

Water and Sanitation in Dhaka Slums

Access, Quality, and Informality in Service Provision

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Abstract

Urban slum residents often have worse health outcomes compared with other urbanites and even their rural counterparts. This suggests that slum residents do not always benefit from the “urban advantage” of enjoying better access to health-promoting services. Limited access to water and sanitation services in slums could contribute to poor health of slum residents. In Bangladesh, these services generally are not delivered through formal utilities, but rather through well-functioning informal markets that are operated by middlemen and local providers. This paper analyzes a household survey to examine living conditions and quality of access to water and sanitation services in small-, medium-, and large-sized slums across Dhaka, Bangladesh. The analysis finds that access to water and sanitation services is overall quite high, but these services are subject to important quality issues related to safety, reliability, and liability. Although water access is nearly universal, water services are often interrupted or sometimes inaccessible.

Sanitation is commonly shared, with the average ratio being 16 households to one facility. When considering fecal sludge management, the study finds that only 2 percent of these households have access to the Joint Monitoring Programme’s conceptualization of “safely managed sanitation.” The paper also finds strong evidence that water and sanitation services are operated by middlemen at various stages of service provision such as installation, management, and payment collection. The paper provides a snapshot of the differential quality in access to these services based on the monetary welfare level of the household. The snapshot shows that access to water and sanitation services is highly correlated to per capita household consumption levels, although quality remains low overall within slums. Overall, it is likely that the informality of water and sanitation services may exacerbate social and environmental risk factors for poor health and well-being.

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Water and Sanitation in Dhaka Slums: Access, Quality, and Informality in Service Provision

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1. Introduction

Dhaka City Corporation or metropolitan area (referred to as Dhaka hereafter) is one of the fastest growing cities in the world. In 2011, the city had a population of about 16 million people and an annual population growth of around 3.9 percent (United Nations 2015). With an area just above 300 square kilometers – about one fifth of London – this mega city holds more than 10 percent of the total population of Bangladesh (UN-Habitat 2016). In 1990, Dhaka was ranked as the 24th largest city in the world and at the current rate of population growth, Dhaka is expected to become the sixth largest city in the world by 2030.

The rapid population growth observed in Dhaka over the past couple of decades is primarily the result of migration of rural residents to urban areas. It is estimated that between 300,000 to 400,000 new migrants arrive each year to Dhaka in search of economic opportunities (World Bank 2007). New migrants contribute significantly to Dhaka's economic growth as they provide a key source of labor supply for manufacturing and services, two central sectors of the local economy (Hossain 2008). Migration from rural to urban areas is also reinforced by poor rural development policies, which create few incentives for the public and private sector to promote job creation in rural areas and intermediate cities.

Rapid urbanization generally improves economic performance, but it also exerts pressure on general livability when cities cannot quickly adapt to demographic transitions. In Bangladesh, although the percentage of the population living below the official poverty line has been declining since 1991/92, the share of the poor who live in urban areas has been increasing steadily at an annual rate of 1.6 percent (World Bank 2014). Moreover, Dhaka has been struggling with poor infrastructure and low levels of public service delivery for many years, resulting in overcrowding, the existence of poor drainage systems, inadequate water supply and waste management, and high pollution. In 2017, Dhaka was ranked as the fourth least livable city in the world by the Economist Intelligence Unit's Global Livability Ranking, just passing Tripoli, Lagos, and Damascus. Its comparatively poor infrastructure score is one of the primary drivers of Dhaka's low ranking (EIU 2017).

Rapid population growth in Dhaka additionally has translated into housing shortages, driving poorer residents into slums. Overcrowding is a particularly important issue in slum areas. The average population density in urban non-slum areas in Dhaka is estimated to be around seven times lower than the density observed in slum areas – 29,857 persons per km² compared to 220,246 persons per

km² (Hossain 2012). Almost four-fifths of slum residents in Dhaka live in rooms that are less than 10 m² (CUS 2006). Dwelling slum structures are overwhelmingly poor in terms of the quality of the construction materials – only 4 percent of dwelling structures are permanent, 26 percent are semi-permanent, and 69 percent are made of *jbupri*, *katcha* or tin (BBS 2014).¹

Household surveys illustrate drastic inequalities in health and nutrition outcomes between urban slum and non-slum households. The 2009 Multiple Indicator Cluster Survey (MICS) suggests that under-5 child mortality is 79 percent higher in slums areas compared to other urban areas and 44 percent higher compared to rural areas (UNICEF 2010). The 2013 Urban Health Survey also finds that around half of all children in slum areas located in City Corporations are stunted compared to 33 percent in non-slum City Corporation areas, while the latest Demographic and Health Survey (DHS) reports that 40 percent of children in rural areas are stunted (NIPORT et al 2015; 2016). Overall, these disparities suggest that slum residents are experiencing worse living conditions than the rest of the urban population and even than their rural counterparts. This implies that slum residents are not benefiting from the “urban advantage” in terms of gaining access to improved health-promoting services that are more likely provided in urban areas than rural areas.

In Dhaka, utilities historically have not been mandated to provide water and sanitation services to slum households due to their informal tenure. These services may instead be provided to slum residents through functioning informal markets that are operated by *mastaans* (landlords or middlemen) who are believed to charge extortionate amounts of money. Hossain and Ahmed (2015) note that a large proportion of the slum residents in Dhaka obtain water from illegal piped connections from the utility company, Dhaka Water and Sewerage Authority (DWASA), or from private pumps. Similarly, sanitation services are obtained through informal channels regulated by *mastaans*. In terms of surface drainage and solid waste disposal, Dhaka gives minimal attention to slums compared to the rest of the city, resulting in garbage and waste commonly found in the periphery of slums (Ahmed 2014). However, as of late, there is some promise of shifting policies that utilities will begin to formalize slum residents as customers.

Informal markets for water and sanitation services may contribute to the deterioration of living standards in slums because they undermine formal accountability systems that allow monitoring and enforcement of a minimum quality of service (UNICEF 2010; Hanchett et al 2003; Muhammad et al

¹ In the context of slums in Bangladesh, *jbupri* and *katcha* are temporary structures with roof and walls that are not made of permanent material and are generally situated close to sewers, large rubbish dumps, rail lines, or the road side.

2016; Adams et al. 2015; Panday 2017). The lack of a comprehensive framework to regulate service provision in these areas has resulted in the existence of poor cooperation and intense conflicts among the different agencies that might have some role in the delivery channel (Banks 2008). The outcome is low standard and irregular services that ultimately increase the vulnerability of slum residents, putting their health and wellbeing at risk.

In this paper, we take advantage of a unique dataset collected in slums of Dhaka North and South City Corporations to study the main patterns in access to water and sanitation services (Bangladesh Urban Informal Settlements Survey 2016).² To identify slums, we align to the government's official definition of these areas based on the 2014 Census of Slums and Floating Population.³ This is a much narrower definition of slum areas than the ones used by previous studies conducted by researchers and non-government agencies (Angeles et al (2009), NIPORT et al (2008), and NIPORT et al (2015)). Although the differences in observable characteristics of the areas classified as slums and non-slums by official and non-official sources are not well-documented, the definition of slums used by the government seems to have more stringent criteria that limits the size of the slum population.

We present stylized facts on access to and quality of water and sanitation services and mechanisms of water and sanitation service delivery, offering descriptions based on the size of the slum, slum ownership, and household welfare status. For access levels, we quantify access to types of improved water sources and improved sanitation facilities using the definitions provided by the Joint Monitoring Programme (JMP), which is the official monitoring agency for the water and sanitation targets of the Sustainable Development Goals (SDG). Following the SDG spirit of shifting focus from “infrastructure to services,” in addition to quantifying access levels to water and sanitation services, we also explore different dimensions related to the quality of the service. We examine reliability, accessibility, reported issues, and perceived quality for water services. For sanitation, we examine sharing status, reliability, accessibility, fecal sludge management, and barriers to investing in sanitation. Finally, we examine some of the characteristics of the informal markets for these services and the

² The micro data from the Bangladesh Urban Informal Settlements 2016 are publicly available and can be accessed at: <http://microdata.worldbank.org/index.php/catalog/2864/overview>.

³ As slums are often informal settlements, they are not included in the National Population and Housing Census, making it difficult to estimate the exact size of the slum population. Angeles et al. (2009) conducted a Census and Mapping of Slums in Bangladesh in 2005 and estimate that around 37 percent of the urban population in Dhaka (3.42 million people) lived in informal settlements in 2005. In contrast, the official estimates produced by the government based on the latest Census of Slums and Floating Population conducted in 2014 suggest that around 6 percent of the urban population in Dhaka (0.65 million people) lived in informal settlements in 2014.

mechanisms of water and sanitation service delivery, including measurements of service providers for installation, day-to-day management, accountability mechanisms, and payment collection schemes.

We find that slum residents have high access rates to both water and sanitation services. Access to improved water sources⁴ in these areas is almost universal at 97.1 percent based on the JMP definition. Yet, almost half of all slum residents report that their water usually has a funny smell/color/taste and 12.2 percent report that the main drinking water source was unusable for at least one full day in the previous two weeks. In terms of sanitation, 86.4 percent of slum residents report having access to a technologically improved sanitation facility.⁵ Yet, 91.1 percent of them report sharing their facilities with other households, bringing the access to improved sanitation to only 8.6 percent, as per JMP criteria. On average, each toilet available in slum areas is shared on a permanent basis by 16.2 households. When considering the JMP's newest indicator for sanitation, we estimate that less than 2 percent of slum residents have access to "safely managed sanitation⁶."

We also find strong evidence of the existence of functioning informal markets for water and sanitation services in Dhaka slums. These markets are not operated by official local utilities companies but rather are managed by *mastaans* who are active in many components of service provision from building infrastructure to managing the day-to-day operations and collecting payments through local leaders. Because this type of service delivery goes unregulated, slum residents could be vulnerable to monopolistic power that offers limited formal channels to escalate issues that often seem to arise. At the same time, however, the existence of these informal markets allows slum residents to access basic services that otherwise would not be available to them. Therefore, in this context, it seems critical to assess how informal markets could be regulated to improve service provision.

The paper continues in seven sections. Section 2 describes the data used in this paper. Section 3 provides a basic profile of the demographic and socio-economic characteristics of slums in Dhaka. Sections 4 and 5 report estimates on access to and quality of water and sanitation services, respectively.

⁴ Per JMP definitions, "an 'improved' drinking-water source is one that, by the nature of its construction and when properly used, adequately protects the source from outside contamination, particularly fecal matter. Improved sources include: piped water, boreholes or tube wells, protected dug wells, protected springs and packaged or delivered water.

⁵ An 'improved' sanitation facility is one that hygienically separates human excreta from human contact." Improved facilities include: flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, composting toilets or pit latrines with slab.

⁶ "Safely managed sanitation" requires that households have access to an unshared improved sanitation facility where excreta are safely disposed and treated

Section 6 presents descriptions of the functioning of the market for water and sanitation services in slums. Finally, Section 7 presents the main conclusions and some policy implications of this analysis.

2. Data

The data used in this paper come from the Bangladesh Urban Informal Settlements Survey 2016 collected in May 2016. This survey was designed to get a better understanding of the main characteristics of the informal water and sanitation markets in slum areas in Dhaka as well as to collect detailed household consumption data that allow to construct measures of monetary poverty that are consistent with the official metric used by the government to monitor living standards in the country. These detailed consumption data includes 333 items for food, non-food, rent or imputed rent, and durables and were collected using the same instrument and field protocols used by the government to monitor monetary poverty in the country.⁷ The measures of access and quality of water and sanitation services were designed following the JMP framework that seeks to measure global targets for the SDG-6 based on harmonized indicators.⁸ These questions are similar to those found in the Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Survey (MICS). In addition, this household survey also collected a large set of questions explicitly designed to get a better understanding of the informal markets for water and sanitation services in slums.

The Bangladesh Urban Informal Settlements Survey 2016 is representative of all slums in the Dhaka North and South City Corporation. The sampling frame used for this survey was the Census of Slum Areas and Floating Population 2014 collected by the Bangladesh Bureau of Statistics (BBS).⁹ The Census of Slum Areas and Floating Population 2014 defines slums as compact settlements of five or more households, which grow unsystematically and haphazardly in unhealthy conditions in either government or privately owned vacant land (BBS 2014). To operationalize the definition of slums, the governments uses five criteria: (i) poor housing structure; (ii) high population density (one room for all household members; 3+ structures per one decimal of land); (iii) poor access to water and sanitation

⁷ The main instrument used by the government to produce the official poverty numbers is the Household Income and Expenditure Survey (HIES). The HIES is a large nationally representative survey that has been collected periodically around every five years since 2000 with the latest round collected in 2016/17.

⁸ Unlike the JMP, we do not include chemical or microbial testing of priority water contaminants.

⁹ The sampling frame included a total of 3,360 urban slums. There were 34 slums originally included in the Census of Slums and Floating Population 2014 that we excluded from the sampling frame because they had fewer than five households as required by the official definition of slums used by the government.

services (unsafe water; 15+ people sharing toilet); (iv) inadequate lighting and road facilities; and (v) low socio-economic status (informal non-agricultural jobs).

The sample is stratified based on the number of slum households living in each community: (i) small (5-10 households); (ii) medium (11-200 households); and (iii) large (more than 200 households). The final sample includes a total of 588 slum households – 30 slum households from six small-sized slums; 259 slum households from 27 medium-sized slums; and 299 slum households from 30 large-sized slums.

The analysis conducted in this paper takes advantage of this explicit stratification of the sample to provide estimates by these different types of slums. In addition, we provide estimates along two other important dimensions of slums – slum land ownership and household welfare levels. The concept of land ownership in slums in Bangladesh is quite complex and prone to measurement error.¹⁰ To construct a measure of slum land ownership, we use a self-reported question on slum land ownership asked to households' heads and then create a slum-level land ownership variable based on the mode of that variable. Interestingly, we find very little variation in the land ownership variable reported by households within slums, which suggests slum residents have quite homogenous information about the land ownership of their slums. To measure household per capita consumption, we construct consumption aggregates that are fully consistent with the ones used by the government to produce the official poverty numbers in the country using the HIES 2016/17.¹¹ Table 1 presents a summary of the distribution of the sample across slum size, slum land ownership, and slum household welfare levels.

The Bangladesh Urban Informal Settlements Survey 2016 contributes to the literature on slums in the country in several ways. First, to the best of our knowledge this is the only household survey on slums that strictly adheres to the official definition of slums used by the government. This distinction is important to align the relevance of the results with the priorities of the government and to better streamline issues into local government planning. Second, this is the first time that detailed consumption data are collected from slum households that allow to produce monetary measures of household welfare that are fully consistent with the metric used by the government to estimate the

¹⁰ There are multiple official agencies in charge of land records in Bangladesh, so it is quite complex to find out information on land tenure for many records, even for those located in privately owned land.

¹¹ For details on how the official poverty numbers are produced in Bangladesh, see the methodological document Description of the Official Methodology Used for Poverty Estimation in Bangladesh for 2016/17 (2017).

official poverty numbers in the country. These data are used in this paper to understand how access to and quality of water and sanitation services vary across different welfare levels of slum households. Lastly, the survey also allows us to construct estimates of access to water and sanitation services that are aligned to the definitions of “improved water” and “improved sanitation” provided by the JMP, which helps to monitor water and sanitation targets for SDG-6 – to provide *universal* access to water and sanitation by 2030.

Table 1. Sample size

	Number of households	Percentage of households
	N	(%)
By slum size		
Small slums	30	2.3
Medium size slums	259	40.8
Large size slums	299	57.0
By slum land ownership		
Public	334	60.8
Private	224	33.5
Others	30	5.7
By slum household per capita consumption		
Poorest	101	16.7
Second quintile	109	18.7
Third quintile	112	19.3
Fourth quintile	123	21.3
Richest	143	24.0
Total	588	100.0

Notes: Bangladesh Urban Informal Settlements Survey 2016.

3. Basic Profile of Slum Households and Slum Residents

Table 2 summarizes the main demographic and socio-economic characteristics of slum households and slum residents by slum size.¹² Slum households in Dhaka are largely concentrated in medium (40.8 percent) and large slums (57.0 percent) with small slums comprising only a small share of the slum households (2.3 percent). On average, each slum household spends every month Bangladesh Taka BDT 4,410 per capita (around USD 53) to cover its expenditures on food, non-food, and housing. This corresponds to an average per capita consumption per day of USD 1.76. This average household per capita expenditure is slightly higher than the national figure which is 3,800 BDT per capita, and below the average for a household living in Dhaka city corporation (6,639 BDT

¹² Tables A1 and A2, in the Appendix, present similar statistics by slum land ownership and quintiles of per capita household expenditure.

per capita). The average consumption expenditure for rural and urban households is 3,376 and 4,933 BDT per capita respectively.

A typical slum household has 4.3 members and 72.1 percent of its residents are dependents as measured by the age dependency ratio.¹³ Therefore, slum households are home to a relatively high number of children and elderly who, in principle, are not likely able to contribute to the household in monetary terms. Household heads are predominantly male (85.9 percent) and are on average 40 years old. They also on average have lived in their current residence for 10 years, suggesting that slums are more likely to be permanent residences rather than temporary living arrangements upon arriving to Dhaka. On average 47.2 percent of adult slum residents report knowing how to read and write, but only 17.5 percent completed primary school. Among school-age children (7-12 years old), 82 percent attend school on a regular basis. Only 4.5 percent of slum households report having benefited from a relief program provided by the government or a non-government organization (NGO) working in the area. Most adult members in the household are actively engaged in activities that generate income for the household – 89 percent and 50.1 percent of adult males and females report working full-time, respectively. Also, 90 percent of adults report that their main source of income is related to the services sector.

Overcrowding, poor housing conditions, and fear of eviction are salient features faced by slum residents. One single room is normally shared by three people and rooms are on average just 12 square meters. Housing structures are mainly constructed using low quality materials including tin-shed (59.2 percent of housing structures) and semi-permanent materials (28.8 percent of housing structures). Only 11.9 percent of housing structures are constructed based on permanent materials. Over half of all slum residents live in permanent fear of being evicted from their housing structures. Slums have also dynamic rent housing markets with 70.6 percent of slum residents reporting renting their housing structure. On average, 60.8 percent of slums in Dhaka are in land reported to be government owned and 33.5 percent of slums are in land reported to be privately owned.

Although slum households and residents have similar characteristics across slums of different sizes, there are some interesting differences that are worth highlighting. On average, small-sized slums seem to attract more educated residents compared to medium size slums (65.3 percent literacy rate versus

¹³ The dependency ratio is defined as the number of household members aged zero to 14 and above the age of 55 divided by the number of household members aged 15 to 55.

46.9 percent, respectively). School-age children in small slums tend to attend school more often than children in medium-size slums (94.1 percent versus 81.4 percent, respectively). Almost all households in small-sized slums report being renters compared to medium-sized slums (96.6 percent versus 82.2 percent, respectively).

There are also some interesting differences among medium- and large-sized slums. Large slums tend to attract relatively more residents working in the industry sector compared to medium slums (15.1 percent versus 4.2 percent, respectively). Large slums are also located in government owned land more often while small and medium size slums are largely located in privately owned land. The share of households who rent their housing structure in large slums is smaller (61.2 percent) than that observed in medium size slums (82.2 percent). This suggest that as slums get bigger there are more incentives for slum residents to establish some sort of proprietorship from their dwelling structures. Still, this does not translate into a significant difference in the quality of the housing structure between medium and large slums. The monthly rent paid by residents of large slums is on average lower than that paid by households in medium size slums – 2,390 Taka versus 2,692 Taka, respectively. As slums get bigger, the perceived risk of eviction by its residents is larger compared to smaller slums – while only 21.8 percent of slum residents report fearing eviction in medium slums, 71.6 percent of slum residents do so in large size slums.

Table 2. Summary statistics by slum size

	Small	Medium	Large	All	t-test small- medium	t-test medium- large
Monetary poverty						
Distribution of slum households (%)	2.3	40.8	57.0	100	-	-
Monthly per capita expenditure (in Taka)	3,956	4,723	4,208	4,410		
Demographics and human capital						
Household size	4.3	4.2	4.3	4.3		
Dependency ratio (%)	80.8	76.1	68.9	72.1		
Age of household head (in years)	39.2	40.2	40.3	40.2		
Female household head (%)	10.3	12.9	15.2	14.1		
Duration of residence hhold head (years)	7.8	8.3	12.6	10.7		*
Literacy rate for adults (%)	65.3	46.9	46.6	47.2	*	
Completed primary school for adults (%)	29.3	16.5	17.8	17.5	*	
School attendance children 7-12 years (%)	94.1	81.4	82.1	82	*	
Household received relief program (%)	3.4	3.8	5	4.5		
Labor markets						
Share of male adults who are earners (%)	94.4	89.9	88.2	89.0		
Share of female adults who are earners (%)	40.9	52.8	48.7	50.1		
Main source of income from industry (%)	6.9	4.2	15.1	10.5		***
Main source of income from services (%)	93.1	95.8	84.9	89.5		***
Housing						
Per capita rooms	0.32	0.32	0.33	0.33		
Room size (in sq. meters)	12.1	11.8	11.7	11.8		
Share of renters (%)	96.6	82.2	61.2	70.6	**	***
Monthly rent (in Taka)	2,849	2,692	2,390	2,548		**
Has separate kitchen (%)	55.2	87.9	63.4	73.2		***
Government owned land (%)	17.2	27.1	86.6	60.8		***
Non-government and private owned land (%)	82.8	72.9	3.3	33.5		***
Others and do not know who owns land (%)	0.0	0.0	10.0	5.7		*
Fear of eviction (%)	17.2	21.8	71.6	50.1		***
Permanent dwelling structure (%)	24.1	12	11.4	11.9		
Semi-permanent dwelling structure (%)	37.9	36.7	22.8	28.8		
Tin-shed dwelling structure (%)	34.5	51.2	65.8	59.2		
Jhupri dwelling structure (%)	3.4	0	0	0.1		
Access to basic services						
Improved drinking water, JMP definition (%)	100	95.4	98.3	97.2		
Improved sanitation, JMP definition (%) ¹⁴	6.9	9.2	8.2	8.6		
Improved sanitation, including shared (%) ¹⁵	100	93.9	80.5	86.4		*
Electricity is main source of light (%)	100	99.2	93.6	96.1		

Notes: Bangladesh Urban Informal Settlements Survey 2016. All summary statistics were computed using household weights except for mean monthly per capita expenditure (in Taka), age, literacy rate for adults, completed primary school for adults, school attendance for children 7-12 years, percentage of male adults who are earners, percentage of female and male adults who are earners, which were computed using population weights. The t-test columns show the results from Wald tests testing whether the difference in means/proportions between small and medium size slums and medium and large slums are significant at * p<0.1, ** p<0.05, *** p<0.01.

¹⁴ The JMP defines access to improved sanitation as unshared facilities that are flushed to piped sewage systems, flushed to septic tanks, pit latrines with slabs, and ventilated improved pit latrines.

¹⁵ This definition follows the same criteria as the JMP but includes as improved sanitation shared or unshared facilities that are flushed to piped sewage systems, flushed to septic tanks, pit latrines with slabs, and ventilated improved pit latrines.

4. Access to and Quality of Drinking Water Sources

4.1. Main sources of drinking water

Overall, 97.2 percent of slum households have access to an improved water source as defined by the JMP guidelines (Table 2). Slum households in small, medium, and large slums have all very similar access rates to improved water and none of the differences in access between the different sizes of slums are statistically significant. Slum households in government owned land have slightly better access to improved water sources compared to those in privately owned land but the difference also is not statistically significant (Table A1). Lastly, when looking at differences by quintiles of per capita consumption expenditure, richer households tend to have higher access to improved water sources compared to poorer households, but the difference is not significant. This suggests that overall there is very little variation across the characteristics of the slums, and virtually all slum households have access to improved water sources.

Table 3 breaks down water access by type of technology. Access to piped water among slum households in Dhaka is nearly universal at 94.8 percent. However, piped connections that run directly into each of the slum dwelling structures are relatively rare (8.1 percent), with most households accessing piped water through a system connected to the slum compound, yard or plot (68.4 percent) or through a public standpipe (18.3 percent). Although there are no significant differences in these patterns across small, medium, and large slums, households that are relatively better off in terms of their monetary consumption tend to have piped connection into their dwellings more often compared to the poorest households. Also, private piped water is much less frequent in privately owned slums or where land ownership is not clear compared to public or privately-owned slums. Poorest households tend to share their water sources with a higher number of households (42 households on average) compared to better-off households (23 households), and this difference is statistically significant at standard levels.

Slum households are generally not located too far away from their main drinking water source (Figure A1 in the Appendix). On average, slum households spend seven minutes to reach their main drinking water source. This estimate is consistent across the sample independently of the size of the slum or the slum land ownership. In contrast, estimates suggest that slum households that are relatively better off tend to live closer to the water sources compared to the poorest slum households.

Table 3. Main source of drinking water by type of technology

	Piped into dwelling (%)	Piped into compound, yard or plot (%)	Public tap / standpipe (%)	Tube well, Borehole (%)	Others (%)	Households who share water source (%)	Average number of households who share water source
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
All	8.1	68.4	18.3	1.8	3.5	93.8	33.2
By size of the slum							
Small slums	6.9	62.1	24.1	6.9	0.0	93.1	13.2
Medium size slums	4.2	72.6	13.5	3.5	6.1	91.1	28.8
Large size slums	10.8	65.7	21.4	0.4	1.7	95.8	37.0
t-test small-medium							**
t-test medium-large	*						
By land ownership							
Public	9.0	66.5	22.2	0.6	1.6	95.3	36.7
Private	5.4	77.9	5.0	4.3	7.5	92.3	21.3
Others	13.3	33.4	53.3	0.0	0.0	86.7	66.7
t-test public-private			***				
By per capita consumption expenditure							
Poorest	4.6	69.6	13.3	5.7	6.8	98.9	42.4
Second quintile	4.9	65.5	21.9	2.1	5.6	94.6	40.8
Third quintile	7.3	67.3	22.2	0.8	2.4	98.0	33.3
Fourth quintile	8.1	68.2	21.0	0.4	2.4	94.2	29.7
Richest	13.5	71.1	13.2	1	1.3	86.1	23.0
t-test poorest - richest	*					***	

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01. Category others include bottle water and other categories not specified.

4.2 Water treatment and testing

Table 4 shows slum household behavior related to treating their drinking water and testing it periodically for arsenic, iron, salinity, and bacteria. Close to three-quarters of slum households do not treat their drinking water periodically to make it safer to drink (74.3 percent). Among those who treat their water periodically, the most common treatment methods include boiling water, straining water using a cloth, and using a water filter. The treatment of water is more frequent in small and medium size slums (48.3 percent and 35.4 percent, respectively) compared to large size slums (17.9 percent). Slum households who are better off treat their drinking water twice as often as the poorest slum households (39.1 percent versus 18.1 percent, respectively). When asked about whether their main source of drinking water was ever tested for water quality issues, on average 90.8 percent of slum households respond that water was not tested or that they do not know if the water has been tested.

This pattern does not seem to change based on the size of the slum, the slum land ownership, or the welfare status level of the households.

Table 4. Household-level water treatment and testing

	Water treated (%)	Water tested (%)
	(1)	(2)
All	25.7	9.2
By size of the slum		
Small slums	48.3	15.8
Medium size slums	35.4	5.5
Large size slums	17.9	11.4
t-test small-medium		
t-test medium-large	**	
By land ownership		
Public	17.2	11.9
Private	45.5	4.8
Others	0.0	3.7
t-test public-private	***	
By per capita consumption expenditure		
Poorest	18.1	8.3
Second quintile	17.1	12.3
Third quintile	19.8	10.1
Fourth quintile	29.4	8.4
Fifth quintile	39.1	7.3
t-test poorest - richest	***	

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01.

4.3 Water quality issues

Table 5 presents a summary of the main quality issues that were identified by households related to the water services available in their slums. Although the results are again subject to interviewer and response bias, these provide interesting insights into the main concerns expressed by slum residents regarding the provision of water services. Residents consistently report that the top issue that they encounter when drinking water is “funny smell/color/taste” (49.6 percent) and “bacterial contamination” (7.4 percent). Other less prevalent issues that slum households report related to water services include availability (7.5 percent) and high prices of water (1.7 percent). Water contamination is a particularly important issue for small slums while larger slums seem to suffer more in terms of availability. Moreover, problems with access and quality of water services are nearly equally shared among poorer and better-off households living in slums and among households located in privately or government owned land, mainly because of the shared services.

Table 5. Top issues reported related to water services

	Bacterial contamination (%)	Funny smell, taste, or color (%)	Not enough water to all the demand (%)	Too expensive (%)	Others (%)
	(1)	(2)	(3)	(4)	(5)
All	7.4	49.6	7.5	1.7	33.8
By size of the slum					
Small slums	3.4	72.4	0.0	0.0	24.1
Medium size slums	7.7	56.7	3.8	0.4	31.4
Large size slums	7.4	43.6	10.4	2.7	36.0
t-test small-medium					
t-test medium-large					
By land ownership					
Public	7.6	46.7	7.2	2.8	35.6
Private	7.7	54.7	4.7	0.0	32.9
Others	3.3	50.0	26.7	0.0	20.0
t-test public-private					
By per capita consumption expenditure					
Poorest	6.5	38.2	6.7	4.6	44.1
Second quintile	5.6	49.4	7.8	2.0	35.1
Third quintile	5.2	49.6	9.5	0.0	35.7
Fourth quintile	10.8	54.4	7.9	0.9	26.0
Richest	8.2	53.4	5.8	1.5	31.2
t-test poorest - richest		*			

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests show the results from Wald tests testing whether the difference in means/proportions are significant at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Category others include arsenic or heavy metal contamination, salinity contamination, no challenges, do not know and other categories not specified.

4.4 Reliability of water sources

Slum households were asked about the reliability to access their main drinking water source. Table 6 reports the proportion of households who claim that their main drinking water source was unusable for at least one full day in the previous two weeks. About 12 percent of the slum households report a service interruption, with larger slums having significantly more service interruptions compared to small- and medium-size slums. There does not seem to be a significant difference between public and private slums, and relatively better-off households seem to be impacted less frequently by service interruptions compared to the poorest households.

Table 6. Accessibility of water sources in the previous two weeks

Water source was unusable in the last two weeks for at least one full day	
(1)	
All	12.2
By size of the slum	
Small slums	6.9
Medium size slums	8.1
Large size slums	15.4
t-test small-medium	
t-test medium-large	
By land ownership	
Public	10.2
Private	9.9
Others	-
t-test public-private	
By per capita consumption expenditure	
Poorest	18.4
Second quintile	7.4
Third quintile	10.2
Fourth quintile	15.7
Fifth quintile	10.2
t-test poorest - richest	

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7 shows the percentage of households who report that their slums experienced flooding in the past year (Column 1). Flooding is quite common in Dhaka, particularly during the monsoon season that runs between June and October of each year. More than half of the slum households report that flooding has affected their communities in the past year, with an average flood lasting around 16 days (Column 2). Almost a third of the households are affected by limited supplies of drinking water during times of flooding (Column 3). Among households that report being affected by flooding, they report being 10 days without access to a functional drinking water source on average during the flooding events (Column 4). Flooding events affect larger slums disproportionately compared to small and medium size slums – 55.7 percent of households in large slums report experiencing flooding in the past year compared to 44.0 percent and 47.7 percent of households in small and medium size slums, respectively. Likewise, the effects of flooding events last much longer in large slums compared to small- and medium-size slums – 18 days on average in large slums compared to 11 days and 5 days in medium and small slums, respectively. Yet, the shortage of drinking water during flooding events is not as severe in larger slums compared to small slums. Also, during flooding times, the issues that arise related to water sources seem to be resolved more quickly in large slums compared to small and

medium slums as measured by the number of days that slum households need to wait to have a functional drinking water source back again. Lastly, better-off households report being affected by flooding more often than poorer households and report that during these times they must wait longer on average to get their water sources repaired. This could also be the result of better-households being more likely to complain after these events happen compared to poorer households.

Table 7. Flooding in slums and access to water services during last year

	Households who experienced flooding (%)	Number of days of flooding	Households with limited water availability	Number of days with a non-functional
	(1)	(2)	(3)	(4)
All	52.2	15.6	28.9	10.4
By size of the slum				
Small slums	44.0	5.0	45.5	3
Medium size slums	47.7	11.4	30.8	16.7
Large size slums	55.7	18.4	27.3	6.4
t-test small-medium		*		**
t-test medium-large				*
By land ownership				
Public	58.2	19.0	36.8	11.4
Private	39.5	8.4	16.2	4.4
Others	62.0	9.3	0.0	-
t-test public-private		*	**	**
By per capita consumption expenditure				
Poorest	43.6	13	26.4	4.2
Second quintile	47.3	21.5	25.4	10.5
Third quintile	53.4	12.8	32.3	11.5
Fourth quintile	54.9	17.1	37.9	10.9
Fifth quintile	58.3	14.0	22.4	12.1
t-test poorest - richest				**

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5. Access to and Quality of Sanitation facilities

5.1. Main sources of sanitation used

On average, only 8.6 percent of slum households have access to an improved sanitation facility as defined by the JMP guideline (Table 2). If the definition is relaxed to allow for shared facilities, this number increases significantly to 86.4 percent. Regardless of shared status, access to flush toilets connected to a piped sewer system or septic tank for households who live in slums in Dhaka is very limited (Table 8). Only 8.2 percent of slum households have access to a flush or piped sewer system

or septic tank. Most slum households access sanitation services through on-site sanitation solutions, with 78.4 percent using improved pit latrines. Slightly above 10 percent of slum households only have access to hanging toilets, which although is a form of fixed-point defecation has similar consequences of spreading disease and contaminating the environment as open defecation due to hanging toilets' inability to safely confine feces. The use of open pits or hanging toilets for sanitation is much more common in large slums and in slums located in government owned land. Better-off households are slightly more likely to have access to a flush toilet though the availability of those is quite limited as documented above and flush toilets are non-existent in small slums as expected.

Access to toilets that are of exclusive use for one household is very rare in slums, with 91.1 percent of households reporting sharing their sanitation facilities with other households (Table 9). On average, one toilet is shared with 16.2 households (around 70 people). Sharing toilet facilities is equally common across all slums independently of their size, though residents of smaller slums tend to share their sanitation facilities with fewer people as expected. It is interesting that slum households in small slums report sharing their sanitation facilities with 12 households on average given that these areas are supposedly comprised of only 5-10 households. This suggests sanitation facilities in small slums might be shared with residents from other slums or contiguous non-slum areas. Households in slums located in publicly and privately-owned land share their toilet facilities with other households just as frequently, but those in privately owned land share their facilities with a larger number of households on average – 19 versus 13 households, respectively. Households that are relatively better off in slums also tend to share their sanitation facilities slightly less frequently (83.9 percent versus 95.4 percent among the poorest), but they still share their facilities with many households (16 versus 19 households, respectively).

Slum residents wait on average 7 minutes on line to use sanitation facilities. In small slums, households wait slightly less than in larger slums – 4.8 minutes in small slums on average compared to 7.2 and 6.7 minutes in medium and large size slums, though there is quite a lot of variability in the waiting time across households (Figure A2). The waiting time is quite consistent across the household per capita income distribution, suggesting that both poorer and better-off households need to wait an equal amount of time on average to access the sanitation facilities. Likewise, the average waiting time in queue to access the sanitation facilities is largely similar for slums across land ownership.

Table 8. Access to sanitation facilities

	Flush to piped sewer system, septic tank, (%)	Flush to somewhere else (%)	Pit latrine Ventilated (%)	Pit latrine with slab (%)	Pit latrine without slab/open pit (%)	Hanging toilet/hanging latrine (%)	Improved sanitation, JMP definition (excluding share) (%)	Improved sanitation (including shared) (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All	8.04	0.2	20.3	58.1	3.2	10.2	8.6	86.4
By size of the slum								
Small slums	0	0	31	69	0	0	6.9	100
Medium size	10.4	0.4	13.8	69.7	0	5.8	9.2	93.9
Large size slums	6.7	0	24.5	49.4	5.7	13.8	8.2	80.5
t-test small-	**							
t-test medium-				*				*
By land ownership								
Public	6	0	20.1	54.6	5.3	14	8.7	80.7
Private	12.6	0.5	24	62.9	0	0	8.2	99.5
Others	3.3	0	0	66.6	0	30	10	70
t-test public-						***		***
By per capita consumption expenditure								
Poorest	5.3	0.0	16.9	61	2.3	14.5	4.6	83.2
Second quintile	8.6	0.0	11.8	71.5	2	6.1	7.3	91.9
Third quintile	7.6	0.0	24.9	50	4	13.6	6	82.5
Fourth quintile	4.7	0.7	23.4	55.6	4.5	11	6.7	83.8
Richest	12.8	0.0	22.8	54.3	3.2	7	16.1	89.8
t-test poorest -	*						**	

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01.

Table 9. Shared sanitation facilities

	Households who share toilet (%)	Average number of households who share toilet
	(1)	(2)
All	91.1	16.2
By size of the slum		
Small slums	93.1	12.3
Medium size slums	90.8	17.7
Large size slums	91.2	15.2
t-test small-medium		*
t-test medium-large		
By land ownership		
Public	90.7	12.4
Private	91.8	19.0
Others	90.0	39.3
t-test public-private		**
By per capita consumption expenditure		
Poorest	95.4	19.4
Second quintile	92.7	14.6
Third quintile	94	16.1
Fourth quintile	91.5	15.7
Fifth quintile	83.9	15.6
t-test poorest - richest	**	

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.2 Perceived satisfaction, safety, and reliability

In terms of satisfaction with sanitation facilities, the large majority of adult¹⁶ male (89.0 percent) and female (84.4 percent) slum residents report feeling secure when using the facility at night (Table 10). Slum residents in smaller and privately-owned slums feel slightly more secure in terms of using sanitation facilities at night and feel that they have good privacy compared to larger and government owned land slums, though the differences are not substantially large. Additionally, adult males from better-off households report feeling more secure using the facilities compared to adult males from poorer households.

Sanitation facilities are reported to be reliable for the most part; however around 10 percent of slum residents report that facilities were temporarily unusable for at least one full day in the past two weeks. This number is substantially higher in small slums, where 27.6 percent of slum residents report that this issue of reliability.

¹⁶ Defined as over 15 years of age.

During times of flooding, 42.1 percent of slum residents said that their sanitation facilities were inaccessible and reported an average of 9.4 days without access to sanitation (Table 11). This number is nearly consistent for small, medium, and large-size slums, but is higher for slums on public land. Consumption quintiles report varying levels of access (32-47 percent), but the lack of access to sanitation during flooding seems to affect disproportionately better-off households. As mentioned earlier, this could be the result of reporting bias where better-off households tend to report these types of issues more often.

Table 10. Satisfaction with sanitation facilities available

	Feels safe using facility at night, adult male (%)	Feels safe using facility at night, adult female	Feels satisfied with privacy, adult male	Feels satisfied with privacy, adult female (%)	Unusable facility for full day in past two weeks (%)
	(1)	(2)	(3)	(4)	(5)
All	89	84.4	73.9	68.9	9.2
By size of the slum					
Small slums	96.6	96.6	82.8	82.8	27.6
Medium size slums	87.3	83.1	65.8	59.1	8.9
Large size slums	89.8	84.8	79.2	75.2	8.7
t-test small-medium		**			
t-test medium-large			*	**	
By land ownership					
Public	87.1	84.5	78.2	74.3	9.6
Private	92.1	88.3	67.8	61.2	8.4
Others	90.0	60.0	63.3	56.7	10.0
t-test public-private					
By per capita consumption expenditure					
Poorest	86.8	86.8	67.6	68.2	11.1
Second quintile	85.7	80.2	65.7	62.2	4.4
Third quintile	87.4	82.6	73.1	68.3	11.0
Fourth quintile	88.4	86.2	76.0	68.3	10.7
Fifth quintile	94.7	85.7	83.0	75.2	8.8
t-test poorest - richest	**		**		

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. Feels satisfied with privacy of sanitation facilities corresponds to 'very satisfied' and 'satisfied' responses reported by households. These statistics were computed using owners and renters who do not have the use of sanitation facilities included as part of their rents.

Table 11. Accessibility of sanitation facilities during times of flooding

	Households who experienced flooding (%)	Number of days of flooding	Households with a non- functional toilet facility during	Number of days with a non- functional toilet
	(1)	(2)	(3)	(4)
All	52.2	15.6	42.1	9.4
By size of the slum				
Small slums	44	5.0	45.5	4.4
Medium size slums	47.7	11.4	41.7	14.6
Large size slums	55.7	18.4	42.2	6.5
t-test small-medium		*		**
t-test medium-large				**
By land ownership				
Public	58.2	19.0	50.7	10.1
Private	39.5	8.4	31.1	6.3
Others	62.0	9.3	-	-
t-test public-private		*		
By per capita consumption expenditure				
Poorest	43.6	13.0	31.8	5.4
Second quintile	47.3	21.5	46.1	11.0
Third quintile	53.4	12.8	46.0	9.0
Fourth quintile	54.9	17.1	47.0	9.1
Fifth quintile	58.3	14.0	37.7	10.7
t-test poorest - richest				**

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. These statistics were computed using owners and renters who do not have the use of sanitation facilities included as part of their rents.

5.3 Fecal sludge management

Table 12 shows statistics on fecal sludge management and on where the sanitation facilities used by slum households empty. Residents were asked to report where contents of their sanitation facilities emptied. Responses were coded as “safe” and “unsafe,” where fecal sludge management was “safe” if contents were emptied directly to a piped sewerage network, a septic tank with no outlet, or lined pit with no outlet. Overall, we find that only 8 percent of households could be classified as practicing safe fecal sludge management, regardless of sharing status. For those households with access to improved sanitation (unshared), only 2 percent practiced safe fecal sludge management. This number most closely represents access to “safely managed sanitation,” the new sanitation indicator developed by JMP for meeting SDG-6. The large majority report that contents are emptied to drains either through lined pits (42.9 percent) or septic tank connected to a drain (9.8 percent). Moreover, 13.7 percent of all the households report that their sanitation facilities are emptied directly to a nearby lake, pond or river, and 6.1 percent to a septic tank connected to open ground. Among owners of pit

latrines or sanitation facilities that link to septic tanks, about 68 percent report never having emptied their pit or septic tank. This does not necessarily tell us about safe fecal sludge management, but at least sheds light on pit and septic tank emptying practices.

Table 12. Fecal sludge management

	Lined pit with overflow to drain elsewhere (%)	Directly to drain/ditch (%)	Directly to lake/pond/river (%)	Septic tank connected to drain (%)	Septic tank connected to opened ground (%)	Others (%)
	(1)	(2)	(3)	(4)	(5)	(6)
All	42.9	13.9	13.7	9.8	6.1	13.6
By size of the slum						
Small slums	44.8	0.0	13.8	37.9	0.0	3.4
Medium size	48.4	11.9	3.1	12.7	8.0	15.8
Large size slums	38.8	15.9	21.2	6.7	5.0	12.4
t-test small-		**				*
t-test medium-			***			
By land ownership						
Public	35.8	19.8	18.6	6.3	5.0	14.6
Private	51.6	5.6	1.4	18.0	9.3	14.1
Others	66.6	0.0	33.4	0.0	0.0	0.0
t-test public-		**	***			
By per capita consumption expenditure						
Poorest	36.5	11.6	15.6	13.8	9.8	12.7
Second quintile	40.2	14.2	10.8	11.5	10.3	13.0
Third quintile	40.0	16.5	14.3	11.0	5.4	12.8
Fourth quintile	48.6	13.9	12.8	7.8	3.4	13.6
Richest	46.6	13.2	14.8	6.8	3.4	15.2
t-test poorest -						

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01. Others include directly to piped sewer system, septic tank connected to piped sewer system, septic tank with no outlet, lined pit with no outlet, unlined pit, and other categories not specified.

5.4 Barriers to upgrading sanitation

Households reported that the main constraints to improving their sanitation facilities are lack of finance and lack of interest by *mastaan* to invest (Figure A3). In large slums, lack of space to build the facilities is also frequently reported as an important issue. Even among better-off households, lack of space is a reported constraint, which suggests that households who might have the financial means to invest in improving sanitation merely do not have the space to do so.

6. Mechanisms of Water and Sanitation Service Delivery

6.1 Installation, management, and accountability

Tables A3, A4 and A5 summarize statistics on the ownership of drinking water sources, management structure, and the accountability mechanisms to escalate complaints. Water infrastructure used by slum residents is mainly installed by *mastaans* (56.8 percent), D-WASA (17.3 percent), which is the local utility company responsible for water distribution in Dhaka, and NGOs (12.9 percent). Although *mastaans* are the owners of virtually all drinking water sources in small- and medium-size slums (100 percent and 80.6 percent, respectively), NGOs own a non-trivial share of water sources in large slums (20.5 percent). *Mastaans* are the main owners of water sources used by slum residents located in privately owned land (89.7 percent), while in large slums D-WASA and NGOs own on average 26.8 percent and 20.5 percent of the drinking water sources used by slum residents, respectively.

Sanitation facilities used by slum residents in Dhaka are mainly installed by *mastaans* (62.6 percent), NGOs (20.0 percent), and private companies or slum residents (14.5 percent) (Table A6). Although *mastaans* are almost the exclusive providers of and investors in sanitation facilities in small- and medium-size slums, NGOs have been supporting several of these investments in large slums. In contrast to the case of water services, there is a much larger role for household investments in sanitation infrastructure particularly in large slums. If we look at these statistics by slum land ownership, we see that NGOs and households themselves have been much more pro-active to invest in sanitation infrastructure in government owned land compared to slums in privately owned land, suggesting that slums in government owned land might be perceived as safer investments. On the contrary, in slums where land ownership is unclear or that is owned by a non-government agency, investments in sanitation facilities have mainly come from NGOs, but few households have felt secure enough to invest in this asset.

To better understand service maintenance, two different questions were asked to households. First, households were asked about the management structure of their water sources and sanitation facilities. Second, households were asked about the existing mechanisms for reporting issues with the water source and sanitation facility. *Mastaans* rely heavily on community leaders for the day-to-day management of both water and sanitation facilities across all types of slums (Table A7). Responses to

perceived management and mechanisms for reporting issues were similar. Slum residents report issues dealing with malfunctioning water and sanitation facilities to community leaders (Table A8).

6.2 Payments for water and sanitation services

Mastaans also seem to depend heavily on community leaders and private individuals to collect water payments from slum households (Table 13). On average, 46 percent of payments for water services in medium-size slums are channeled through community leaders, while in large slums NGOs take some of the payment collection responsibility (16.8 percent). The use of community leaders to collect water payment is slightly more prevalent in slums located in privately owned land (around 40.3 percent) compared to those located in government owned land (34.5 percent). Interestingly, community leaders are responsible for collecting the water services payments from the poorest households, while better-off households tend to pay directly to the *mastaan* or NGOs operating in the slum.

Table 13. Water Payment: To whom do you pay?

	<i>Mastaan</i> (%)	D-WASA (Central Government) (%)	Private company/ person (%)	NGO (%)	Community leaders (%)	Others (%)
	(1)	(2)	(3)	(4)	(5)	(6)
All	13.3	5.5	24.5	13.6	35.0	8.2
By size of the slum						
Small slums	-	-	-	-	-	-
Medium size slums	12.5	8.3	16.7	0.0	46.0	16.5
Large size slums	13.5	4.8	26.3	16.8	32.3	6.2
t-test small-medium	-	-	-	-	-	-
t-test medium-large				**		
By land ownership						
Public	14.4	4.2	26.6	14.8	34.5	5.5
Private	0.0	19.9	0.0	0.0	40.3	39.8
Others	-	-	-	-	-	-
t-test public-private	***		**	**		
By per capita consumption expenditure						
Poorest	0.0	0.0	37.2	0.0	56.4	6.4
Second quintile	17.5	4.4	30.6	9.6	37.9	0.0
Third quintile	15.0	16.0	20.8	5.7	26.4	16.1
Fourth quintile	14.8	0.0	24.6	27.7	22.9	10.0
Richest	15.1	6.8	14.2	19.5	34.6	9.8
t-test poorest - richest	*	**				

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01. Others include tanker truck manager, water vendor, and other categories not specified.

Table 14 shows different measures of the size of payments made by slum households for water services. Column (1) reports the percentage of slum households who are renters. On average, 70.6 percent of slum households rent their housing structure. Among those slum households who rent, on average 89.2 percent have their water utilities included as part of the rent (Column 2). Therefore, rent inclusive of water services is a quite common arrangement in slums.¹⁷ In Column (3), we report the average payment for water services among slum households who report owning their housing structures. Although the proportion of slum households reporting they owned their housing structure is not very large (29.4 percent), these estimates provide a broad approximation that can serve as a reference on how much slum households pay to access water services. Slum households owning their housing structure pay on average Taka 169 monthly for water services (around USD 2). Access to water services is on average cheaper in larger slums at around Taka 155 per month compared to medium size slums where households pay on average Taka 308 monthly for these services – for small slums, no household reports owning their housing structure. These estimates should be interpreted with caution, however, as they are based on small sample sizes. In terms of quintiles of per capita distribution, slum households that are better off pay slightly more for water services compared to the poorest households. Lastly, as a share of total per capita consumption (food, non-food, and housing Column 4), slum households spend around 1 percent of their expenditures on water services and this amount is negatively correlated with the slum size – households in large slums spend 1 percent of their total per capita expenditure on water services while households in medium size slums pay almost 2 percent. Also, as expected, the average water payment budget shares are slightly lower for better-off households and higher for the poorest households.

Figure A4 shows how frequently payments for water services are collected from slum households who own their housing structure or pay for water services separately from their rent. Most households are charged monthly or weekly, with payments collected per use being relatively rare. The poorest households tend to pay per use or be charged weekly, while better-off households are almost always charged monthly. Similarly, households living in slums located in privately owned land are billed for water services on a weekly basis exclusively. This suggests that *mastaans* provide different rent payment frequencies to potential renters, perhaps based on their ability to pay.

¹⁷ Table A9 in the Appendix presents a summary of the utilities that are reported to be included as part of the housing rent payment by slum households who are renters. Results suggest that almost all renters have their water and electricity utilities automatically included in their rents as a fixed payment. In small slums and medium-size slums, almost without exception water is always included, while within larger slums some renters pay for their water services separately.

Table 14. Payments for water services

	Share of households who are renters (%)	Share of renters whose rent includes water utilities	By dwelling owners (in Taka per month)	Budget shares for dwelling owners (%)
	(1)	(2)	(3)	(4)
All	70.6	89.2	168.9	1.00
By size of the slum				
Small slums	96.6	100	-	-
Medium size slums	82.2	96.2	308.3	1.9
Large size slums	61.2	81.9	155.3	0.9
t-test small-medium	**	**		
t-test medium-large	***	**	**	
By land ownership slum				
Government	60.4	83.5	168.9	1.0
Private	93.0	97.5	-	-
Others	46.7	71.5	-	-
t-test public-private	***	**		
By per capita consumption expenditure				
Poorest	82.1	91.7	108.2	1.0
Second quintile	76.3	92.0	152.7	1.3
Third quintile	74.5	86.1	211.8	1.3
Fourth quintile	67.3	89.9	179.4	0.9
Fifth quintile	57.8	86.5	178.4	0.7
t-test poorest - richest	***			

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Budget shares are based on total household consumption (food, non-food, and housing).

Mastaans also rely largely on community leaders to collect payments for the use of the sanitation facilities by slum residents. On average, 77 percent of slum residents pay to community leaders for sanitation services (Table 15). While private companies act as collector agencies frequently for the provision of water services (24.5 percent), community leaders are almost exclusively responsible for collecting payments for using sanitation facilities. This trend does not vary across the different types of slum size, land ownership, or the socio-economic status of households.

Previously, we documented that a small fraction of slum renter residents paid a fixed monthly or weekly rent for using the sanitation facilities available in the slum (Table A9). Unlike water services, only 5.7 percent of slum residents who rent their dwelling report having the use of sanitation facilities included as part of their rent. In small slums, 17.9 percent of renters' report having the use of sanitation facilities included as part of their rent, which is consistent with the higher average rents paid by

residents in these slums compared to larger slums. In contrast, only 7.7 percent of renters in large slums report having the use of sanitation facilities included as part of their rent.

Table 15. Sanitation payment: To whom do you pay?

	<i>Mastaan</i> (%)	Private company/ person (%)	NGO (%)	Community leaders (%)	Others (%)
	(1)	(2)	(3)	(4)	(5)
All	17.9	2.0	1.6	77.0	1.5
	By size of the slum				
Small slums	0.0	75.0	0.0	25.0	0.0
Medium size slums	32.2	0.0	0.0	64.4	3.3
Large size slums	6.2	0.0	3.1	90.6	0.0
t-test small-medium					
t-test medium-large					
	By land ownership				
Public	4.5	0.0	4.5	86.9	4.1
Private	40.6	5.5	0.0	53.8	0.0
Others	5.9	0.0	0.0	94.1	0.0
t-test public-private					
	By per capita consumption expenditure				
Poorest	25.8	4.3	5.3	64.6	0.0
Second quintile	25.3	0.0	0.0	74.7	0.0
Third quintile	8.9	0.0	0.0	81.1	10.0
Fourth quintile	11.5	2.9	0.0	85.6	0.0
Richest	15.8	0.0	0.0	84.2	0.0
t-test poorest - richest					

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. Others include tanker truck manager and other categories not specified. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01.

Table 16 shows different measures of the magnitude of payments made by slum residents for sanitation services. Column (1) reports the amount paid per month on average by residents who are renters and do not have the use of sanitation facilities included as part of their rent. Column (2) report the amount paid per month on average by residents who are dwelling owners. Although the sample sizes are generally small, these numbers suggest that slum residents pay on average between 32 and 47 Takas per month for using the sanitation facilities available in slums, which represents between 0.2%-0.4% percent of the total household's budget share. The amount spent on sanitation services is substantially lower than the amount spent on water services – indeed, accessing water services costs households on average five times more than sanitation facilities. Access to sanitation facilities is almost two times higher in small slums compared to large slums and better-off households tend to spend slightly more on average in accessing these services. Households in privately owned land report paying

slightly more on average for sanitation services compared to those in government owned land, although they seem to share their facilities with a larger number of households. Lastly, payments for using sanitation services are billed to households monthly as a fixed amount, though in some cases such as in large and publicly owned slums residents are offered the possibility of paying for accessing the sanitation facilities weekly (Figure A5).

Table 16. Payments for use of sanitation facilities

	By renters who do not have service included in rent (in Taka per month)	By owners (in Taka per month)	Budget shares for renters who do not have service included in rent (%)	Budget shares for owners (%)
	(1)	(2)	(3)	(4)
All	48.2	36.3	0.4	0.2
By size of the slum				
Small slums	90	-	0.86	-
Medium size slums	47.4	48.3	0.39	0.2
Large size slums	43.6	33	0.25	0.2
t-test small-medium				
t-test medium-large				
By land ownership				
Public	48.7	32.7	0.4	0.2
Private	50.4	50.0	0.4	0.2
Others	35.0	40.0	0.2	0.3
t-test public-private				
By per capita consumption expenditure				
Poorest	44.2	20.0	0.45	0.2
Second quintile	41.5	30.0	0.39	0.2
Third quintile	55.3	37.8	0.28	0.3
Fourth quintile	52.5	47.1	0.29	0.2
Fifth quintile	53.8	38.4	0.3	0.2
t-test poorest - richest		**		

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01. Budget shares are based on total household consumption (food, non-food, and housing).

6.3 Provision of water services to slums by D-WASA

To the extent that formal markets for water services do not exist in slums, it is interesting to observe that D-WASA plays some role in water service provision, whether it be in installation, accountability, management, or payment of services. This is particularly true in large slums and might suggest that D-WASA is providing water points at the border of slums or even in some cases inside the slums. To explore this hypothesis, we look at the location of the main drinking water source for households who report receiving their water services directly from D-WASA in large slums. Table 17 shows these statistics estimated separately for four groups of slum residents: (i) those who report that D-WASA installed their water source; (ii) those who report that D-WASA manages their water source; (iii) those who report reporting issues with the water source to D-WASA; and (iv) those who report paying for water service to D-WASA.

Results suggest that between 50 to 65 percent of residents who report receiving water services from D-WASA, access this water source directly from their own dwelling, yard, or plot. Among those who pay for water services directly to D-WASA, more than 82 percent have the water source installed directly in their own yards or plots. Overall, these estimates suggest that D-WASA is not only installing water sources in the border of slums but might be providing direct services to some slum households, albeit the share benefiting from this direct service is very small (between 5.5 and 17.5 percent of slum residents).

Table 17. Location of water sources reported by D-WASA clients

	D-WASA ...			
	installed water source (%)	manages water source (%)	is accountable for water source (%)	collects payment (%)
	(1)	(2)	(3)	(4)
In own dwelling	14.6	7.9	8.3	-
In own yard/plot	50.7	38.2	42.0	82.3
Elsewhere - outside slum	10.9	19.0	27.1	17.7
Elsewhere - somewhere inside slum	23.8	34.9	22.7	-
Share of slums households (%)	17.5	9.3	4.2	5.5

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. Accountable for water sources refers to if your water source is not functioning and you or any of your neighbors cannot fix it, who would you report the problem to.

7. Discussion

This paper focuses on measuring access levels to water and sanitation and assessing “informality” of service markets in the slums of Dhaka, Bangladesh. Given the lack of formal mandates of public utilities to serve slum areas, we interestingly find that overall access to water and sanitation in slums is quite high. Access to improved water is nearly universal at 97 percent, and about 86 percent of households use shared or unshared improved sanitation technology. These results seem to be consistent with findings from other surveys with slum disaggregation in Bangladesh (NIPORT et al 208; 2015 and UNICEF 2015). Water and sanitation services are mostly provided by non-regulated providers, with evidence to support claims of “informality” and strong presence of local middlemen providers. We find a mix of actors that play the role of service providers in terms of installation, management, payment collection, and accountability. The data suggest that *mastaans* (local landlords or middlemen) install close to 58 percent of water services and 63 percent of sanitation facilities. Most households report that water services are included in the monthly rent, paid directly to the *mastaan*/landlord, while use of sanitation facilities is paid for in a diverse number of ways (e.g. rent, pay-per-use, etc.). D-WASA, the local utility, seems to have a limited role in the overall spectrum of service delivery. These findings should inform opportunities for government intervention to provide sustainable water and sanitation services such as formalized mandates and clearer roles for utilities and private entities.

The high access numbers to basic water and sanitation infrastructure mask important quality issues. For instance, although the clear majority of households (94.8 percent) use piped water connections for their main drinking water source, 12.2 percent of slum households report that their water source was not functional for at least one full day in the previous two weeks. Service interruption can be a sign of leakages and malfunctioning pipes that compromise water quality and heighten risks to public health and safety (Shams et al 2016; Ecrumen et al 2015). Although this survey did not measure water contamination, over half of the households report issues related to poor water quality. Likewise, other studies have found that piped water supply is one of the most heavily contaminated types of water sources in Bangladesh even compared to surface water sources such as ponds or rivers (World Bank 2018; UNICEF 2014; Pickering et al 2014). The 2013 MICS survey, for example, finds that 55 to 82 percent of all piped water sources in Bangladesh were found to have *E. coli* bacteria (UNICEF 2014). Although piped water technology offers convenience and time-savings for households, its benefits cannot be fully realized without proper management and maintenance. Informal connections to piped

water could be putting slum communities at higher risk for drinking contaminated water. Point-of-tap water treatment, such as the adoption of automated chlorination systems on taps, could be a viable solution and should be further tested in slum settings (Pickering et al. 2015). Contamination of drinking water can additionally happen within the household particularly due to unhygienic handling practices and unsanitary environments. However, this study finds that only a quarter of all slum households reported treating their water. In addition to improved regulation of piped water supply, it is imperative to implement behavior-change interventions that encourage households to properly handle and treat drinking water supply before consumption.

On sanitation, open defecation and use of unimproved sanitation technology seem to be minimal in Dhaka slums, with less than 15 percent of households reporting access to hanging toilets or unimproved latrines. However, unsurprisingly, there is a high dependence on shared or public toilets. Over 90 percent of households share their sanitation facilities, and the average number of households to sanitation facility is 16 to 1. Moreover, shared sanitation cannot be considered as improved sanitation adhering to JMP standards. When excluding improved sanitation that is shared between two or more households, access to improved sanitation is limited to merely 8.6 percent. These findings suggest that slums will not be able to meet the improved sanitation target of 100 percent set by SDG-6 because sharing of sanitation facilities seems to be inevitable in these areas due to space constraints. They also suggest that if slums are to be prioritized in the SDG agenda, policy makers would need to develop sanitation targets that can be feasibly achieved in slums. This target could be adaptable to shared sanitation facilities, with the aim of at least reducing the sharing ratio and improving management of public toilets. Furthermore, rather than focusing on building more toilets, a better approach could be to focus on improving sustainability and overall fecal sludge management, where sewage from sanitation facilities is regularly emptied, transported, and safely treated. When considering fecal sludge management, we estimate that only 2 percent of these households have access to the JMP's conceptualization of "safely managed sanitation." The issue of safe fecal sludge management is not limited to only slum communities. One study estimates that 2 percent of the human excreta in Dhaka is safely managed, while the rest is discharged into open water. This is mostly due to the lack of regular maintenance of on-site sanitation facilities such as pit latrines and septic tanks (Blackett, Hawkins, and Heymans 2014). Policy makers have urged for better fecal sludge management by implementing city-wide sanitation initiatives that are inclusive to both on-site and off-site sanitation technologies. It is vital that slum communities are also included in these strategies.

Resilience of water and sanitation infrastructure also seems to be a major issue in slums, particularly during monsoon seasons. About a third of slum households report that they were unable to access their water source during flooding, and among those households that are affected, the average number of days that they are unable to access their water source during a flood is 10 days. Sanitation is similarly unreliable, with nearly half of all households reporting that their sanitation facility is inaccessible during flooding. On average, affected households report that they are unable to use their sanitation facility for 9 days. These water and sanitation service delivery failures may particularly be contributing to risks of contracting waterborne illnesses. Better drainage and pervious landscaping are needed to prevent flooding, but regular maintenance by skilled staff is essential to increasing resilience of water and sanitation infrastructure. However, the lack of formal service providers in slum communities is a unique barrier to improving operational maintenance.

In addition, we find that there are significant differences related to water and sanitation across welfare groups. Relatively wealthier slum households can treat their drinking water more often, are able to pay for water and sanitation services on a monthly basis (rather than weekly basis), share their sanitation facilities with fewer people, and report overall more satisfaction with the level of privacy of their sanitation facilities. Interestingly, relatively better-off households also report issues with water more often compared to poorer households and disproportionately report water and sanitation services issues after flooding events.

This study also highlights inequalities across slums based on the characteristics of the community itself, such as the size of the slum and whether the slum is located on private or public land. For instance, households living in larger slums are more likely to face threats of eviction and experience more crowding. On the other hand, residents living in larger slums are also more likely to be able to take advantage of the variety of providers for water and sanitation services such as NGOs and government services compared to *mastaans* who have monopolistic power in small slums and most medium slums.

Finally, this study responds to knowledge gaps on understanding basic characteristics of slum populations. We provide a snapshot of the heterogeneity of slum populations and give evidence that slum communities are vulnerable for a multitude of reasons, such as from threats of eviction and lack of quality services. Slums are not a transitory place for migrants, with household heads, on average, reporting about 11 years of residence in the community. There seems to be a mix of consumption patterns, illustrating that not every household is living under the national poverty line and households

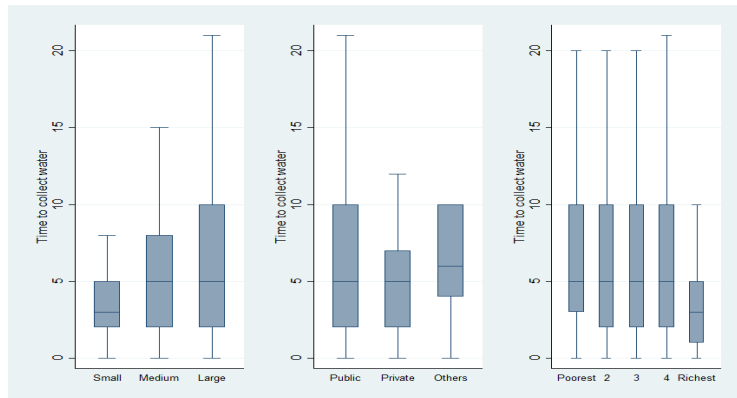
are making conscious trade-offs between financial gains and living conditions. Previous studies have illustrated the salient health inequalities between slum populations and other urban and rural populations (NIPORT et al 2008; 2015; UNICEF and BBS 2015). These poorer health outcomes could be a function of welfare status, but are also likely the product of an environment that poses extreme exposure risks to health. Slum communities will need to be a focal population in sustainable development strategies limited not only to poverty reduction, but also to improving health, equitable access to basic services, and economic, social, and environmental resilience. Doing this will require better monitoring and research efforts that can better describe the unique problems slum residents face as well as the institutions and stakeholders that impact their communities.

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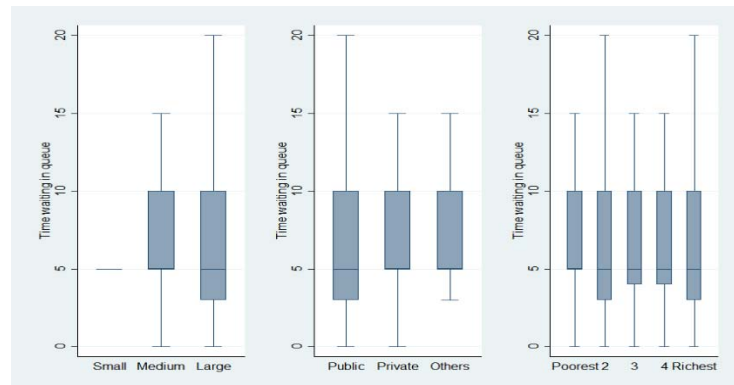
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Figure A1. Time to collect water from main drinking water source (in minutes)



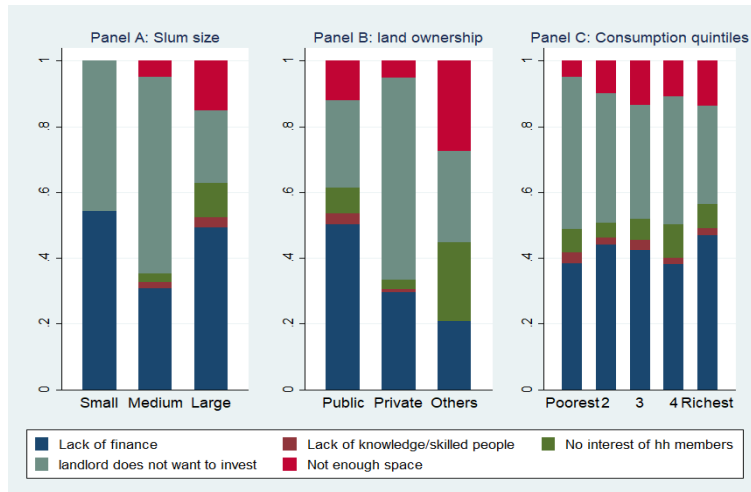
Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption.

Figure A2. Time waiting to get access to sanitation facility (in minutes)



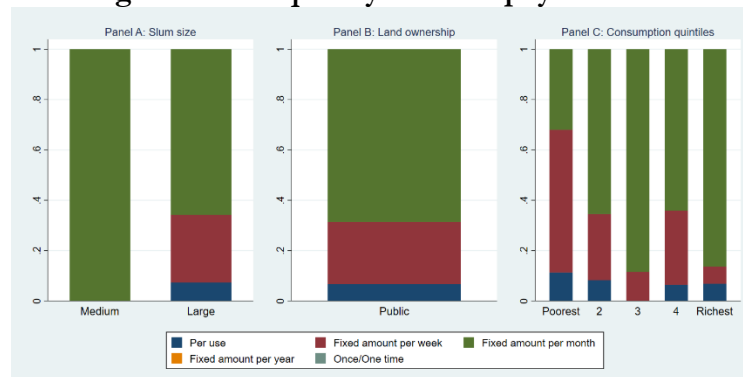
Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption.

Figure A3. Main challenges for upgrading sanitation facilities



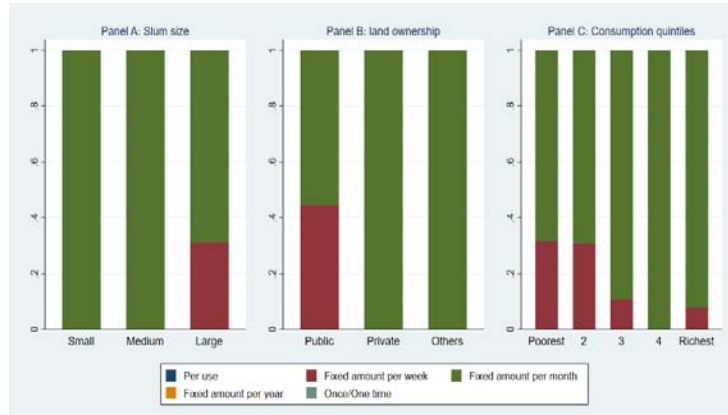
Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption.

Figure A4. Frequency of water payments



Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. These statistics were computed using owners and renters who do not have the use of sanitation facilities included as part of their rents.

Figure A5. Frequency of sanitation payments



Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. These statistics were computed using owners and renters who do not have the use of sanitation facilities included as part of their rents.

Table A1. Summary statistics by land ownership

	Public	Private	Public, Others, Do not know	All	t-test	t-test
	(1)	(2)	(3)	(4)	(1)-(2)	(2)-(3)
Monetary poverty						
Distribution of slum households (%)	60.8	33.5	5.7	100	-	-
Monthly per capita expenditure (in Taka)	4,165	4,772	5,125	4,410		
Demographics and human capital						
Household size	4.3	4.2	4.0	4.3		
Dependency ratio (%)	73.6	74.0	45.5	72.1		***
Age of household head	39.9	40.7	40.9	40.2		
Female household head (%)	13.7	13.9	20.0	14.1		
Duration of residence hhold head (years)	11.9	7.1	19.8	10.7	**	*
Literacy rate for adults (%)	48	44.6	53.5	47.2		
Completed primary school for adults (%)	18.0	17.3	18.6	17.5		
School attendance children 7-12 years (%)	83.1	81.2	66.7	82.0		**
Household received relief program (%)	6.1	2.4	0	4.5		
Labor markets						
Share of male adults who are earners (%)	87.6	91.4	90.2	89.0		
Share of female adults who are earners	49.0	54.9	37.8	50.1		
Main source of income from industry (%)	14.0	3.6	13.3	10.5	***	
Main source of income from services (%)	86.0	96.4	86.7	89.5	***	
Housing						
Per capita rooms	0.3	0.3	0.4	0.3		***
Room size (in sq. meters)	12.0	11.9	8.5	11.8		***
Share of renters (%)	60.4	93.0	47.0	70.6	***	**
Monthly rent (in Taka)	2,198	2,932	2,879	2,548	***	
Has separate kitchen (%)	66.2	92.1	36.7	73.2	***	**
Fear of eviction (%)	68.6	14.1	63.3	50.1	***	***
Permanent dwelling structure (%)	5.6	14.7	63.3	11.9	*	*
Semi-permanent dwelling structure (%)	23.8	42.4	3.3	28.8	*	***
Tin-shed dwelling structure (%)	70.5	42.9	33.4	59.2	**	
Jhupri dwelling structure (%)	0.1	0.0	0.0	0.1		
Small size slum (%)	0.6	5.6	0.0	2.3	***	***
Medium size slum (%)	18.2	88.8	0.0	40.8	***	***
Large size slum (%)	81.2	5.7	100.0	57.0	***	***
Access to basic services						
Improved drinking water (%)	98.7	94.7	95.2	97.2		
Improved sanitation, JMP definition (%)	8.7	8.2	10.0	8.6		
Improved sanitation, including shared	80.7	99.5	70.0	86.4	***	
Electricity is main source of light (%)	93.8	99.5	100	96.1	*	

Notes: Bangladesh Urban Informal Settlements Survey 2016. All summary statistics were computed using household weights except for mean monthly per capita expenditure (in Taka), age, literacy rate for adults, completed primary school for adults, school attendance for children 7-12 years, percentage of male adults who are earners, percentage of female and male adults who are earners, which were computed using population weights. The t-test columns show the results from Wald tests testing whether the difference in means/proportions between slums in public and privately-owned land are significant at * p<0.1, ** p<0.05, *** p<0.01.

Table A2. Summary statistics by quintiles of per capita household expenditure

	Poorest	Q2	Q3	Q4	Richest	All	t-test poorest - richest
Monetary poverty							
Distribution of slum households (%)	16.7	18.7	19.3	21.3	24.0	100	-
Mean monthly per capita expenditure (in Taka)	2,290	3,091	3,831	4,779	8,108	4,410	***
Demographics and human capital							
Household size	5.3	4.6	4.4	4.1	3.6	4.3	***
Dependency ratio (%)	120.4	75.9	75.7	63.4	48.8	72.1	***
Age of household head	41.8	40.6	39.7	40.9	39.1	40.2	
Female household head (%)	16.7	14.9	13.3	15.7	11.6	14.1	
Duration of residence hhold head (years)	9.4	9.7	9.5	11.1	12.6	10.7	
Literacy rate for adults (%)	33.7	37.5	45.1	47.2	61.8	47.2	***
Completed primary school for adults (%)	10.0	13.7	16.8	19.8	22.5	17.5	***
School attendance for children 7-12 years (%)	69.0	78.7	87.6	89.7	90.6	82.0	***
Household received relief program (%)	5.2	7.5	3.6	4.0	3.2	4.5	
Labor markets							
Share of male adults who are earners (%)	90.5	87.9	92.2	86.9	88.6	89.0	
Share of female adults who are earners (%)	55.2	57.0	50.9	51.9	39.3	50.1	***
Main source of income from industry (%)	11.7	17.1	13.7	9.2	4.3	10.5	
Main source of income from services (%)	88.3	82.9	86.3	90.8	95.7	89.5	
Housing							
Per capita rooms	0.2	0.3	0.3	0.4	0.4	0.3	***
Room size (in sq. meters)	11.1	11.6	11.7	12.4	11.8	11.8	
Share of renters (%)	86.6	75.4	73.3	68.6	58.8	70.6	***
Monthly rent (in Taka)	1920	2425	2722	2774	2877	2548	***
Has separate kitchen (%)	72.3	72.1	67.3	71.1	80.2	73.2	
Government owned land (%)	58.0	62.3	72.1	61.6	52.7	60.8	
Non-government and private owned land (%)	37.9	34.5	25.0	30.4	39.0	33.5	
Others and do not know who owns land (%)	4.1	3.2	3.0	8.0	8.3	5.7	
Fear of eviction (%)	37.7	49.7	59.3	47.4	52.1	50.1	*
Permanent dwelling structure (%)	4.9	4.3	9.8	14.9	19.7	11.9	**
Semi-permanent dwelling structure (%)	26.2	26.5	29.9	32.0	28.5	28.8	
Tin-shed dwelling structure (%)	68.8	69.2	60.4	52.8	51.8	59.2	*
Jhupri dwelling structure (%)	0.0	0.0	0.0	0.4	0.0	0.1	
Small size slum (%)	4.4	3.0	0.8	1.1	2.6	2.3	
Medium size slum (%)	42.6	41.2	37.0	40.3	42.6	40.8	
Large size slum (%)	53.0	55.8	62.2	58.6	54.8	57.0	
Access to basic services							
Access to improved drinking water (%)	93.1	94.4	98.2	97.6	100.0	97.2	
Improved sanitation, JMP definition (%)	4.6	7.3	6.0	6.7	16.1	8.6	**
Improved sanitation, including shared (%)	83.2	91.9	82.5	83.8	89.8	86.4	
Electricity is main source of light (%)	93.2	93.6	97.4	96.4	97.9	96.1	

Notes: Bangladesh Urban Informal Settlements Survey 2016. All summary statistics were computed using household weights except for mean monthly per capita expenditure (in Taka), age, literacy rate for adults, completed primary school for adults, school attendance for children 7-12 years, percentage of male adults who are earners, percentage of female and male adults who are earners, which were computed using population weights. The t-test columns show the results from Wald tests testing whether the difference in means/proportions between slum households in the quintiles 1 and 5 of the per capita household consumption distribution are significant at * p<0.1, ** p<0.05, *** p<0.01.

Table A3. Who installed the drinking water source?

	<i>Mastaan</i> (%)	D-WASA/ DPHE (Central Government) (%)	Private (%)	Mosque/ school/ clinic (%)	NGO (%)	Community leaders (%)	Others (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
All	56.8	17.3	3.4	2.6	12.9	3.9	3.0
By size of the slum							
Small slums	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Medium size slums	80.6	5.0	2.3	0.4	3.0	6.3	2.3
Large size slums	38.0	26.8	4.3	4.3	20.5	2.3	3.7
t-test small-medium	***					**	
t-test medium-large	***	***			***		
By land ownership							
Public	39.5	26.9	5.6	0.6	20.6	3.6	3.1
Private	89.7	2.3	0.0	0.5	0.0	5.2	2.3
Others	46.7	3.3	0.0	36.6	6.7	0.0	6.7
t-test public-private	***	***			***		
By per capita consumption expenditure							
Poorest	63.1	11.4	4.4	1.1	12.5	4.0	3.4
Second quintile	56.0	18.8	3.1	2.0	16.5	2.7	0.8
Third quintile	51.9	25.0	4.4	3.0	8.8	3.4	3.6
Fourth quintile	55.7	13.2	2.7	2.7	16.5	4.9	4.3
Richest	57.8	17.7	2.9	3.8	10.6	4.3	2.9
t-test poorest - richest							

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01. Others include not applicable, use surface water, and do not know.

Table A4. Who manages the main drinking water source?

	<i>Mastaan</i> (%)	D-WASA/ DPHE (Central Government) (%)	Private (%)	Mosque/ school/ clinic (%)	NGO (%)	Community leaders (%)	Others (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
All	59.0	9.5	6.6	2.3	2.3	19.3	1.0
By size of the slum							
Small slums	51.7	17.2	0.0	0.0	0.0	31.0	0.0
Medium size slums	62.9	7.4	2.7	0.4	0.0	25.5	1.2
Large size slums	56.5	10.8	9.7	3.7	4.0	14.4	1.0
t-test small-medium							
t-test medium-large					*		
By land ownership							
Public	55.6	12.7	10.4	0.0	3.8	16.7	0.9
Private	67.2	4.9	0.9	0.5	0.0	25.1	1.4
Others	46.7	3.3	0.0	36.6	0.0	13.3	0.0
t-test public-private			**				
By per capita consumption expenditure							
Poorest	58.4	5.5	10.1	0.0	0.0	26.0	0.0
Second quintile	60.5	9.7	9.2	1.0	2.2	17.3	0.0
Third quintile	53.0	12.3	8.2	3.0	2.0	19.8	1.8
Fourth quintile	58.2	10.2	3.6	2.7	5.0	18.7	1.6
Richest	63.7	9.3	3.7	3.8	1.7	16.3	1.4
t-test poorest - richest							

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01. Others include not applicable, use surface water, and do not know.

Table A5. Who would you report issues with water services to?

	<i>Mastaan</i> (%)	D-WASA/ DPHE (Central Government) (%)	Private (%)	Mosque/ school/ clinic (%)	NGO (%)	Community leaders (%)	No one (%)	Others (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All	54.2	4.2	4.5	1.0	2.1	20.6	11.1	2.3
By size of the slum								
Small slums	65.5	0.0	0.0	0.0	0.0	31.0	3.4	0.0
Medium size slums	55.2	2.3	2.7	0.0	0.0	23.5	11.7	4.6
Large size slums	53.1	5.7	6.0	1.7	3.7	18.1	11.0	0.7
t-test small-medium								
t-test medium-large					*			
By land ownership								
Public	52.5	5.4	6.9	0.0	3.5	19.4	12.0	0.3
Private	60.4	2.8	0.9	0.0	0.0	22.7	7.5	5.6
Others	36.7	0.0	0.0	16.7	0.0	20.0	23.3	3.3
t-test public-private			*		*			
By per capita consumption expenditure								
Poorest	60.3	3.4	6.7	0.0	0.0	23.2	6.5	0.0
Second quintile	58.4	7.6	4.1	1.0	1.2	17.5	9.3	0.8
Third quintile	54.7	6.6	4.2	0.0	0.0	26.7	6.2	1.6
Fourth quintile	52.6	3.6	4.5	1.8	6.8	19.4	9.9	1.5
Richest	47.9	0.8	3.7	1.6	1.8	17.3	20.8	6.1
t-test poorest - richest							***	*

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01. Others include not applicable, use surface water, and do not know.

Table A6. Who installed this toilet facility?

	<i>Mastaan</i> (%)	D-WASH D-PHE (%)	Private (%)	NGO (%)	Community leaders (%)	Households (%)	Others (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
All	62.6	1.0	0.5	20.0	0.5	14.5	0.9
By size of the slum							
Small slums	96.6	0.0	0.0	0.0	0.0	3.4	0.0
Medium size slums	83.0	0.0	0.8	4.3	0.8	10.8	0.4
Large size slums	46.7	1.7	0.3	31.9	0.3	17.6	1.3
t-test small-medium	**						
t-test medium-large	***	**		***			
By land ownership							
Public	48.6	1.6	0.8	27.8	0.3	19.9	0.9
Private	93.0	0.0	0.0	0.0	0.9	5.6	0.5
Others	33.4	0.0	0.0	53.3	0.0	10.0	3.3
t-test public-private	***	**		***		***	
By per capita consumption expenditure							
Poorest	74.0	0.0	0.0	19.4	0.0	5.5	1.1
Second quintile	67.9	2.2	1.9	16.5	1.0	9.5	1.0
Third quintile	66.5	1.0	0.0	19.6	0.0	12.0	1.0
Fourth quintile	51.4	0.9	0.7	30.3	0.0	16.0	0.7
Richest	57.5	0.8	0.0	14.2	1.3	25.4	0.8
t-test poorest -	*					***	

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01.

Table A7. Who manages this toilet?

	<i>Mastaan</i> (%)	D-WASA/ DPHE	Private (%)	NGO (%)	Community leaders (%)	Household (%)	Others (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
All	51.3	0.2	0.5	1.5	19.8	24.5	2.1
By size of the slum							
Small slums	48.3	0.0	0.0	0.0	31.0	20.7	0.0
Medium size slums	55.6	0.4	0.4	0.0	25.9	13.1	4.6
Large size slums	48.4	0.0	0.7	2.7	15.0	32.9	0.3
t-test small-medium				**			
t-test medium-large						***	
By land ownership							
Public	48.6	0.0	0.9	2.5	13.0	34.1	0.8
Private	59.3	0.5	0.0	0.0	26.0	9.6	4.7
Others	33.4	0.0	0.0	0.0	56.6	10.0	0.0
t-test public-private			*	**		***	
By per capita consumption expenditure							
Poorest	60.4	0.0	1.1	1.1	23.9	13.4	0.0
Second quintile	59.1	0.0	1.9	1.0	17.3	19.0	1.7
Third quintile	49.4	0.8	0.0	1.0	20.6	26.6	1.6
Fourth quintile	48.1	0.0	0.0	4.5	21.9	24.0	1.5
Richest	43.4	0.0	0.0	0.0	16.6	35.3	4.7
t-test poorest - richest	*					***	

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. Others include mosque/school/clinic, and other categories not specified. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01.

Table A8. Who you report issues related to your toilet facility?

	<i>Mastaan</i> (%)	Private (%)	NGO (%)	Community leaders (%)	No one (%)	Others (%)
	(1)	(2)	(3)	(4)	(5)	(6)
All	55.9	0.6	1.9	21.7	15.4	4.5
By size of the slum						
Small slums	65.5	0.0	0.0	31.0	3.4	0.0
Medium size slums	57.9	0.0	0.0	25.9	11.2	5.0
Large size slums	54.1	1.0	3.4	18.4	18.8	4.4
t-test small-medium		*	*			
t-test medium-large						
By land ownership						
Public	54.0	0.9	3.1	16.4	21.5	4.1
Private	63.3	0.0	0.0	25.6	5.1	6.1
Others	33.4	0.0	0.0	56.6	10.0	0.0
t-test public-private		*	*		***	
By per capita consumption expenditure						
Poorest	64.7	1.1	1.1	24.1	8.9	0.0
Second quintile	62.1	1.0	2.0	17.3	12.4	5.1
Third quintile	57.0	0.0	3.0	25.5	11.0	3.6
Fourth quintile	52.4	0.9	2.7	22.8	15.4	5.7
Richest	47.2	0.0	0.8	19.6	25.6	6.8
t-test poorest - richest	*				***	*

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * p<0.1, ** p<0.05, *** p<0.01.

Table A9. Share of renters whose rent payments includes utilities (%)

	Water	Sanitation	Electricity	Gas
	(1)	(2)	(3)	(4)
All	89.2	5.7	85.7	66.1
By size of the slum				
Small slums	100.00	17.9	82.1	85.7
Medium size slums	96.2	2.8	91.1	75.6
Large size slums	81.9	7.7	80.8	55.8
t-test small-medium	**			
t-test medium-large	**			*
By land ownership				
Government	83.5	7.4	82.9	49.4
Private	97.5	3.5	89.7	85.4
Others	71.5	7.1	78.6	71.5
t-test public-private	**			***
By per capita consumption expenditure				
Poorest	91.7	7.0	89.0	62.1
Second quintile	92.0	6.2	83.3	60.4
Third quintile	86.1	6.7	84.9	63.8
Fourth quintile	89.9	4.5	86.9	71.6
Fifth quintile	86.5	3.9	84.5	72.8
t-test poorest - richest				

Notes: Bangladesh Urban Informal Settlements Survey 2016. Small size slums include 5-10 households, medium size slums include 11-200 households, and large size slums include more than 200 households. Quintiles are estimated based on per capita household consumption. The t-tests rows show the results from Wald tests testing whether the difference in means/proportions are significant at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.