Environmental Health Risks in Disadvantaged Urban Slums

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ABSTRACT

This paper presents a comparative assessment of diarrhea occurrence in two urban slums to identify salient factors influencing case prevalence. Primary data were collected using a structured closed-ended questionnaire coupled with water quality sampling and analysis at households reporting diarrhea cases. The water quality analysis showed contamination at the household level due primarily to the location of water storage tanks. Descriptive statistics and Chi-Square distribution tests revealed significant difference in diarrhea cases in both study areas which was correlated with the educational level of household head, financial status, type of water storage tank and corresponding cleaning frequency as well as the adoption of measures to treat water or the use of bottled water.

Keywords: Urban Slum; Water supply quality; Sanitation; Diarrhea prevalence.

INTRODUCTION

Rapid industrialization and urbanization in a setting of poor economic performance and governance has led to an increase in the number of people living in urban slums, reaching around 1 billion people worldwide (UN-HABITAT, 2003). Slums are characterized by inadequate access to safe water, sanitation, poor quality housing, and other infrastructure as well as overcrowding and insecure residential status (Keraka and Wamicha, 2003; UN-HABITAT, 2003). In these types of settings and living conditions, slum dwellers become more susceptible to various health problems, including diarrhea (Sclar *et al.*, 2005), which represents a key public health challenge to the unsanitary nature of these settlements (Pahwa *et al.*, 2010). In this study, a systematic community-based comparative assessment approach was adopted to define determinants of diarrhea prevalence in urban slums. For this purpose, the

incidence of water-related diarrhea was examined in two slums with nearly similar cultural and demographic characteristics and where water and sanitation management have been improved in one area with the aim to assist in defining interventions to reduce the incidence of diarrhea in the other slum.

STUDY AREAS

The study areas are located in Lebanon and Jordan (Figure 1). The Tebbaneh region is considered as one of the poorest urban areas in the city of Tripoli, Lebanon. Besides being disadvantaged at various socio-economic levels, it suffers from the absence of proper hygienic sanitation, inadequate access to clean water and quality housing, and poor waste management practices, satisfying the characteristics of a slum area. An-Nasr area in the city of Irbid, Jordan, is equally an urban slum of similar social fabric, cultural background, and economic characteristics as Tebbaneh. Both slums are overcrowded with population densities reaching 10 times that of any other urban area within their respective countries. In addition, both regions are facing several urban challenges commonly associated with poverty and congestion in urban slums.
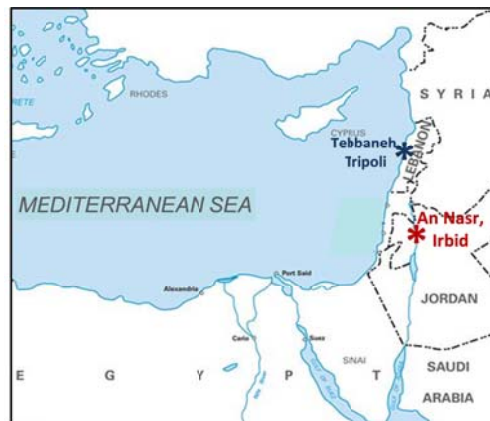

Figure 1. Location of study areas

RESEARCH METHODOLOGY

Primary data related to socio-demographics, economic and health indicators, water sources and usage, wastewater collection, among others, were collected using a standardized, close-ended, structured and coded field questionnaire. It was administered using stratified random sampling procedures first at An-Nasr, Jordan (293 households) and then at Tebbaneh, Lebanon (325 samples). Following the field surveys, a water sampling program was initiated in Tebbaneh to assess the quality of drinking water in ~60 percent of households that reported, during the field survey, cases of diarrhea within the last three months. The sampling program targeted the drinking water supply network (76 water samples) and stored water tanks (63 samples). The samples were analyzed for selected physico-chemical (temperature, pH, color, turbidity, total dissolved solids, residual chlorine and nitrate) and microbiological parameters (fecal coliform and total coliform).

The collected data were analyzed descriptively and inferentially using the Statistical Package for Social Sciences (SPSS 16.0). The Analysis of Variance (ANOVA) and Pearson's Chi-Square tests were conducted to assess the significance of the various variables that differed between both study areas, and to evaluate their possible correlation with the occurrence of diarrhea episodes in Tebbaneh. The Kendall tau-b statistic was employed to measure the sign and the strength of the association between the variables, whenever it was found to be statistically significant.

RESULTS AND DISCUSSION

The survey results revealed a statistically significant difference at $\alpha = 0.05$ regarding the incidence of diarrhea in the two urban slums whereby, during the last three months prior to administering the questionnaire, 14.8 percent of households in An-Nasr reported the occurrence of one or more cases of diarrhea, as compared to 38.5 percent of households in Tebbaneh ($p < 0.001$). Since the wastewater infrastructure has been recently rehabilitated in Tebbaneh similar to An-Nasr area, as outlined below, this difference in diarrheal incidence can be attributed more to water sources, water supply systems, or hygienic practices at the household level rather than direct wastewater management at the community level. Water quality monitoring in the Tebbaneh revealed that network water is of relatively acceptable quality with few contamination incidences at deteriorated sections, whereby Fecal Coliform was detected at low ranges (0-3 CFU/100 ml) in 4 percent of the surveyed households (N = 3). The main quality problems are from the piping within the buildings and the use of attic tanks, whereby total coliforms were detected in water from 26 surveyed households (41 percent) of which 10 had their storage tanks in the attic.

Figure 2 illustrates the main differences in the layout of the water supply systems within buildings in Tebbaneh and An-Nasr. In the Tebbaneh study area, the water supply is almost continuous, but at low pressure. People store water in tanks (96 percent of respondents) whereby each household has an individual water pump located at the building entrance to pump water from the network to household storage tanks. The stored water is not used for drinking purposes but usually used for common household chores. The survey revealed that household storage tanks were located either in the attic (45 percent of respondents) or on the building's roof. Most storage tanks are not well covered and often not covered at all. At An-Nasr, the public water supply reaches consumers at an acceptable pressure and is either stored in a reservoir at ground level from where it is pumped to roof-top storage tanks, or it reaches the roof top storage tanks directly. No attic storage tanks are present (Figure 2) thus eliminating cross contamination from potential sanitary leakage. In addition, buildings in An-Nasr seldom exceed three stories. In both areas, more than 90 percent of respondents withdraw water from water storage tanks using the household pipe system and without additional treatment. However, at $\alpha = 0.05$, a statistically significant difference was discerned in the percentage of respondents cleaning their water storage tanks and in the percentage implementing measures to improve drinking water quality ($p < 0.001$). Nearly 40 percent at Tebbaneh reported never

cleaning water tanks compared to 17 percent at An-Nasr. Also, while water quality is better at An-Nasr, more households (34 percent) were implementing measures to improve drinking water quality than at Tebbaneh (18 percent). In addition, a statistically significant difference at $\alpha = 0.05$ was found in the sources of drinking water between Tebbaneh and An-Nasr ($p < 0.001$) whereby only 3.85 percent of Tebbaneh households use the tank water for drinking as compared to 66.2 percent at An-Nasr. All respondents in An-Nasr purchased bottled water compared to 51 percent in Tebbaneh. However, in both areas, half of those who purchase bottled water do so only when a member of the household is sick.

a) Existing system in Tebbaneh   b) Existing system in An-Nasr
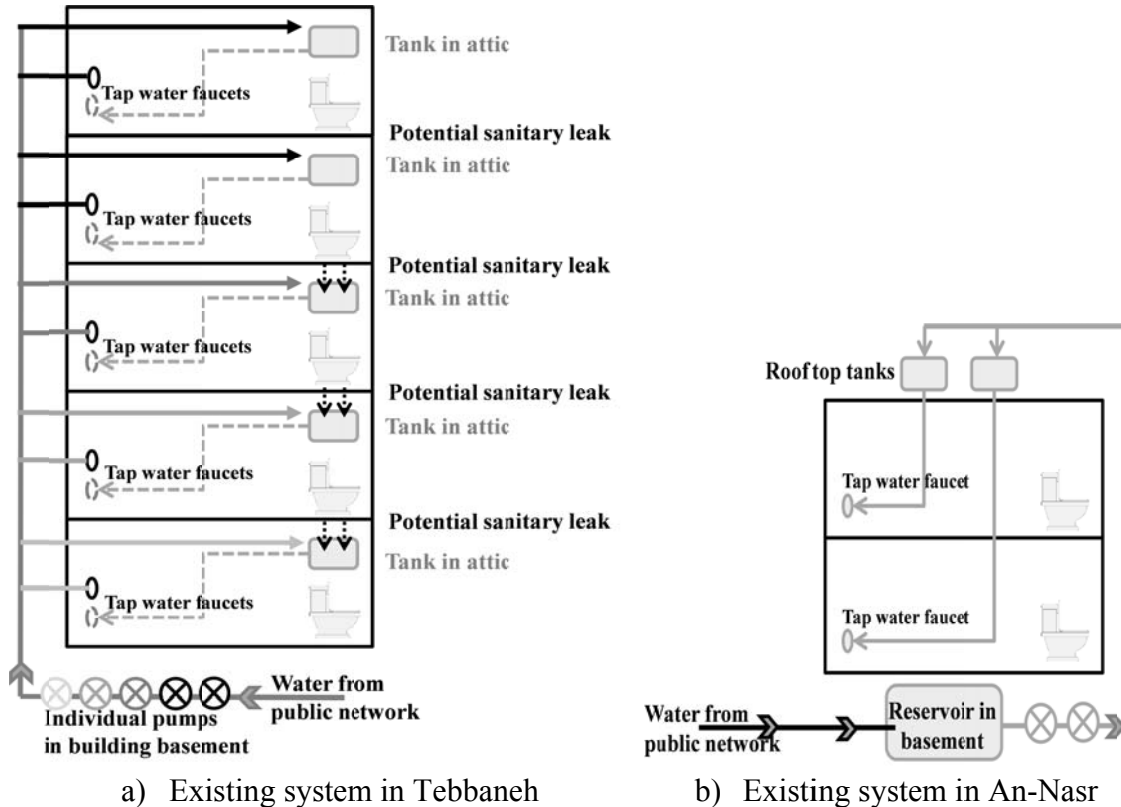
Figure 2. General layout of water supply systems within buildings in study areas

The main socio-demographic indicator showing a statistically significant difference between the Tebbaneh and An-Nasr slums was the educational level of household heads ($p < 0.001$), whereby around 42 percent of An-Nasr male household heads had a university education compared to only 1.2 percent of those at Tebbaneh. For females, more than 75 percent of housewives at An-Nasr had a secondary degree or higher as compared to only 4 percent of housewives in Tebbaneh. Economically, statistically significant differences between Tebbaneh and An-Nasr ($p < 0.001$) were observed in the number of household members working and generating income, in their ability to secure 100 USD within one week, and in household ownership, whereby these economic indicators appeared better at An-Nasr.

Each factor showing a statistically significant difference between Tebbaneh and An-

Nasr was correlated with the occurrence of diarrhea in Tebbaneh. Statistically significant associations were found for educational level of the female household head, household ownership, the ability to secure an amount of 100 USD within one week, type of water storage tanks (attic versus roof), frequency of water tank cleaning, and the use of bottled drinking water (Table 1). These associations were significant at $\alpha = 0.05$ except for correlation of diarrhea cases with frequency of tank cleaning and type of water tank which were found to be significant at $\alpha = 0.1$. The Kendall tau-b (τb) statistic revealed a negative association between the incidence of diarrhea and the educational level of the female household head (-0.141), household ownership (-0.112), the ability to secure 100 USD within one week (-0.123), and the type of water storage (--0.097). Accordingly, the likelihood of diarrhea incidence at the household increases with a lower level of education of the female household head. Similarly, the likelihood of diarrhea incidence decreases with increased household ownership and the ability to secure 100 USD within one week.

The presence of roof top tanks was also found to be less associated with diarrhea incidence whereas the frequency of tank cleaning was positively correlated with diarrhea incidence (+0.118), whereby the incidence of diarrhea increased with less frequent tank cleaning. On the other hand, a positive relationship was discerned between bottled water use for drinking purposes and diarrhea (+0.135) which can be attributed to 1) bottled water was found to be polluted at times, thus increasing the incidence of diarrhea, and 2) a higher tendency to use bottled water as an aversive behavior in households with diarrhea incidence.

The main variable of interest from the water sampling program was the presence/absence of fecal and total coliforms. At $\alpha = 0.05$, a significant association was evident between the type of storage tank used (attic vs. roof top) and the presence of fecal coliforms ($p = 0.032$). The association between the type of storage tank and the presence of total coliforms in the water was significant at $\alpha = 0.1$ ($p = 0.066$). The Kendall tau-b (τb) statistic revealed a relatively strong positive correlation between attic tanks and fecal coliform (+0.279), supporting the hypothesis that wastewater is likely to leak into water stored in attic tanks as illustrated in Figure 2.

CONCLUDING REMARKS

The overall analyses of the statistically significant correlations imply that the condition of the water system at the household level is an equally strong factor impacting the incidence of diarrhea. This situation is aggravated by poor hygienic practices influenced by a low educational level of housewives and the lack of enforced monitoring of bottled water quality emphasizing the need for interventions to improve water supply network, storage, and handling. Diarrhea morbidity can reportedly be reduced by ~21 percent through improved water supply (Bartram *et al.*, 2005). Recent studies have also shown that point of use drinking water treatment have a higher impact on diarrheal outcome than source quality since deterioration of microbiological drinking water quality could also occur during storage (Herbst *et al.*, 2008) which is more representative of the situation in the subject area. A better water

source alone may not accomplish full health benefits if it is not accompanied with improved water storage practices and hygienic habits at the household level (Checkley *et al.*, 2004; Mafuya and Shukla, 2005).

Table 1. Association between variables identified as statistically significant relative to An-Nasr and occurrence of diarrhea cases at Tebbaneh

Dependent variable	Independent Variable	Association	Pearson's Chi Square (X^2)	p-value	Kendall Tau-b
Reporting of diarrhea cases in the past three months	Educational level of female household head	Yes	11.47	0.009	- 0.141
	Household ownership	Yes	4.04	0.044	- 0.112
	Ability to secure 100 USD within one week	Yes	4.89	0.027	- 0.123
	Type of water storage tank (roof versus attic)	Yes	2.90	0.089	- 0.097
	Frequency of water tank cleaning	Yes	6.99	0.072	+ 0.118
	Use of bottled water for drinking purposes	Yes	6.65	0.036	+ 0.135
	Educational level of male household head	No	3.08	0.379	-
	Use of tank water for drinking purposes	No	0.489	0.484	-
	Measures to improve drinking water quality	No	2.294	0.807	-
	Reporting wastewater problems	No	1.35	0.246	-
Presence/ absence of Total Coliform	Type of water storage tank (roof vs. attic)	Yes	3.39	0.066	- 0.192
	Wastewater problems	No	2.62	0.105	-
Presence / absence of Fecal Coliform	Type of water storage tank (roof vs. attic)	Yes	4.62	0.032	+ 0.279
	Reporting wastewater problems	No	1.36	0.243	-

Thus, simple structural interventions (replacing attic tanks with roof tanks, rehabilitation of water and sanitary pipes at the household and building levels, maintenance of roof tanks, avoiding direct pumping from the network) coupled with enforcement of monitoring programs of network and bottled water as well as targeted awareness campaigns on proper hygienic practices constitute effective and low cost measures for reducing diarrhea incidence in Tebbaneh and similar slums.

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