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Prevalence and economic costs of diarrheal illness among adult slum dwellers in Khulna City, Bangladesh

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Abstract

Introduction: The aim of this research was to determine prevalence, determinants and economic costs of diarrheal illness among adult slum dwellers in Khulna City, Bangladesh.
Methods: This was a cross-sectional study in adult aged 20 years or more living in slum areas of Khulna City. Descriptive statistics, logistic regression, and a multivariate analysis with a generalized linear model of Poisson, and a Tobit model were conducted using STATA software. The statistical significance was set to $P < 0.05$.
Results: The highest prevalence of diarrheal illness was at the age group 30-39 (31%), among illiterate (46%) and married (92%) slum dwellers who were living in small families with ≤ 4 household size (66%), and with a household income level ≤ 5,000 BDT per year. Awareness of diseases was the only negative predictor of diarrheal illness ($P < .05$). Socioeconomic variables such as age ($P < .001$), to be married ($P < .05$), household income ($P < .001$), BMI ($P < .001$), and behavioral variables, such as hand washing ($P < .001$), awareness of diseases ($P < .05$), daily water consumption ($P < .001$), boiling water ($P < .05$), and household with latrines and piped sewer system ($P < .001$), were statistically significant associated with number of days of work missed due to diarrheal illness. Age ($P < .05$) and cooking food ($P < .05$) were associated with overall burden disease (direct and indirect costs). The overall cost calculated for each episode of diarrheal illness was BDT 1,120 (14 US $).
Conclusion: Our study showed prevalence, determinants and economic costs of diarrheal illness. Our findings can be important for policy makers in order to reduce prevalence and economic burden of diarrheal illness among slum dwellers in Bangladesh.

KEY WORDS: Diarrheal disease; Bangladesh; cost of illness; slum dwellers; public health.

Riassunto

Introduzione: L'obiettivo di questa ricerca è stato quello di determinare la prevalenza, i determinanti ed il costo economico della malattia diarroica tra gli abitanti adulti dei bassi fondi di Khulna City, in Bangladesh.
Metodi: Questo è uno studio trasversale effettuato in adulti con più di 20 anni di età, residenti nei bassifondi di Khulna City. Sono state effettuate attraverso lo STATA software statistiche descrittive, la regressione logistica, ed un'analisi multivariata con un modello generalizzato lineare di Poisson ed un modello di Tobit. La significatività statistica è stata stabilita con $P < .05$.
Risultati: La prevalenza più alta di malattia diarroica è stata rilevata tra gli adulti di età compresa tra i 30 ed i 39 anni (31%), analfabeti (46%), sposati (92%), con famiglie composte da 4 individui o meno (66%) e con un reddito familiare pari a ≤ 5.000 BDT/annui. La conoscenza della malattia diarroica è stato l'unico predittore negativo di malattia diarroica ($P < .05$). Variabili socio-demografiche come l'età ($P < .001$), lo stato coniugale ($P < .05$), il reddito familiare ($P < .001$) ed il BMI ($P < .001$) e variabili di tipo comportamentale come il lavaggio delle mani ($P < .001$), la conoscenza della malattia diarroica ($P < .05$), il consumo giornaliero d'acqua ($P < .001$), la bollitura dell'acqua ($P < .05$) e le case provviste di latrine e di un sistema di scarico fognario ($P < .001$) sono state associate in modo statisticamente significativo al numero di giorni di lavoro perduti per malattia diarroica. L'età ($P < .05$) e la cottura dei cibi ($P < .05$) sono state associate al costo economico complessivo (diretto ed indiretto) di malattia diarroica che per ciascun caso di malattia è risultato essere pari a 1.120 BDT (14 dollari USA).
Conclusione: Il nostro studio ha evidenziato la prevalenza, i determinanti ed il costo economico della malattia diarroica. I nostri risultati possono essere importanti per i decisori politici per ridurre la prevalenza ed il carico economico della malattia diarroica negli abitanti dei bassifondi del Bangladesh.

TAKE-HOME MESSAGE

Prevalence, determinants and economic costs of diarrheal illness among adult slum dwellers in Khulna city, Bangladesh, were studied in order to improve strategies to promote their health levels and socio-economic conditions.

Competing interests - none declared.

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INTRODUCTION

Waterborne diseases are transmitted and spread through contaminated water, where contamination can be chemical or biological. Bacteriological contamination is more common in areas where open defecation is the norm, chemical contamination is more common in regions where there has been high use of fertilizers and pesticides in agriculture. Defecation in open air is common all over Bangladesh. Overall condition in rural Bangladesh is congenial for rapid transmission of enteric pathogens through the fecal-oral route. In addition, in cities there is usually some sanitation system in place but the system suffers from many inadequacies and cannot be regarded as intrinsically much better. Although cities provide water to their dwellers, which is supposed to be safe, the poorly maintained sewerage system often contaminates the water during distribution, and overflows of sewage during rain and flooding is a regular phenomenon releasing heavy load of germ on the surface. Therefore, fecal-oral transmission of pathogenic microorganisms can lead to waterborne diseases that are transmitted in contaminated fresh water. Among various waterborne diseases diarrheal illness is very severe and diffuse in the slum areas, especially due to unavailability of fresh water and open defecation nearby the residence of the slum dwellers. Infection commonly results during bathing, washing, drinking, in the preparation of food, or the consumption of food that is infected. Various forms of diarrheal illness probably are the most prominent examples, and affect mainly children in Bangladesh and other developing countries. Indeed, diarrheal illness is considered as the second leading cause of death in children under five years [1]. Types of microorganisms that may cause diarrheal illness are protozoa, bacteria, intestinal parasites, and viruses. According to the Environmental Protection Agency (EPA), the most frequent diarrheal illnesses can be the following: Amebiasis (protozoa); Campylobacteriosis, Shigellosis, Typhoid fever and Cholera (bacteria); Cryptosporidiosis and Giardiasis (protozoa); and epatitis and viral gastroenteritis (viruses) [2–4]. The health burden of poor water quality is enormous. It was estimated that over one billion people across the world do not have access to safe drinking water, although as a basic human need, it is an integral constituent of the right to life. For this reason, reducing this number by half by 2015 was one of the United Nations' Millennium Development Goals [5]. During the 1980s and 1990s there was a considerable investment in the provision of water supply and sanitation in developing countries [5, 6]. However, the progress of achieving the Millennium Development Goals (MDGs) on halving the proportion of people without access to clean water and basic sanitation by 2015 has thus far been delayed [7]. The socioeconomic costs of water pollution are extremely high. In the developing world, diseases associated with poor water and sanitation still have considerable public health significance. In 2003, it was estimated that 4% of the global burden of disease and 1.6 million deaths per year were attributable to unsafe water supply and sanitation, including lack of hygiene [8]. For instance, in India it is estimated that around 1.5 million children under 5 years die each year due to water-related diseases, 200 million person days of work are lost each year, and the country loses about 5.48 billion US$ each year due to water-related diseases. According to the World Health Organization (WHO), such diseases account for an estimated 3.6% of the total DALY (Disability-Adjusted Life Year) global burden of disease, and cause about 1.5 million human deaths annually. The WHO estimates that 58% of that burden or 842,000 deaths per year are attributable to unsafe water supply, sanitation and hygiene [9]. The diseases associated with poor sanitation and unsafe water account for about 10% of the global burden of disease [10, 11]. Diarrheal diseases are the most common sanitation-related diseases. Globally, about 1.7 million people die every year from diarrheal diseases, and 90% are children under 5 years, mostly in developing countries. Eighty-eight percent of cases of diarrheal diseases worldwide are attributable to

unsafe water, inadequate sanitation, and poor hygiene [12]. Bangladesh is a country with the highest population density in the world. On the contrary, economically this country is generally ranked among the world's 10 poorest countries. Clean drinking water and safe disposal of faces are two pre-requisites for reducing the spread of water-borne diseases. Over 80% of the population of Bangladesh live in the villages, which lack good sanitation and clean drinking water, and have numerous other problems such as poor communication, lack of electricity, and inadequate health services. Diarrheal diseases can have a significant impact on the economy, locally as well as internationally. People who are infected by a diarrheal disease are usually confronted with related costs and seldom with a huge financial burden. This is especially the case in less developed countries. The financial losses are mostly caused by costs for medical treatment and medication, costs for transport, special food, and by the loss of manpower. Many families must even sell their land to pay for treatment in a proper hospital. On average, a family spends about 10% of the monthly household income per person infected [13]. Bangladesh is a country of about 146 million of people containing nearly 5.3 million of slum people. Slum is a word that reflects the miseries of deprived people who have to struggle with poverty to survive. Usually poor people migrated from village and very poor people in urban areas live in slum. Indeed, in Bangladesh the urban population has been growing very rapidly since liberation in 1971 and continues to do so at over 3.5 percent annually. Currently, the country has an urban population of about 50 million. This rapid growth has been due primarily to migration by the rural poor, particularly to large metropolitan areas. On arrival, these poor migrants routinely turn to slums and squatter settlements for shelter. All major urban centres in Bangladesh have slums and squatter settlements, the largest concentrations being in Dhaka, followed by Chittagong, Khulna, and Rajshahi [13]. The prevailing literature on slum areas in Bangladesh highlights the causes of diarrheal diseases in children and their impact on human health. However, there is little research on the prevalence of diarrheal diseases among adult population and on the economic burden of diarrheal disease in the slum areas of Bangladesh and, to our knowledge, no specific study in Khulna City. Therefore, the aim of this research was to fill this gap. For this reason, the objective of the present study was twofold: 1) to determine prevalence and determinants of diarrheal illnesses passed on through the oral-fecal route; and 2) to determine their economic impact on adult slum dwellers.

METHODS

Description of the study area

Khulna is the third-largest city in Bangladesh after Dhaka and Chittagong and it is located in Southwest Bangladesh. The city occupies an area of approximately 267 sq Km. The City Corporation is headed by an elected Mayor and operates through 41 elected Ward Commissioners, one for each of the 31 Wards and an additional 10 women Ward Commissioners. Khulna is humid during summer and pleasant in winter. Khulna has an annual average temperature of 26.3 °C, and monthly means varying between 12.4 °C (54.3 °F) in January and 34.3 °C (93.7 °F) in May. Approximately 87% of the annual average rainfall occurs between May and October.

Study design and population

This cross-sectional study was conducted, between January and June 2015, among adult slum dwellers aged 20-80 years in Khulna city, which has an estimated population of about 900,000 people distributed in 31 wards. The number of slum households in Khulna was 37,826 in 2005. The sample size of our study was calculated considering both the number and the distribution of slum households in all the wards of Khulna city. A multi stage sampling method was used. Three out of the thirty-one wards were chosen using the table of random numbers of the random sampling method. The chosen wards were the

following: ward 21 ('Rail Station Area'); ward 22 ('Rupsha Area'); and ward 31 ('Labon Chora Area'). From each wards we randomly selected 30 slum households using the table of random numbers of the random sampling method. We distributed the questionnaires among the slum households selected from house to house. The questionnaires were shared to a maximum of 1 adult per house selected.

Slums in Bangladesh

A slum is a cluster of compact settlements of 5 or more households, which grow unsystematically in government owned or private vacant land. The walls and roofs of such houses are generally made of straw leaves, gunny bag, polythene paper, bamboo, etc. The physical and hygienic conditions of such houses are far below those of a common urban residential area. Generally, this segment of people is distressed and forced to live in such unhygienic condition due to economic reasons.

Research methodology

Water supply, water quality, sanitation, and hygiene collectively determine disease outcomes [14]. From the literature we identified the main risk factors for diarrheal diseases: 1) open defecation; 2) inadequate human waste systems (pit, septic tanks, and PUB system); 3) inadequate water supply and storage; 4) limited availability of safe drinking water; and 5) poor personal hygiene. The link between inadequate water supply, sanitation, and hygiene, on one hand, and disease incidence, on the other hand, is well-established in literature. Indeed, pathogenic microorganisms are transmitted through the consumption of contaminated freshwater, which results in diarrheal illness.

The Questionnaire

The tool for collecting data in this study was a self-administered questionnaire. The questionnaire was divided into two sections; section A and B. In Section A of the questionnaire, information on the socio demographic characteristics of the respondents was sought. In Section B, questions on the prevalence of at least one hospital-recovery for diarrheal diseases during the last year, and subsequent economic costs were asked as well as questions on number of workdays lost. All the questionnaires were distributed to each subject by face-to-face interviews during the study period January 2015 - June 2015.

Outcome and explanatory variables

The questionnaire included questions on socio-demographic (gender, age, marital status, households' monthly income pattern, educational level, and number of households), and behavioural characteristics including low-cost technologies (hand washing routinely with soap and water), awareness of water-borne diseases by media (print, radio or TV), daily water recreation, intake of safe food by adequate cooking, boiling of drinking water, chlorination, water filtration, and safe storage using containers with narrow openings. Other items included building characteristics (household with or without latrines, use of water from open wells). Medical information includes BMI and to be affected by a diarrheal disease in the last year. The Body Mass Index (BMI) was calculated as a ratio of weight divided by height squared (kg/m^2). World Health Organization classifications were used to define BMI categories: underweight (< 18.5 kg/m^2); normal (18.5–24.9 kg/m^2); overweight (25.0–29.9 kg/m^2); and obese (≥ 30 m^2) [15]. In our study, we only included fecal-oral diarrheal diseases, while we excluded non-fecal-oral water-washed diseases (e.g., Scabies, Trachoma), water-based diseases (e.g., Legionellosis, Tularemia), insect-vector diseases (e.g., Malaria, Yellow Fever) and rodent-vector diseases (e.g., Leptospirosis).

Cost-of-illness and diarrheal diseases

The COI studies traditionally stratify costs into three categories: direct; indirect; and intangible costs. The direct costs consist of healthcare costs and non-healthcare costs. The former are defined as the medical care expenditures for diagnosis, treatment, and rehabilitation, etc., while the latter are related to

the consumption of non-healthcare resources like transportation, household expenditures, relocating, property losses, and informal cares of any kinds. On the other side, the term 'indirect' refers to productivity losses due to morbidity and mortality. In our study, the results of the COI analysis were used to estimate the monetary burden. The COI analysis measured direct and indirect costs. The direct medical costs include medication, physician visits, emergency room visits and hospital stays. Lost productivity, an indirect cost, is estimated based on a fraction of the duration of illness. The COI estimates did not include averting behavior costs or defensive expenditures, costs of epidemiologic investigation or litigation, nor did they consider anxiety, pain and suffering or lost leisure time. We chose not to estimate the monetary burden from mortality. Therefore, the direct costs were measured as a sum of all the costs of recovery, therapy and medications. The indirect costs were measured as the number of days of work missed because of illness, as this indicator can be considered as a good measure of measure of productivity losses [14, 16]. We used the following formula:

$$F = L + M$$

where F = Total cost per illness (in BDT); L = Income loss per illness (in BDT); M = Medical cost (in BDT). BDT is the currency of Bangladesh (1 US Dollar = 80.27 BDT).

$$L = \sum^{n}_{i=1}(A_{ij})D, A_{ij}$$

was the formula to calculate the income loss per illness, where D = Workday income (in BDT); A = Prevalence Ratio of slum dwellers affected by diarrheal illness in our sample; i = Number of work-loss days due to each diarrheal illness (j)

$$M = Cj\ E$$

was the formula to calculate medical costs, where Cj = Prevalence Ratio of slum dwellers requiring medical attention for diarrheal illness (j), and E = Medical cost per visit.

Data analysis

Descriptive statistics such as percentage and 95% confidence interval were used to summarize prevalence of diarrheal disease with regard to socio-demographic and other variables. We performed a binary logistic regression with the diarrheal disease diagnosis (cases vs. non-cases) as the dependent variable and all individual and households risk factors as predictive variables. The influence of individual and household explanatory variables on the number of work-loss days was tested through the estimation of a generalized linear model of Poisson. Finally, a Tobit model was used to identify which factors affected treatment costs. Data analysis was performed by STATA software. The statistical significance was set to $P < 0.05$.

Ethical consideration

The study was approved by the Academic Committee of Economics Discipline, Khulna University, Bangladesh. Informed consent was sought from respondents by explaining the nature, purpose and extent of the study and assuring them that confidentiality would be maintained. Names and addresses of respondents were not required in order to maintain confidentiality of the information obtained from them.

RESULTS

In our study the overall prevalence of diarrheal illness was 66 percent (M = 86%, F = 14%). As showed by Table 1, the highest prevalence of diarrheal disease was at the age group 30-39 (31%), among illiterate (46%) and married (92%) slum dwellers who were living in small families with ≤ 4 household size (66%), and with a household income level ≤ 5,000 BDT per year.

Table 1. Prevalence of diarrheal illness according to demographic and socioeconomic aspects in our sample (*n* = 90).

Variables	Diarrheal Illness	
	%	95% CI
Gender		
Male	0.86	0.78–0.94
Female	0.14	0.05–0.23
Age group (Age in years)		
A ≤ 29	0.29	0.17–0.41
30 ≤ A ≤ 39	0.31	0.18–0.43
40 ≤ A ≤ 49	0.23	0.13–0.33
A ≥ 50	0.17	0.07–0.27
Education (E = schooling years)		
Illiterate (E = 0)	0.46	0.33–0.59
Primary school (1 ≤ E ≤ 5)	0.25	0.14–0.36
High School (6 ≤ E ≤ 10)	0.25	0.14–0.36
Others (E > 10)	0.04	0.01–0.07
Marital status		
Single	0.08	0.01–0.15
Married	0.92	0.85–0.99
Household Income Level (Y=BDT)		
Y ≤ 5,000	0.48	0.34–0.61
5,000 <Y ≤ 10,000	0.41	0.28–0.54
Y > 10,000	0.11	0.03–0.19
Household size (N = members)		
N ≤ 4	0.66	0.54–0.78
N > 4	0.34	0.22–0.46

Table 2. Results of the logistic regression analysis with individual and household parameters predicting cases of diarrheal illness (DI) in our sample (*n* = 90).

Predictor	ß	*P*	*Odds ratio*	*95 % CI for OR*	
				Lower	*Upper*
Gender *(Male = 1, Female = 0)*	1.03	0.20	2.81	0.58	13.51
Age *(Years)*	-0.02	0.28	0.98	0.94	1.02
Marital status *(Married = 1, Otherwise = 0)*	0.06	0.97	1.06	0.09	12.42
Households' income *(BDT/Month)*	0.0001	0.10	1.00	1.00	1.00
BMI *(Kg/m^2)*	0.05	0.56	1.05	0.89	1.24
Educational level *(Schooling year)*	-0.08	0.32	0.93	0.79	1.08
Household size *(No. of members)*	-0.50	0.13	0.61	0.32	1.16
Hand washing *(Yes = 1, No = 0)*	-0.01	0.98	1.01	0.28	3.65
Awareness of diarrheal illness *(Yes = 1, No = 0)*	-1.41	0.02**	4.10	1.29	13.07
Daily fresh water consumption *(Liter/Day)*	0.01	0.64	1.01	0.96	1.08
Cooking food *(Yes = 1, No = 0)*	0.35	0.72	1.42	0.21	9.60
Boiling water *(Yes = 1, No = 0)*	-0.90	0.58	2.46	0.10	62.00
Water chlorination *(Yes = 1, No = 0)*	-0.42	0.65	0.65	0.10	4.08
Water filtration *(Yes = 1, No = 0)*	-0.63	0.57	1.87	0.21	16.46
Safe storage *(Yes = 1, No = 0)*	-0.69	0.42	1.99	0.38	10.49
Household with latrines and piper sewer system *(Yes = 1, No = 0)*	-0.09	0.89	0.92	0.28	2.99
Piped water into dwelling *(Yes = 1, No = 0)*	-0.61	0.33	1.84	0.54	6.32

CI = Confidence Interval *** P < 0.01, ** P < 0.05

Table 3 shows results of regression analyses predicting variance in number of workdays lost due to diarrheal illness from demographic, behavioral and household characteristics. Our study found that both socioeconomic variables such as age, marital status, household income, BMI, and behavioral variables such as hand washing, awareness of diseases, daily water consumption, boiling water and household with latrines and piped sewer system showed a statistically significant relationship with number of days of work missed due to diarrheal illness. Specifically, when age increased (β = -0.02, P < .001) number of working days lost decreased, while when slum dwellers were married (β = 0.60, P < .05) number of days of work missed increased. Moreover, household income (β = - 0.0001, P < .001) and awareness of diarrheal illness (β = - 0.23, P < .05) showed a negative impact on the number working days missed; on the contrary, BMI (β = 0.06, P < .001) was related to an increases number of workdays lost. Finally, it was found that hand washing (β = - 0.48, P < .001), daily fresh water consumption (β = - 0.03, P < .001), household with latrines and piped sewer system (β = - 0.44, P < .001), and boiling drinking water (β = - 0.66, P < .05) could reduce number of days of work missed due to diarrheal illness.

Table 3. Summary of regression analyses predicting variance in number of working days lost due to illness from demographic, behavioral and household characteristics in our sample (*n* = 90).

Variables	*Poisson*
Gender (Male=1, Otherwise=0)	0.06
Age (Years)	-0.02***
Marital status *(Married = 1, Otherwise = 0)*	0.60**
Households' income *(BDT/Month)*	0.0001***
BMI *(Kg/m^2)*	0.06***
Educational level *(Schooling year)*	-0.02
Household size *(No. of member)*	-0.20***
Hand washing *(Yes = 1, No = 0)*	-0.48***
Awareness of diarrheal illness *(Yes = 1, No = 0)*	-0.23**
Daily fresh water consumption *(Liter/Day)*	-0.03***
Cooking food *(Yes = 1, No = 0)*	0.07
Boiling water *(Yes = 1, No = 0)*	-0.66**
Water chlorination *(Yes = 1, No = 0)*	-0.13
Water filtration *(Yes = 1, No = 0)*	-0.19
Safe storage *(Yes = 1, No = 0)*	-0.28
Household with latrines and piper sewer system *(Yes = 1, No = 0)*	-0.44***
Piped water into dwelling *(Yes = 1, No = 0)*	-0.12
Constant	0.33

*** P < .001, ** P <.05

Observations Summary

Poisson
Outcome variable: Number of work-loss days
Number of observation: 90
LR χ^2: 127
Prob > χ^2: 0
Log likelihood: - 277.70
Pseudo R-squared: 0.19

Table 4 shows results of Tobit model for total (direct and indirect) costs of diarrheal diseases, where age (β = -55.73, P < 0.05) and cooking food (β = 2124.37, P < 0.05) were predictors showing a statistically significant impact on the overall burden of disease.

Table 4. Summary of Tobit model predicting variance in costs of treatment for diarrheal illness from demographic, behavioral, and household characteristics (*n* = 90).

Variables	Coefficient	t	P > [t]
Gender *(Male = 1, Female = 0)*	1313.07**	1.70	0.09
Age *(Years)*	-55.73**	-2.69	0.01
Marital status *(Married = 1, Otherwise = 0)*	602.75	0.59	0.56
Households' income *(BDT/Month)*	-0.03	-0.42	0.68
BMI *(Kg/m²)*	122.04	1.52	0.13
Educational level *(Schooling year)*	-64.53	-0.89	0.37
Household size *(No. of member)*	-67.46	-0.23	0.82
Hand washing *(Yes = 1, No = 0)*	-155.05	-0.24	0.81
Awareness of diarrheal illness *(Yes = 1, No=0)*	-698.21	-1.25	0.22
Daily fresh water consumption *(Liter/Day)*	46.41	1.63	0.11
Cooking food *(Yes = 1, No = 0)*	2124.37**	2.54	0.01
Boiling water *(Yes = 1, No = 0)*	-1386.32	-1.06	0.29
Water chlorination *(Yes = 1, No = 0)*	-42.25	-0.05	0.96
Water filtration *(Yes = 1, No = 0)*	-697.25	-0.70	0.49
Safe storage *(Yes = 1, No = 0)*	-90.39	-0.12	0.91
Household with latrines and piper sewer system *(Yes = 1, No = 0)*	-178.70	-0.32	0.75
Piped water into dwelling *(Yes = 1, No = 0)*	-241.05	-0.43	0.67
Number of work-days loss	83.74**	1.80	0.08
Constant	-2055.73	-0.96	0.34

*** P < .001, ** P < .05; Sigma: 2027.19

Observations Summary

Outcome variable: Costs of treatment for diarrheal illness
Number of observations: 90
LR χ^2: 29.82
Prob > χ^2: 0.04
Log likelihood: -572.37
Pseudo R-squared: 0.03

As showed in Table 5, our study calculated costs of diarrheal illness. Consistent with past studies carried out in India [16, 17], the calculated cost for each episode of diarrheal illness among adult slum dwellers was BDT 1,120 (14 US $).

Table 5. Cost of Illness Calculation [16].

Number of work-loss days per diarrheal illness	BDT
1	0.00
2	0.21
3	0.24
4	0.18
5	0.06
6	0.06
7	0.15
9	0.03
10	0.03
15	0.03
30	0.00
Total work-loss days per Illness	4.62
Effective daily income (BDT)	217.04
Income loss per illness (BDT)	1,004
Ratio of no. medical visit per illness	0.79
Medical cost per visit (BDT)	146.56
Medical cost per illness (BDT)	115.78
Total cost per illness (BDT)	**1,119.78**

DISCUSSION AND CONCLUSION

In Bangladesh, diarrheal diseases are a major cause of morbidity and mortality in children under five years and, therefore, this topic was almost always studied in children. Indeed, every year in Bangladesh, approximately 125,000 children aged less than 5 years die due to diarrheal diseases. Moreover, according to several studies, the average health care expenses due to diarrheal illness in children are about 14 US $ per each diarrheal illness in urban India, while in rural and urban areas of Indonesia they are 9 US $ and 7 US $, respectively [17–22]. The strength of our research, however, is that it focuses on diarrheal disease among adult slum dwellers, for which the literature is scarce. Consistently with literature showing that slum dwellers are a population at high risk for oral-fecal transmission diseases, in our study about two-thirds of adult slum dwellers suffered from a hospital recovery for diarrheal illness during the last year. In the current study, we focused on diarrheal diseases that, according to literature [23], ranks first among waterborne diseases in the slum areas. In our study, we showed the highest prevalence of diarrheal disease at the age group 30-39, and among illiterate and married slum dwellers who were living in small families with ≤ 4 household size, and with a low household income level. These findings are generally consistent with prior study in Bangladesh where indicators of lower socioeconomic status (SES) were key correlates of cholera risk in rural and urban children [24]. Indeed, past studies carried out in Bangladesh found that higher levels of

education were associated with a reduced risk for cholera hospitalization in both rural and urban Bangladesh [25], in Matlab [26–27], and in different context such as the Peruvian Amazon [28]. A study conducted in India found that listening radio and reading newspaper may create a positive impact among the household members to use safe drinking water [12]. The study also stated that there is an inverse relationship between education and frequency of diarrheal diseases in India [12]. However, the exact mechanism through which education affects diarrheal diseases has not been determined and should be worthy of further study. Probably, as showed in report about diarrheal diseases in Bangladesh, educational level and household income are directly related to important and well-known behavioral and environmental risk factors to diarrheal diseases, as the following: daily fresh water consumption; cooking food; boiling drink water chlorination and filtration; safe water storage; and living in house provided by latrines and piped sewer system. Therefore, according to a systematic review on this topic, diarrheal episodes can be largely reduced improving water supply, sanitation, through hand washing, and water treatment and safe storage [22]. WHO estimates that most cases (94%) of diarrheal illness are preventable through modifications to the environment, including interventions to increase the availability of clean water, and to improve sanitation and hygiene [29]. One important finding of our study is that awareness of diarrheal diseases among slum dwellers was revealed as the only statistically significant and negative predictor of this illness. However, although this relationship should be further investigated, it is in agreement with findings of past studies carried out in USA, India and Nepal [10–12, 15] showing that awareness of diseases reduces the probability to be affected by diarrheal disease. Unfortunately, the association between diarrheal illness and household income was not statistically significant in our study. According to literature, individuals who live in households that have no latrines (i.e., use beach, lagoon, and/or bush), that living in traditional and mixed houses when compared to permanent houses, or in households that are located in villages with higher proportion of households that use only the beach, bush, or lagoon are more likely to suffer from diarrheal diseases [30].

In our study, number of days of work missed due to diarrheal disease was used as the most available indicator to measure the monetary burden of diseases. In this way, we showed a statistically significant relationship between number of working days lost as predictor dependent and socioeconomic variables such as age, marital status, household income, BMI, and behavioral variables, such as hand washing, daily water consumption, boiling water and household with latrines and piped sewer system as independent variables. In disagreement with prior research carried out in India [22], our study showed that educational level was not a statistically significant predictor of number of work missed. However, it is well-known that a high-educational level is able to reduce the number of days missed to illness, because of a better level of knowledge of therapy. As regard to hand washing, a past study in Dhaka city showed that hand washing with soap and water can prevent the spread of diarrheal diseases in poor areas where supply of safe water and improved sanitation are not possible [31]. Finally, as expected, the number of working days missed due to diarrheal illness was associated with the overall burden of disease, which in our study was estimated to be 14 USD for each episode of diarrheal illness, resulting in a very high cost for low-income people as slum dwellers. However, our study has also some limitations. Indeed, it has only considered diarrheal illness among various waterborne diseases; in addition, diarrheal illnesses that are notified comprise only a fraction of actual disease cases for several reasons: 1) Not all people who have an infectious disease visit a medical practitioner, because gastroenteritis is a self-limiting disease and most people recover without medical intervention; 2) Not all cases are diagnosed by the medical practitioner; 3) Not all cases present a specimen for laboratory confirmation;

4) Not all diagnosed cases are reported to the disease surveillance system. The proportion of cases that are captured by the notification system is not likely to be consistent for all diseases or population groups. In addition, our study studied only adults, where in Bangladesh children bear the largest diarrheal diseases burden [23]; finally, a study with a larger sample size might provide a more accurate estimate of this study variables. However, this study highlighted that prevalence of diarrheal disease is high among adult slum dwellers in Bangladesh. As showed by literature, socio-economic conditions like a low educational level and a low-income household and behavioral variables such as hand washing, awareness of diseases, daily water consumption, boiling water and household with latrines and piped sewer system are probably associated with the onset of diarrheal diseases. Therefore, the economic burden of poor water and sanitation practices is a product of a complex interaction between many different factors relating to inadequate water supply, sanitation, and hygiene at both individual and village levels [30]. It is well-known that incidence of diarrheal illness can be greatly reduced by provision of clean drinking and safe storage water. For this reason, Bangladesh has hand operated tube-well water to over 80% of the village population. In rural Bangladesh, there are an estimated 10 million point sources based water supply systems, which are operated and maintained by individuals or user groups. Furthermore, motor-operated deep tube-wells are common in the villages that are used to irrigate paddy fields, which also provide clean drinking water. However, clean water is not alone of sufficient impact on diarrheal diseases, concomitant improvement in disposal of faces is also essential. In conclusion, our study showed a high prevalence and a huge economic burden of diarrheal illness among adult slum dwellers in Bangladesh. This study also confirmed the importance of the major determinants of diarrheal illness that are well-described in literature. Therefore, the findings of our study can be important for policy makers in order to improve socio-economic conditions of this group of disadvantaged people.

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