International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Gastric Symptoms and Its Determinants: A Household Level Analysis in Urban Slums of Dhaka and Adjacent Rural Areas

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Received: 30/07/2015 *Revised: 20/08/2015* *Accepted: 31/08/2015*

ABSTRACT

Background and objectives: The living conditions in the slums of the megacity Dhaka, the capital of Bangladesh are poor and, therefore, often lead to a high exposure to factors with negative impact on health. In this study, we aimed to highlight the prevalence of gastric symptoms at a household level and take the seasonality of these symptoms into account. Furthermore, we aimed to describe the determinants which influence the prevalence of gastric symptoms.
Methods: The data is based on a one-year cohort study (2008-2009); the total sample included 3,207 respondents. The selection of independent variables concentrated on the place of residence, age, household structure and aspects regarding environment and hygienic conditions. We performed descriptive, bivariable, and multivariable analyses (Cox regression and multinomial logistic regression).
Results: Gastric symptoms were reported in 33.4% of all households within the observation period of one year. The prevalence of gastric symptoms revealed seasonal variations with especially high rates in autumn. Although several factors were significantly associated with gastric symptoms in the bivariable analyses, only some variables retained their significance in the multivariable analyses. Gastric symptoms were significantly associated with age, the place of residence and the availability of electricity.
Conclusion: Several actions to reduce the risks of the transmission and acquisition of infectious agents concentrating on environmental conditions (e.g. drinking-water, sanitary conditions) have been implemented, but still need further attention. Additionally, the living conditions in slums in terms of overcrowding also need further attention, because the spread of infectious diseases is facilitated under these conditions.

Key words: slum, gastric symptoms, Bangladesh, seasonality.

INTRODUCTION

Bangladesh is a densely populated developing country and is highly vulnerable to infectious and non-communicable diseases. The vulnerability to floods and cyclones, for example, leads periodically to high losses within agriculture and contamination of drinking-water and, therefore, a high risk of mortality and morbidity. [1] Furthermore, a pluralistic health system and imbalanced patterns of health improvements as well as a poor use of basic health services, a low national gross domestic product (GDP; 673 US$ per head), income inequalities and persisting high levels of poverty (32%) might reduce health advances. Only 3.7% of the GDP in Bangladesh is spent on health and 47 million people live below the poverty line. Nevertheless, Bangladesh has accomplished exceptional health achievements during the last decades. [2]

Bangladesh is currently experiencing an epidemiological and demographic transition. It is undergoing a shift in disease and causes of death from communicable diseases to non-communicable diseases. Even so, communicable diseases still made up more than 10% of the mortality in 2010. [2,3] The Bangladeshi population faces the challenges of a rapid urbanization, which generates cities with high population density and congestion. Currently, changes to lifestyle and environmental factors are being witnessed in both urban and rural regions. [4] Urban surroundings influence behavioral and environmental factors in various aspects, which might affect human health and wellbeing positively and negatively. The advantages of improved health care and better accessibility to information and health education have to be viewed alongside the common areas of deteriorated physical and social environments in cities. For this reason, there is raising concern on the impact of these living conditions on health in megacities of developing countries, such as Dhaka, the capital of Bangladesh. [5] In Dhaka, one of the fastest growing megacities in the world, especially the growth of slums is emerging and poses a public health challenge, because these settlements do not provide sufficient infrastructures. Adequate water supply and sanitary facilities are often missing. Furthermore, the overcrowding and non-durability of housing are common in this setting. [6] Therefore, the slum population is even more exposed to factors with negative impact on health, especially for infectious diseases.

Helicobacter pylori, for example, which is a gram-negative bacterium that colonizes in the human gastric mucosa is one important agent for gastric symptoms. [7-9] Globally, around 50% of the total population is infected with H. pylori, [10-12] with higher prevalence in developing countries. [13,14] In Bangladesh, the prevalence is higher than 90% in asymptomatic adults and 50-80% in children under the age of five years. [9,10] The acquisition of H. pylori occurs mainly during childhood via intrafamilial transmission. [15] Several further studies have concentrated on transmission due to water- and foodborne pathways, transmissions within families or close-living communities, as well as zoonotic and iatrogentic transmissions. [12,14] Transmission may occur in vertical mode, e.g. from parents to children, or horizontal mode, across individuals or from environmental contamination. [13] Nevertheless, H. pylori is just one infectious agent among many other viral, bacterial and parasitic agents causing gastric symptoms.

Waterborne transmission through contaminated drinking-water and inadequate sanitation practices, especially in developing countries, seem to be related to a higher prevalence of gastric infections. These infections are associated with poor social and economic development, overcrowding, poor sanitation and personal hygiene practices, low socioeconomic status, and absence of hygienic drinking-water and food habits. The educational level of parents, the type of housing, number of family members, and the type of community were also found to be factors determining an infection causing gastric symptoms. [10,11,13,16,17]

This emphasizes the complexity of gastric symptoms caused through a multifactorial interacting process. The risk factors described indicate the public health relevance for the context in a developing country such as Bangladesh. Little is known about the prevalence rates of gastric symptoms in the urban slums of Dhaka, the seasonality and associated factors for the household population. Therefore, this is the first study which aimed to highlight the prevalence of gastric symptoms, which may be caused by a gastrointestinal infection, at a household level and take the seasonality of these symptoms into account. Furthermore, we aimed to describe the determinants on a household level which influence the prevalence of gastric symptoms.

MATERIALS AND METHODS

Study design

The data are based on two baseline surveys (2008/09) which were designed for a one-year cohort study. The study was conducted under the priority programme of the German Research Foundation 'Megacities – Megachallenge: Informal Dynamics of Global Change'. The research focused on health outcomes among slum dwellers in Dhaka, Bangladesh. The total sample included 3,207 respondents aged 10 years and older from 12 slums in Dhaka and three rural villages located nearby. Information on 1,269 respondents was gathered by interviews in three urban slums (n = 662) and rural villages (n = 607) in 2008. In 2009 the sample size was increased by conducting a similar survey with 1,938 adults from nine additional slums in Dhaka.

Only one person from each household was interviewed by face-to-face interviews by trained interviewers in each baseline survey. The aims of the surveys were explained and consent was given by each respondent. Verbal consent was obtained because a large amount of the slum population is illiterate and could not provide written consent. The verbal content was documented by the interviewer before he or she started with the items of the questionnaire. Similar questionnaires were used for both surveys, which included validated items of different scales. Furthermore, the questionnaire was pretested before data collection.

A systematic sampling approach for the selection of households was used. In this approach, secondary information on the overall 4,900 slums in Dhaka (e.g. name of the slum, number of households, estimated population) provided by the Centre for Urban Studies (CUS) was used to select the slums. The inclusion criteria were a minimum number of 500 households in the slum and at least six acres of land. As a next step, the slum households selected were mapped, taking Google maps as a base. A unique identification number was provided for each household to make a sampling frame. Because no pilot study for estimating the prevalence of gastric symptoms (P) was performed, a recommended value of P = 0.50 was chosen. Thus, a maximum variance and a maximum sample size could be provided. The sample sizes depended on the number of households in each slum. Sample sizes for each slum were calculated by using a statistical approach. A sampling rate (r) was calculated by dividing the number of families in the slum by the sample size calculated. A systematic sampling approach was used to locate households for interview. Therefore, one adult was interviewed in every rth household. The interviewed person was asked about the health of all other family members. No adjustments for non-responding were made, because those households were replaced by the next available household in the baseline survey. Similar techniques were applied for the selection of rural villages.

Four consecutive surveys (baseline and three follow-ups) were conducted in March, June, September, and December. Therefore, each survey covered a period of three months. In the baseline survey, a detailed questionnaire was employed to gather information on the socio-demographic characteristics of each household member. In the follow-up surveys, only health-related information was collected. It was attempted to always interview the same person in the household. Therefore, the oldest family member available during the survey was always interviewed, because it was assumed that older people are more knowledgeable regarding the health problems of the family members. Overall, 2,330 respondents participated in all four consecutive surveys, which indicated a loss to follow-up of 27.3%. Only households from the urban slums were lost to follow-up. Further detailed information on the sampling strategy is published elsewhere. [4,6,18]

Selection of variables

The information of interest was gastric symptoms at a household level. Each respondent was asked to report if any family member was affected by gastric symptoms in the past three months. We calculated two dependent variables based on this information for the following analyses. The first calculated variable provided information whether at least one household member was affected by gastric symptoms during the whole observation period of one year (categories: 'yes' or 'no'). In the second variable we differentiated whether gastric symptoms at a household level did not occur, occurred once or for more times within the year (categories: 'household not affected', 'household affected with gastric symptoms once' or 'household affected with gastric symptoms twice or more').

The selection of independent variables concentrated on variables on household level to avoid ecological fallacy. In addition to information on the place of residence ('urban slum' or 'rural village'), which also included the single slums and villages in the descriptive analysis, we used further household characteristics. Therefore, socio-demographic and socioeconomic variables were calculated. They include the average age of household members, average education (in years) and average family income. Furthermore, the household structure was considered by the number of family members, the average number of people living in one room and the percent of married family members.

Aspects regarding environment and hygienic conditions are represented by the drinking-water source for the household ('piped water' or 'tubewell or other'), the number of people sharing one toilet, the availability of electricity in the household, the sufficiency of food for the family, and the exposure to flooding. All computed and recoded variables were checked by plausibility controls in the form of cross-tables.

Statistical analyses

All statistical analyses were performed using the statistical software package IBM SPSS Statistics 21. The analyses started with descriptive statistics to gain an insight in the data structure. We calculated the family prevalences of gastric symptoms for the whole year and for the follow-ups. Simple frequency analyses including percentages and means were conducted for the independent variables. Additionally, histograms and the Kolmogorov-Smirnov test (KS) were used to test normal distribution. The p-value of the KS showed highly significant results ($p < 0.001$) for all variables selected, which indicates that the variables do not follow normal distribution (data not shown).

We conducted cross-table analyses in the bivariable analyses to explore the associations between the prevalence of gastric symptoms and the nominally or ordinally scaled independent variables. We used the Chi-square test (χ^2) of independence to analyse the associations of two variables with multiple categories. All tests were two-sided and statistical significance was based on an alpha-level of 0.05. As a second step of bivariable analysis, we calculated correlations between all variables selected. The results are presented in a correlation matrix. Comparatively small intercorrelations between independent variables were a first hint that the variables did not suffer from multicollinearity. In addition, the Variance Inflation Factor (VIF) was calculated to prove this appraisal. The VIF ranged from 1.096 to 1.705 for the nine variables which were significant in the bivariable analyses and, therefore, included for the further multivariable analyses. The statistically significant variables were average age, place of residence, average education, average family income, people per room, number of family members, drinking-water source, people sharing one toilet, and availability of electricity.

Two different approaches were chosen for the multivariable analyses. We applied multivariable Cox regression modelling using the first dependent variable, which provided information whether anyone in the family was affected by gastric symptoms during the one year period. The nine independent variables mentioned above, which revealed significant results in the bivariable analyses, were selected to find significant covariates influencing gastric symptoms on a household level. We estimated hazard ratios (HR) including 95% confidence intervals (95% CI) and p-values calculated by a Chi-square test to determine significance.

Furthermore, the same nine independent variables were employed in a multinomial logistic regression model. In this case, we used the second dependent variable which provided information, whether a household was not affected, affected once or affected twice or more with gastric symptoms during the one year period. We calculated odds ratios (OR) including 95% CI and p-values. Nagelkerke's R^2 (0.271) was calculated for the multinomial logistic regression model to provide an overview of the percentage of the dependent variable that may be accounted for by all the independent variables selected.

RESULTS

Descriptive analyses

Gastric symptoms were reported in 33.4% of all households within the observation period of one year. The prevalence of gastric symptoms revealed seasonal variations with especially high rates in the time of September to November: (18.3%). During summer time (June to August), only 11.6% of households reported gastric symptoms. Taking into consideration the number of household members affected confirmed the results. The percentage of households with two or more family members affected was 13.2% in total (Tab. 1).

Tab. 1: Household prevalence of gastric symptoms in different periods

	Baseline (Dec.-Feb.)	1st follow-up (March-May)	2nd follow-up (June-Aug.)	3rd follow-up (Sept.-Nov.)	Total (1 year)
Total households interviewed	3,207	2,967	2,639	2,333	3,207
Households affected by gastric symptoms[1]	450	487	306	428	1,070
% of households which reported gastric symptoms	14.0	16.4	11.6	18.3	33.4
Gastric symptoms reported in the household:					
None of the household members	2,757 (86.0)	2,480 (83.6)	2,333 (88.4)	1,907 (81.7)	2,137 (66.6)
Only one member in the household	402 (12.5)	453 (15.3)	267 (10.1)	362 (15.5)	648 (20.2)
Two or more members in the household	48 (1.5)	34 (1.1)	39 (1.5)	64 (2.7)	422 (13.2)

[1] Irrespective of family members affected by gastric symptoms.

The socio-demographic and socioeconomic characteristics of the sample are described in Table 2. Most households (81.1%) are located in urban slums. Overall, 15 urban slums or adjacent rural areas were investigated. The average age of family members is quite low, with 80.3% aged under 30 years. The average education and average income was comparatively low in most households. Furthermore, more than three people lived in one room in 72.3% of all households. A household consisted of three to four family members in 47.7% of cases and more than five people lived in one household in 42.3%. A characteristic of the sample is that many people share one toilet. Most households had electricity (67.5%), but very often it was indicated that the food was not sufficient (57.8%) (Tab. 2).

Tab. 2: Gastric symptoms by selected household characteristics

Variables	Categories	Sample		% gastric symptoms	p-value
		n[1]	%		
Average age (in years)	10-19	1,191	37.1	22.3	< 0.001
	20-29	1,387	43.2	34.8	
	30-39	459	14.3	49.7	
	40+	170	5.3	55.3	
Place of residence	urban slum	2,600	81.1	27.3	< 0.001
	rural village	607	18.9	59.1	
Name of slum/village	Abdullahpur bus stand bosti, Dhaka	206	6.4	35.9	< 0.001
	Abdullapur gate bosti, Dhaka	185	5.8	30.3	
	Adabor no-10 bosti, Dhaka	176	5.5	19.9	
	Baguntila bosti, Dhaka	180	5.6	30.0	
	Bishil and sarag bosti, Dhaka	254	7.9	22.8	
	Bosnoshri Bhuiapara bosti, Dhaka	219	6.8	27.4	
	Kampangir chor bosti, Dhaka	220	6.9	31.8	
	Koral bosti, Dhaka	221	6.9	29.9	
	Kullanpur pura bosti, Dhaka	311	9.7	28.0	
	Kunipara bosti, Dhaka	249	7.8	21.3	
	Mohammadpur bosila bosti, Dhaka	130	4.1	35.4	
	West jurian bosti, Dhaka	249	7.8	20.9	
	Khalia biad village, Monohordi	200	6.2	34.5	
	Gerua village, Savar	200	6.2	60.0	
	Purbochor paratola village, Katiadi	207	6.5	82.1	
Average education (in years)	0	702	21.9	30.5	< 0.001
	1-5	2,168	67.6	32.9	
	6+	337	10.5	42.4	
Average family income (in Taka)	< 1,000	588	18.5	41.0	< 0.001
	1,000-1,999	1,638	51.5	33.0	
	2,000+	952	30.0	27.6	
People per room	1-2	889	27.7	36.0	0.048
	3+	2,315	72.3	32.3	
Number of family members	1-2	321	10.0	29.0	< 0.001
	3-4	1,530	47.7	27.6	
	5+	1,356	42.3	40.9	
Percent of married people	< 50%	996	31.1	35.4	0.094
	≥ 50%	2,211	68.9	32.4	
Drinking-water source	Piped	1,590	49.6	29.9	< 0.001
	Tubewell or other	1,617	50.4	36.7	
People sharing one toilet	1-19	1,029	32.1	45.1	< 0.001
	20-49	1,102	34.4	27.0	
	50+	1,076	33.6	28.7	
Electricity	Yes	2,165	67.5	29.0	< 0.001
	No	1,042	32.5	42.5	
Family has sufficient food	Yes	1,310	42.2	32.9	0.400
	No	1,796	57.8	34.4	
Flood affected area	Affected	2,166	67.7	34.8	0.243
	not affected	1,034	32.3	32.7	

[1] Sample sizes may not add up to 3,207 due to missing values

Bivariable analyses

The bivariable analyses in terms of cross-table analyses and p-values of Pearson's χ^2 showed significantly higher rates of gastric symptoms in older people. Gastric symptoms were significantly higher in rural villages (59.1%) than in urban slums (27.3%; $p < 0.001$). Gastric symptoms increased with higher average education and decreased with higher average income ($p < 0.001$). Receiving drinking-water from a tubewell or other water sources was significantly associated with higher rates of gastric symptoms (36.7%) than piped water (29.9%; $p < 0.001$). If fewer than 20 people share one toilet, a higher prevalence (45.1%) was witnessed compared to 20-49 (27.0%) and 50 and more people (28.7%; $p < 0.001$) sharing one toilet. Households with electricity revealed significantly lower rates of gastric symptoms (29.0%) than households without electricity (42.5%; $p < 0.001$).

Correlation analyses were performed as a second step of the bivariable analysis. The correlations between gastric symptoms and independent variables are significant for all variables except the three factors on the percent of married household members, sufficient food and flood affected areas, which were also not significant in the cross-table analysis. All other correlations between the dependent variable and independent variables showed slight – and in some cases moderate – correlations, which indicated no multicollinearity regarding the independent variables included for further multivariable analyses.

Cox regression

All the statistically significant variables ($p < 0.05$) in the bivariable analysis were employed in a multivariable Cox regression model (Tab. 3). This led to the exclusion of the percent of married people, sufficient food and flood affected areas. Furthermore, the variable on slums and villages was excluded, because this information was used only for descriptive purposes and is imbedded in the variable in the place of residence. Four variables (education, income, drinking-water source, and people sharing one toilet) lost their significance level in the Cox regression model. The average age revealed highly significant and considerable results: The HR for people aged 40 years and more was 3.07 (95% CI: 2.37-3.98; $p < 0.001$) compared with households with average ages between 10 and 19 years. The chance of being affected by gastric symptoms in rural villages nearly doubled in comparison to urban slums (HR = 1.92; 95% CI: 1.56-2.36; $p < 0.001$). More people living in one room showed a slightly protective effect (HR = 0.80; 95% CI: 0.68-0.94; $p = 0.006$). By contrast, more family members led to a higher HR. The HR for households without electricity was 37% higher (95% CI: 1.11-1.70; $p = 0.004$) compared to households with electricity.

Multinomial logistic regression

The same independent variables were used in a multinomial logistic regression model (Tab. 4). In this model, a differentiation between households affected with gastric symptoms once a year and twice or more a year was performed. Most variables became insignificant for households affected once a year. Only electricity showed a protective effect, because households without electricity had an OR of 1.46 (95% CI: 1.04-2.04; $p = 0.027$). For the other variables, only some categories showed significant effects (Tab. 4).

Tab. 3: Cox regression

Variables	Categories	HR	95% CI	p-value
Average age (in years)	10-19	1.00		
	20-29	1.52	1.30-1.77	< 0.001
	30-39	2.31	1.92-2.78	< 0.001
	40+	3.07	2.37-3.98	< 0.001
Place of residence	urban slum	1.00		
	rural village	1.92	1.56-2.36	< 0.001
Average education (in years)	0	1.00		
	1-5	1.00	0.85-1.12	0.984
	6+	0.95	0.75-1.22	0.702
Average family income (in Taka)	< 1,000	1.00		
	1,000-1,999	1.01	0.86-1.19	0.911
	2,000+	0.85	0.68-1.04	0.119
Persons per room	1-2	1.00		
	3+	0.80	0.68-0.94	0.006
Number of family members	1-2	1.00		
	3-4	1.27	0.97-1.66	0.078
	5+	1.85	1.39-2.47	< 0.001
Drinking water source	Piped	1.00		
	Tubewell or other	0.93	0.81-1.07	0.302
People sharing one toilet	1-19	1.00		
	20-49	1.05	0.87-1.28	0.611
	50+	1.04	0.86-1.25	0.702
Electricity	Yes	1.00		
	No	1.37	1.11-1.70	0.004

Tab. 4: Multinomial logistic regression

Variables	Categories	Households affected with gastric symptoms once			Households affected with gastric symptoms twice or more		
		OR	95% CI	p-value	OR	95% CI	p-value
Average age (in years)	10-19	1.00			1.00		
	20-29	1.21	0.86-1.71	0.273	2.26	1.50-3.41	< 0.001
	30-39	2.36	1.49-3.74	< 0.001	6.00	3.64-9.90	< 0.001
	40+	2.11	0.98-4.56	0.057	6.74	3.10-14.65	< 0.001
Place of residence	urban slum	1.00			1.00		
	rural village	1.13	0.64-1.99	0.680	14.68	7.25-29.74	< 0.001
Average education (in years)	0	1.00			1.00		
	1-5	1.10	0.68-1.78	0.693	1.18	0.63-2.23	0.600
	6+	1.15	0.59-2.23	0.692	1.24	0.60-2.57	0.568
Average family income (in Taka)	< 1,000	1.00			1.00		
	1,000-1,999	0.81	0.56-1.16	0.252	0.77	0.52-1-15	0.207
	2,000+	0.86	0.52-1.41	0.540	0.79	0.45-1.34	0.369
Persons per room	1-2	1.00			1.00		
	3+	0.82	0.51-1.34	0.432	0.58	0.37-0.92	0.920
Number of family members	1-2	1.00			1.00		
	3-4	1.53	0.73-3.22	0.258	1.60	0.72-3.53	0.248
	5+	2.45	1.09-5.47	0.029	3.67	1.57-8.58	0.003
Drinking water source	Piped	1.00			1.00		
	Tubewell or other	1.08	0.74-1.56	0.689	0.57	0.36-0.88	0.012
People sharing one toilet	1-19	1.00			1.00		
	20-49	1.50	0.85-2.68	0.165	2.54	1.18-5.48	0.018
	50+	1.10	0.66-1.84	0.717	1.59	0.87-2.91	0.134
Electricity	yes	1.00			1.00		
	no	1.46	1.04-2.04	0.027	1.58	1.07-2.34	0.022

Concentrating on the households affected with gastric symptoms twice or more within the observation period led to more significant results. The average age is a highly significant and relevant factor, because people aged 40 years and more showed a 6.74-fold (95% CI: 3.10-14.65; $p < 0.001$) and people aged 30-39 years a 6.00-fold chance (95% CI: 3.64-9.90; $p < 0.001$) of being affected with gastric symptoms compared with the age group 10-19. The OR for gastric symptoms was much higher in rural villages (OR = 14.68; 95% CI: 7.25-29.74; $p < 0.001$) than in urban slums. Higher average education led to a higher chance of being affected with gastric symptoms. Higher family income revealed a protective effect, although neither variable was significant. The drinking-water source showed a significant effect for the first time in the multivariable analyses: People using water from a tubewell or another water source showed an almost halved OR (OR = 0.57, 95% CI: 0.36-0.88; p = 0.012) compared to piped water. The likelihood of a family being affected two or more times in a year was significantly higher for those who shared the toilet with other people (Tab. 4).

Overall, higher associations between independent variables and gastric symptoms are found in households affected twice or more within the one year observation period. Nagelkerke's R^2 indicated that 27% of the variance of gastric symptoms could be explained by the selected variables of the model.

DISCUSSION

Our study disclosed a high prevalence of gastric symptoms in urban slums and adjacent rural areas. Overall, 33.4% of all households were affected at least once with gastric symptoms in the one year study period. Especially high rates were found during the pre-monsoon (March-May) and post-monsoon (September-November) period. Gastric symptoms were significantly associated with age, the place of residence and the availability of electricity. Therefore, increasing average age of people within the households led to a higher prevalence of gastric symptoms. The likelihood of being affected with gastric symptoms in rural areas was higher than in urban slums.

The seasonality of gastric symptoms which was obvious in our study, is also described in other studies. Before the monsoon season, the weather is rather dry, which may lead to the stagnation of water reservoirs and, therefore, cause a lack of sanitation and personal hygiene. Many areas are flood affected in the period after monsoon, which may lead to further contamination of water and sanitation systems. [6,8]

The higher prevalence of gastric symptoms with increasing age is consistent with previous studies, which showed a higher prevalence of H. pylori infection in older age groups in Bangladesh [8,16] and also in a study conducted in South India. [19] The reason for this might be the worse status of the immune system in older aged people and, therefore, lower body defences against infectious agents. [19]

Higher average income and higher average education as variables for the socioeconomic living conditions showed only a slightly protective but insignificant effect in the multivariable models. Reasons for the higher prevalence are attributed to social and environmental factors. Although crowded households were described as a risk factor for gastric symptoms in the literature, [19,20] we cannot confirm this result in our study, either by Cox regression or by multinomial logistic regression. In Cox regression, the likelihood of being affected with gastric symptoms was significantly lower for three or more people living in one room compared to one or two people per room. However, the trend was opposite for the number of family members: More people living in one household led consequentially to a higher household prevalence, because the likelihood of one affected person increases with the number of household members. Furthermore, there is a higher chance of intrafamiliar transmission.

It is suggested in other studies that the impact of environmental factors is more important than socioeconomic status and housing conditions. [19,21] Precarious hygiene standards and deficient sanitation were reported to be further conditions that are conducive to the acquisition of gastrointestinal infections. Local drinking-water, swimming in rivers and the ingestion of faecal-contaminated vegetables were described as multifactorial risk factors for an infection. [19,22] In our study, no significant associations between gastric symptoms and the drinking-water source or the number of people sharing one toilet were found in the multivariable analyses. The study indicated significant associations for households which were affected twice or more with gastric symptoms only in the multinomial logistic regression: Using tubewell or other drinking-water sources had a protective effect compared to piped water. More people sharing one toilet showed higher odds of being affected with gastric symptoms compared fewer people.

Our study revealed inconclusive results regarding the impact of drinking-water, because the results are mainly not significant or indicate a protective effect for tubewell or other drinking-water sources. This might be the case, because some tubewells or other central water points in the slums are organized by non-governmental organizations (NGOs) which try to install additional tubewells and also toilet facilities considering aspects of hygiene and safety. [23,24] In the last years, NGOs have addressed issues of poverty, health, education and the environment to improve the living conditions amongst other aspects due to better sanitation [2,14] to minimize and prevent the risk of the acquisition and transmission of infectious agents. [12] Furthermore, the relevance of boiling drinking-water regularly was emphasized. [19] Our results indicate consistently higher HR and OR for households without electricity, which might influence the behaviour of boiling water, although in this setting water is boiled mainly by using wood fuel or gas.

In our study, several risk factors from other studies, such as a higher prevalence of gastric symptoms in older ages, and higher risks of acquiring these symptoms in rural areas and in larger households were confirmed. Some social (education) and environmental factors (drinking-water source and toilet facilities) revealed ambiguous results, which are either not significant or inconsistent with the literature. Areas which were flood affected showed no significant association with gastric symptoms which is a further inconsistent finding. Nevertheless, this study focused on the urban slum dwellers and adjacent rural areas. Therefore, the determinants of gastric symptoms in this subpopulation might differ from the results in other studies. This study adds a focused consideration of this subgroup, and thereby, provides a comprehensive overview of determinants of gastric symptoms in slum dwellers in Dhaka and adjacent rural areas.

The household prevalence of gastric symptoms was high both in urban slums and especially in rural areas. Chowdhury et al. [2] mentioned that particularly development in education had considerable effects on health improvements in addition to several strategies in policy and health care. In our study, education was not associated with gastric symptoms. Nevertheless, campaigns for health education may lower the prevalence of gastric symptoms, because people are more aware of potential risk factors. [12] However, households with higher income can afford better housing conditions, which may positively influence the family's overall health situation. The population living in developing countries under socioeconomically disadvantaged conditions and their needs have to be taken into account for the establishment of further strategies to reduce gastric symptoms. The rights of people living in slum settlements or adjacent rural areas which are faced by social disparities and health inequalities need more recognition. This is reinforced by the fast progress of urbanization in Dhaka. Slum settlements are an integral part of the city and are characterized by poor living and environmental conditions, insufficient access to basic (health) services and higher vulnerability to extortion and exploitation. [23]

According to the results of our study, the availability of electricity is an important protective factor for the acquisition of gastric symptoms. Therefore, more households should be able to access electricity, for example, for boiling water before drinking. [12] Until now, electricity is very often only available in slum settlements illegally and at extorted prices which are three times higher than for people who have legal access to electricity. Therefore, some laws need to be implemented to allow for legal tenure of land, so that slum dwellers have the right to use legal access to electricity. [23] Additionally, routine testing of drinking-water for sources of contamination is essential. The surveillance system needs to be improved to develop effective strategies to reduce the transmission and acquisition of bacteria causing gastric symptoms. [12]

Limitations

The results need a cautious interpretation, because the study faces several limitations. First of all, the information on gastric symptoms as the outcome and the independent variables as determinants are based on self-reporting. The gastric symptoms were not verified by a health-care provider and no information on the severity of those symptoms is available. All kinds of stomach pain were reported as gastric symptoms. Although the dynamics between infections causing gastric symptoms, it is not possible to distinguish between different gastric diseases.

Furthermore, we calculated household prevalences with information which was provided by only one household member. Gastric symptoms are a common problem, but since the symptoms did not frequently cause severe discomfort, the prevalence might still be underestimated in this study. A further problem reinforcing this underestimation is a possible recall bias, because information on the past three months was assessed for all family members. Additionally, no information of the duration of the symptoms was assessed. The aim of our study was not to identify the specific cause of gastric symptoms. Another important limitation is that the information on gastric symptoms is so scarce that it is not clear whether the gastric symptoms were caused by an infection or by other factors. The limitations described made it difficult to derive conclusions about the relevant factors determining gastric symptoms.

Only a descriptive analysis of seasonal variation was possible in our study. For further analyses, a more detailed analysis including more factors related to weather extremes, different data sources and an application of time-series analysis could facilitate more precise results. [6] The calculation of the time variable is also faced by several limitations, because of the small number of time plots and a wide range of three months until the next information on symptoms was provided. Information is missing due to loss-to-follow-up and absence of study participants. About a third of the slum families left their domicile during the one-year study period. This may have influenced the results, because the reasons for movements were not assessed and may have been associated with poor housing and environmental conditions. In further studies, the time intervals should be shortened, the reasons for non-responding should be assessed and combined sources using self-reporting and biomarkers should be used. Objective information on the health and immune status are needed in further studies.

CONCLUSION

The study revealed high rates of gastric symptoms at a household level in slums and adjacent areas of Dhaka, Bangladesh. A third of all households declared gastric symptoms during the one-year study period, which highlights the public health relevance of this topic. According to the results of the study, especially increasing age, rural place of residence and no access to electricity were significantly associated with high rates of gastric symptoms. Although some other environmental factors such as the drinking-water source or the number of people sharing one toilet, showed not consistently significant results, they may nevertheless influence the acquisition of several infectious agents which may lead to the development of gastrointestinal disorders in people with a poor immune status.

Several actions to reduce the risks of the transmission and acquisition of infectious agents concentrating on environmental conditions (e.g. drinking-water, sanitary conditions) have been implemented, but still need further attention. Additionally, the living conditions in terms of overcrowding also need further attention, because the spread of infectious diseases is facilitated under these conditions. The basic amenities of the population being exposed to poor living and housing conditions need to be improved. This will lead to sustainable success in improving the health status of the population in general and of the vulnerable groups in particular. [6]

In the light of rapid urbanization especially in developing countries, more research focusing on slum dwellers is needed. Since the characteristics of slums are similar, our results could be generalizable in similar settings. At least, this study shows that more research on the determinants of gastric symptoms is needed: Firstly, because the findings presented lead to the conclusion that gastric symptoms are common in disadvantaged areas, secondly, because there are further determinants of gastric symptoms that were not assessed in the study, and thirdly, because some of the results differ from the studies dealing with this topic in other settings. Only strong evidence on the influencing factors of gastric symptoms, and also other diseases, will allow for the implementation of effective strategies to promote the health of vulnerable populations in developing countries.

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How to cite this article: Fischer F, Steinmann AM, Kraemer A et al. Gastric symptoms and its determinants: a household level analysis in urban slums of Dhaka and adjacent rural areas. Int J Health Sci Res. 2015; 5(9):458-471.

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