentioned and confirmed from the health center were fever (67.9%), diarrhea (47.7%), headache (46.8%), cough and colds (41.8%), and muscle pain (39.6%).

Regression results

Results of the multiple linear regression analysis demonstrated that among the different factors examined, exposure to dumpsite, education, household size, water source and age were important factors on the occurrence of waterborne illnesses among those householders living in the "with" and "without dumpsite" communities of the Payatas estate, Philippines (Table 2).

Table 2: Determinants of waterborne illness occurrence among respondents of the Payatas estate, Philippines 2004.

Variable (X_I)	Estimated coefficient (β_i)	Estimated standard error (se)	Coefficient standard error
Constant	0.473	0.445	1.06
Exposure to dumpsite	1.094	0.376	2.91
Education	0.643	0.341	1.89
Water Source	0.471	0.321	1.47
Household Size	0.600	0.313	1.92
Age	0.616	0.352	1.75

Results showed that the possibility of getting sick with waterborne illnesses is higher among individuals constantly exposed to the dumpsite, particularly for those living in the community "with dumpsite" (Odds Ratio (OR) = 2.99, β = 1.0994) than those living in the community "without dumpsite." Householders with low educational attainment (OR = 1.90, β = 0.643) were more likely to

be at risk of getting waterborne illnesses particularly diarrhea than those with high educational attainment. Householders who use water from uncertain water sources like wells (OR = 1.60, β = 0.471) were likewise found to have higher probabilities of getting waterborne illnesses than those getting water from other sources like bottled water and water through the distribution systems. The study likewise showed that higher probabilities of getting waterborne illnesses were likewise noted for individuals whose ages were below 40 years old (OR = 1.85, β = 0.616) and households having more than five members (OR = 1.82, β = 0.60) (Tables 3 and 4).

Table 3: Modeling stepwise regression estimates on the factors affecting the occurrence of waterborne illnesses among the householders of the Payatas Estate, Philippines 2004.

Step No.	Variable entered	Log-likelihood	Likelihood ratio statistic	DF	P-value
0	[constant]	- 167.26			
1	Exposure to dumpsite	- 159.46	15.61	1	0.0001
2	Education	- 157.55	3.82	1	0.0505
3	Water Source	- 156.59	1.92	1	0.1661
4	Household Size	- 155.15	2.88	1	0.0894
5	Age	- 153.70	2.89	1	0.0889
6	Occupation	- 153.33	0.74	1	*0.3884
7	Income (per day)	- 151.99	2.67	1	0.1025
8	Year of Stay	-151.80	0.38	1	0.5361
9	Sex	- 151.78	0.05	1	0.8264

* - Variable for removal

Table 4: Estimated Odds Ratio (OR) and 95% Confidence Interval for the Multivariate model containing the factors influencing the occurrence of waterborne illnesses in Payatas, Philippines.

Factor (x_i)	Odds Ratio	95% CI
Exposure to dumpsite	2.99	1.43, 6.24
Education	1.90	0.97, 3.71
Water Source	1.60	0.85, 3.01
Household Size	1.82	0.99, 3.36
Age	1.85	0.93, 3.69

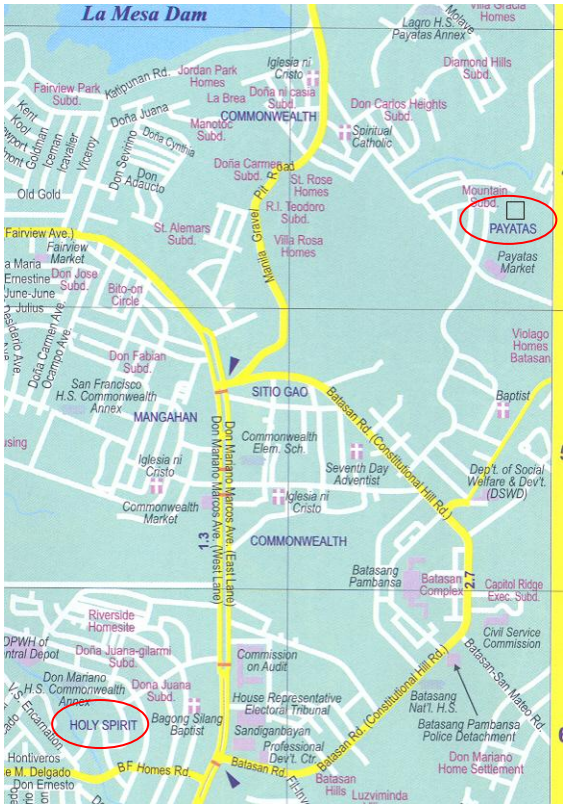

Figure 1: The study areas, Holy Spirit (control) and Payatas (exposed) are indicated in red circles. The Payatas dumpsite is indicated with a black square.

Discussion

This was a cross-sectional study and its scope was limited to waterborne diarrhea. Other health impacts induced by dumpsites such as respiratory disease, cardiovascular disease, poisoning and cancer were not covered in this study due to inadequate secondary technical information. Health histories and data used were site-specific cases obtained through interviews with the community and from records of the health centers. The health symptoms (specifically diarrhea) are generally more present in the infant and children populations; however this study categorizes the age factor based on the distribution of the data in particular the mean age of the householders. All of the dependent factors were dichotomously categorized as the other and referent groups and all the groups' categorization were arbitrarily set.

Results of the multiple linear regression analysis showed that exposure to dumpsite, education, household size, water source and age were important factors contributing to the occurrence of waterborne illnesses among those householders living close to the dumpsite (Table 2). Results likewise showed that the impact of the dumpsite on public health was higher on individuals who were constantly exposed to the hazards emanating from the dumpsite in particular those living close to it (Odds Ratio (OR) = 2.99, $\beta = 1.0994$). This is supported by Nguyen et al. (2003) who stated that populations are at high risk for parasitic, enteric and viral infections when they are frequently exposed to dumpsites and are more prone to the occurrence of diseases due to the physical dangers posed by dumpsites. Kumar and Harada (2002) reported that high occurrences of diarrhea might be attributed to the impacts of water pollution and poor sanitation on the neighborhood. Householders with low educational attainment (OR = 1.90, $\beta = 0.643$) were more likely to be at risk of getting waterborne illnesses particularly diarrhea than those who had high educational attainments. Similarly, Tiglao (1964) presented that education plays an important role in influencing people's decisions in accepting health innovations. People who have higher educational attainments tend to adopt up-to-date ideas, norms and values that predispose changes in their health attitudes and practices. Householders who use water from uncertain sources like wells (OR = 1.60, $\beta = 0.471$) were likewise found to have higher occurrences of waterborne illnesses than those getting water from proper water supplies like bottled water and water through the distribution systems. This result agreed with the findings of Hoque (2000) who stated that individuals who lack access to safe water and sanitation increase their chances of getting diarrhea. Findings of the study likewise showed that individuals younger than 40 years old (OR = 1.85, $\beta = 0.616$) and households having more than five members (OR = 1.82, $\beta = 0.60$) had higher probabilities of getting waterborne illnesses. This study further showed that the prevalence of diarrhea is not uniform for the general population and that waterborne diseases particularly diarrhea tend to be more prevalent among adults who live in unhygienic environments and are exposed to contaminated water or foods. Gasana et al. (2002) likewise supported the observation that high occurrences of diarrhea in Rwanda were due to poor sanitation and high population density. Both of these factors are important as they severely affect community wellbeing. Narayan et al. (2000) emphasized that poor sanitation and hygiene makes an individual more vulnerable to possible infections.

Conclusion and recommendations

This study assessed the impact of a dumpsite and was able to link community health condition to drinking water sources located nearby. Results showed that exposure to dumpsite, low educational attainment, bigger household sizes, use of water from uncertain sources and age are important factors that aggravates the occurrences of waterborne illnesses. Constant exposure of communities situated close to dumpsites had led to considerable public health consequences particularly those brought about by water pollution. More in-depth studies on the effects of dumpsites on the well being of communities and that of the drinking water sources should be conducted in order to address the hazards and safeguard the environment and public health. Results of these researches would eventually guide decisions and environmental health policies on the protection of water sources and the people's lives depending on dumpsites.

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