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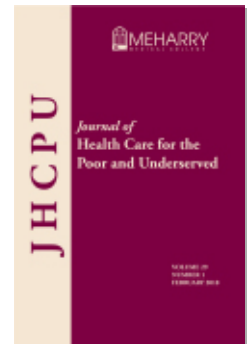
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Water, Sanitation and Hygiene Situation in Kenya's Urban Slums

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Abstract: Kenya has undergone rapid urbanization as people migrate to the cities in search of economic opportunities. This has given rise to informal settlements characterized by overcrowding, poor infrastructure, and inadequate social amenities. A cross-sectional study on water, sanitation, and hygiene (WASH) status was carried out in Mathare, an informal settlement in Nairobi. A random sample of 380 households was used. The average household size was five people, and 26% of the household heads had completed secondary or higher level of education. The main source of income (70%) was self-employment with 41% of the households living on less than 1.5 USD per day. The WASH situation in the urban slums is below the minimum standard recommended by the World Health Organization (WHO). There is need to improve the situation by improving and installing basic infrastructure including water, sanitation, and solid waste collection.

Key words: Sanitation, water, hygiene, urbanization, poverty, informal settlement, slums, Kenya.

Adequate sanitation, together with good hygiene and safe water, are fundamental to good health and socioeconomic development.¹ By 2010, sub-Saharan Africa together with four other regions did not meet the Millennium Development Goal (MDG) concerning access to improved drinking water.² Over two billion people have gained access to improved sanitation since 1990, however the global sanitation target was missed by almost 700 million people. This means that one in three (2.4 billion) people have no access to improved sanitation; most of these people are in sub-Saharan Africa, Southern Asia, and Eastern Asia. Overall, one in five people practice open defecation.³

A vast majority of people without improved sanitation (70%) live in rural areas. Nonetheless, this situation is changing due to the focus of sanitation agencies in rural areas coupled with rapid and uncontrolled explosion of urban population. Evidently, most of the developing countries did not meet the 7th MDG whose target 7 was to halve the proportion of people without access to basic sanitation and safe drinking water by 2015 from the 1990 levels.³ In developing regions, only half of the population has

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access to improved sanitation, the overall situation has deteriorated with the number of people without sanitation increasing by over 30% in the last two decades.⁴

Over 90% of the one billion people living in slums or informal settlements are in low and middle income countries.⁵ The growth in informal settlements has been attributed to high rates of rural urban migration at rates unanticipated in the urban development projections. For example, in 1971, only a third of Nairobi's population was living in informal settlements. It is estimated that between 60% and 70% of Nairobi residents live in slums. Incidentally, the Nairobi's informal settlements occupy only 5% of the city's 684 square kilometres. Slum infrastructure remains inadequate since government policy does not support development in informal settlements. Consequently, the Kenyan urban poor living in informal settlements live in inadequate housing and have little access to clean water and proper sanitation. This situation puts their health and that of the neighboring communities at risk.^{6,7,23}

The world's poorest people bear the heaviest burden from lack of proper sanitation. Diarrhea, one of the consequences of inadequate water supply and sanitation facilities, is the leading cause of death among children in Africa and the second globally.⁸ About 90% of all diarrheal cases are attributed to inadequate water supply. Approximately 37,500 Kenyans including 27,400 children aged younger than five years die each year from diarrhea.²⁴ Diarrhea has been cited as the major factor responsible for the slow decline in child mortality rates in Kenya. At 1.5% annual decline against a target of 4.4%, Kenya was unlikely to achieve the MDG 4 targets.⁹ Besides diarrhea, inadequate sanitation has a significant impact on malnutrition, malaria, and acute respiratory infections, which are among the leading causes of child mortality.⁸

To address poor sanitation status in the slums, a number of interventions have been tried out. For instance, Urban Community Led Total Sanitation pioneered by Plan International has been piloted in Mathare Slums.¹⁷

Methods

A cross-sectional study was conducted in the Mathare informal settlement in Nairobi, Kenya's capital, in May 2012. Mathare is one of the four clustered informal settlements in Starehe Sub County of Nairobi County. It is an urban area seven kilometers Northeast of Nairobi's central business district with a cosmopolitan population drawn from most of the ethnic communities of Kenya. The seven-village settlement has a population of 153,000 of whom 35% are women of reproductive age while 18% are children under five years.¹⁰

Four of seven villages that constitute Mathare slums were randomly selected. A minimum sample size of 380 was calculated using appropriate sample size estimation methods.¹¹ The number of households to participate in the survey from each village was proportionately determined and individual households identified using systematic random sampling. A household questionnaire was administered by trained data collectors to heads of households to get data on the respondents' knowledge, attitude, household behaviour and practices on selected WASH aspects. Informed consent was sought from respondents before administration of questionnaire. The objective of the study was to gain an understanding of the WASH situation in the slums.

Results

Demographic characteristics. The average age for respondents was 34.6 years ($SD = 10.9$). A majority of respondents were females (67%), and 36% had completed secondary level of education. Sixty-seven percent were married while 20% had never been married. The average household size was 5 (61% of households had children younger than five years). Overall, 19% of the household population were children younger than five years. The main source of household income was self-employment (70%) in small businesses ranging from dressmaking to green grocers while forms of formal employment ranged from casual labor in construction industry to shop attendants. A majority of the households (59%) had a monthly income of Kenya Shillings (KES) ≥ 4000 (USD 50). Less than a quarter (23%) lived in their own houses, the rest rented at average of KES 2018 (USD 25.2) a month. Most homeowners (63%) feared that they could be evicted any time from their houses owing to lack of title deeds (Table 1).

Water supply and access. Residents obtained water for domestic use from public standpipes (84%) and water peddlers (16%). Roof catchment of rainwater was not mentioned by any respondent despite majority of households having an iron-sheet roof (88%). The average consumption was 65.5 liters per household (median 60 liters) which translates to 14.6 liters per capita per day. About 1 in 5 respondents got water all the time without interruption while the rest had erratic water supply. The residents had spent an average of five days without water a fortnight prior to the study. During downtimes, 9% waited until water was available while the rest sought alternative sources (52% piped water ferried from other areas, 21% water vendors, 16% borehole, and 2% distant stand pipes).

Most (87%) households paid for water. The average cost of water was KES 3.3 (US Cents 4.13) per 20 liters (median = KES 2.0). This amount is paid to the vendors who are usually private businesses who are metred by the water company. There was a negative correlation between the amount of water used and the cost of water ($r = -0.24$, $p < .001$). The association between the water cost and consumption was statistically significant ($p < .001$). For every 1 KES (1.25 US cents) increase in the cost of water, the household water consumption was reduced by 1.8 liters as shown in Figure 1 below.

All households stored water to safeguard against the erratic supplies (58% did not have water throughout). Most households (93%) had narrow mouthed storage containers (<3 cm opening) and 58% had wide mouthed containers. All containers had covers in 67% of the households, 30% had some containers covered while containers in the rest had no covers. Generally, narrow mouthed containers were more likely to be covered than wide mouthed ones. Many households (97%) place the water storage containers on the floor without any form of elevation. Majority (46%) draw water by tilting the container with over 13% drawing water by dipping. Less than a third (32%) of the household treated drinking water with 58% treating by chlorination and 38% by boiling (Table 2).

Sanitation facilities. Almost one in every 20 households had no access to a sanitation facility. The main sanitation facilities were pour flush toilets (72%) connected to a sewer line, septic tank or draining into a river. Only 17% of the facilities were designated for use for a particular gender. Most of the facilities were shared among households

Table 1.
DEMOGRAPHIC CHARACTERISTICS

Variable	Village				Overall (n=380)
	Mtoni (n=130)	Polisi (n=77)	Mabatini (n=57)	Mashimoni (n=116)	
Age of respondent					
Average	36.9	38.90	35.5	28.42	34.6
Median	36.0	36.00	31.0	28.00	32.0
HHs with children <5 years old	57.7%	41.6%	82.5%	65.5%	60.5%
Sex of respondent					
Female	61(46.9%)	46(59.7%)	42(73.7%)	106(91.4%)	255(67.1%)
Male	69(53.1%)	31(40.3%)	15(26.3%)	10(8.6%)	125(32.9%)
Marital status					
Married	89(68.5%)	52(67.5%)	33(57.9%)	81(69.8%)	255(67.1%)
Separated or Divorced	10(7.7%)	5(6.5%)	10(17.5%)	10(8.6%)	35(9.2%)
Single	31(23.9%)	10(13%)	14(24.6%)	20(17.2%)	75(19.7%)
Windowed	0(0%)	10(13%)	0(0%)	5(4.3%)	15(4%)
Highest level of education completed					
None	0(0%)	16(20.8%)	18(31.6%)	16(13.8%)	50(13.2%)
Primary	94(72.3%)	36(46.8%)	15(26.3%)	50(43.1%)	195(51.3%)
Secondary	31(23.9%)	25(32.5%)	24(42.1%)	45(38.8%)	125(32.9%)
Tertiary	5(3.9%)	0(0%)	0(0%)	5(4.3%)	10(2.6%)
Main source of income					
Employed	35(26.9%)	26(33.8%)	28(49.1%)	26(22.4%)	115(30.3%)
Self employed	95(73.1%)	51(66.2%)	29(50.9%)	90(77.6%)	265(69.7%)
Monthly income					
Below KES 4000	10(7.7%)	55(71.4%)	25(43.9%)	65(56%)	155(40.8%)
KES 4000–6000	61(46.9%)	15(19.5%)	9(15.8%)	30(25.9%)	115(30.3%)
Above KES 6000	59(45.4%)	7(9.1%)	23(40.4%)	21(18.1%)	110(29%)
Size of household					
Average	3.7	4.1	4.9	5.4	4.5
Median	4.0	4.0	5.0	5.0	4.0
House ownership					
No	89(68.5%)	62(80.5%)	46(80.7%)	96(82.8%)	293(77.1%)
Yes	41(31.5%)	15(19.5%)	11(19.3%)	20(17.2%)	87(22.9%)
Monthly rent					
Mean (KES)	1,731	1,876	2,874	1,966	2,018
Median (KES)	1,700	1,750	2,000	2,000	1,700
Likelihood of eviction among homeowners (n = 87)					
Don't know	0(0%)	5(33.3%)	5(45.5%)	10(50%)	20(23%)
Not likely	11(26.8%)	0(0%)	1(9.1%)	0(0%)	12(13.8%)
Likely	30(73.2%)	10(66.7%)	5(45.5%)	10(50%)	55(63.2%)

Note

KES= Kenya Shillings

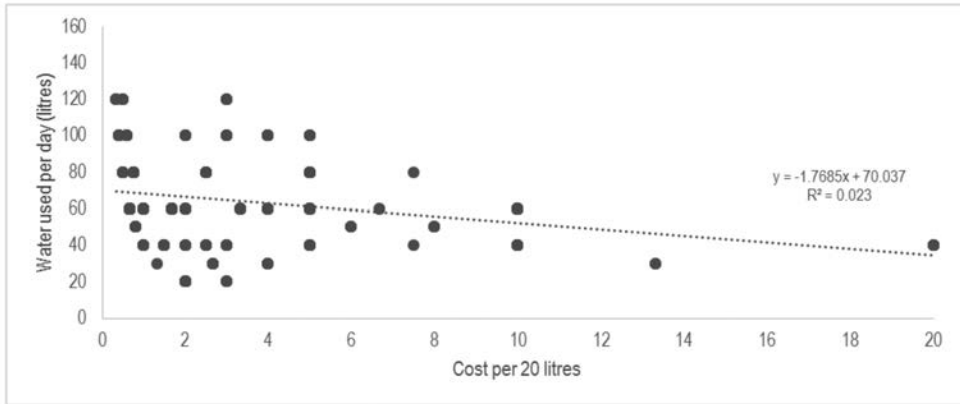


Figure 1. Relationship between water cost and access.

(average of 13 households [\approx 65 people] per facility) and were usually located outside the compound (see Table 3). Of the facilities outside the compound, 13% were located over 50 meters away. Four out of five sanitation facilities were used at a fee. The average fee being KES 7 (US cents 8.75) for a single visit (median = KES 5 [US cents 6.25]). The fee is paid to the entrepreneur. Due to cost, insecurity, few female-only facilities and distance, 30% of the respondents were unable to safely dispose of fecal matter consistently. Furthermore, only 45% of the households properly dispose of children fecal matter. For a variety of reasons, 58% of the households were dissatisfied with their sanitation facilities (Figure 2).

Hygiene knowledge and hand washing practices. About one in every five sanitation facilities had a provision for washing hands. All sanitation facilities with a handwashing provision had had running water with a quarter having both running water and water in basins. Soap was only present in 19% of the facilities while towels for drying hands were present in 13% of the households with a hand washing facility. Over half of the respondents (57%) knew at least three of the critical handwashing moments. Washing hands before eating was the most widely known moment for handwashing (93% of respondents) while washing hands after cleaning or changing the baby was the least widely known critical moment (21%).

A large majority of the households had soap (82%) during the time of the survey. Among these households soap was mainly used for laundry (94%) and bathing (84%). The most popular critical moments when respondents washed their hands with soap were before eating and before preparing food (50% and 45% respectively) while the least were after changing baby's diaper or cleaning a baby's bottom (7%). Only 44% of the respondents regularly washed their hands after visiting a latrine. Knowledge that one should wash hands before eating was the most prevalent, however, only 44% of those who knew practiced. Most of those who knew it was important to wash hands after visiting latrine were adherent (79%). A quarter of the respondents washed hands during at least three of the critical moments. On average, hand-washing was practiced 27% of the critical moments. Residents of Mabatini village were more likely

Table 2.**WATER SUPPLY AND ACCESS IN MATHARE SLUMS**

Variable	Village				Overall
	Mtoni	Polisi	Mabatini	Mashimoni	
Main source of drinking water					
Piped	110(84.6%)	37(48.1%)	57(100%)	116(100%)	320(84.2%)
Water vendor	20(15.4%)	40(52%)	0(0%)	0(0%)	60(15.8%)
Availability / source reliability					
Water all the time	55(42.3%)	9(11.7%)	0(0%)	10(8.6%)	74(19.5%)
Some hours a day	21(16.2%)	6(7.8%)	2(3.5%)	15(12.9%)	44(11.6%)
Some days a week	54(41.5%)	62(80.5%)	55(96.5%)	91(78.5%)	262(69%)
Mean days without water	5.2	5.8	5.5	3.8	4.9
Options when water is unavailable					
Waits till it's available	6(11.1%)	0(0%)	6(10.9%)	11(12.1%)	23(8.8%)
Piped water	17(31.5%)	33(53.2%)	35(63.6%)	51(56%)	136(51.9%)
Water vendor	11(20.4%)	29(46.8%)	0(0%)	15(16.5%)	55(21%)
Borehole	15(27.8%)	0(0%)	14(25.5%)	14(15.4%)	43(16.4%)
Stand pipes	5(9.3%)	0(0%)	0(0%)	0(0%)	5(1.9%)
Water payment (KES)					
Pays for water	130(100%)	72(93.5%)	52(91.2%)	71(61.2%)	325(85.5%)
Average pay per 20 liters	3.1	3.0	5.3	2.5	3.3
Median pay per 20 liters	1.5	2.8	5.0	0.8	2.0
Household water consumption per day (liters)					
Average	57.8	64.5	64.2	75.3	65.5
Median	60	60	60	80	60
Water storage					
All containers covered	96(73.9%)	21(27.3%)	52(91.2%)	86(74.1%)	255(67.1%)
Some containers covered	29(22.3%)	51(66.2%)	5(8.8%)	30(25.9%)	115(30.3%)
No container is covered	5(3.9%)	5(6.5%)	0(0%)	0(0%)	10(2.6%)
Fetching water from container					
Pouring	85(65.4%)	17(22.1%)	17(29.8%)	56(48.3%)	175(46.1%)
Pouring and Dipping	45(34.6%)	40(52%)	40(70.2%)	25(21.6%)	150(39.5%)
Dipping	0(0%)	20(26%)	0(0%)	30(25.9%)	50(13.2%)
Container has a tap	0(0%)	0(0%)	0(0%)	5(4.3%)	5(1.3%)
Water treatment					
Treats water	40(30.8%)	5(6.5%)	15(26.3%)	60(51.7%)	120(31.6%)
Chlorination	10(25%)	5(100%)	15(100%)	40(66.7%)	70(58.3%)
Boiling	25(62.5%)	0(0%)	0(0%)	20(33.3%)	45(37.5%)
Other methods	5(12.5%)	0(0%)	0(0%)	0(0%)	5(4.2%)

Note

KES= Kenya Shillings

Table 3.
SANITATION METHODS IN MATHARE SLUMS

Type of facility	Location of facility ^a					Facility sharing					Gender Segregation
	Overall	Inside ¹	Within ²	Outside ³	NA	Not shared	Everyone	Few households	NA		
Pour flush to sewer or septic	243(63.9%)	50(20.6%)	78(32.1%)	115(47.3%)	0(0%)	20(8.2%)	158(65%)	65(26.7%)	0(0%)	38(15.6%)	
Simple pit latrine	60(15.8%)	10(16.7%)	5(8.3%)	45(75%)	0(0%)	0(0%)	45(75%)	15(25%)	0(0%)	16(26.7%)	
Improved pit latrine	20(5.3%)	5(25%)	15(75%)	0(0%)	0(0%)	0(0%)	15(75%)	5(25%)	0(0%)	5(2.5%)	
Open defecation	17(4.5%)	0(0%)	0(0%)	0(0%)	17(100%)	0(0%)	0(0%)	0(0%)	17(100%)	0(0%)	
Bucket / open pour-flush	30(7.9%)	15(50%)	5(16.7%)	10(33.3%)	0(0%)	15(50.0%)	10(33.3%)	5(16.7%)	0(0%)	0(0%)	
Ecological sanitation	5(1.3%)	0(0%)	5(100%)	0(0%)	0(0%)	0(0%)	5(100%)	0(0%)	0(0%)	0(0%)	
Water closet	5(1.3%)	0(0%)	0(0%)	5(100%)	0(0%)	0(0%)	5(100%)	0(0%)	0(0%)	5(100%)	
Total(Overall)	380(100%)	80(21.1%)	108(28.4%)	175(46.1%)	17(4.5%)	35(9.2%)	238(62.6%)	90(23.7%)	17(4.5%)	64(16.8%)	

Note

^a(1) Inside the house, (2) Within the compound, (3) Outside the compound.

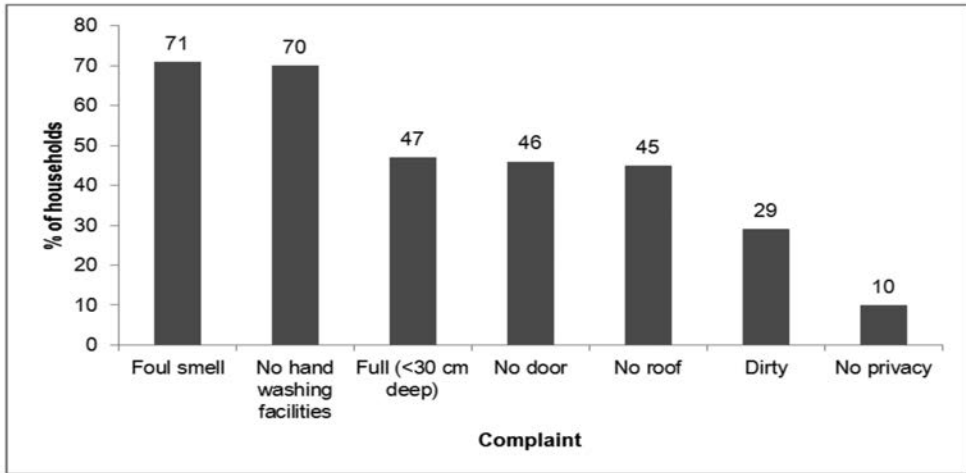


Figure 2. Households’ complaints about sanitation facilities.

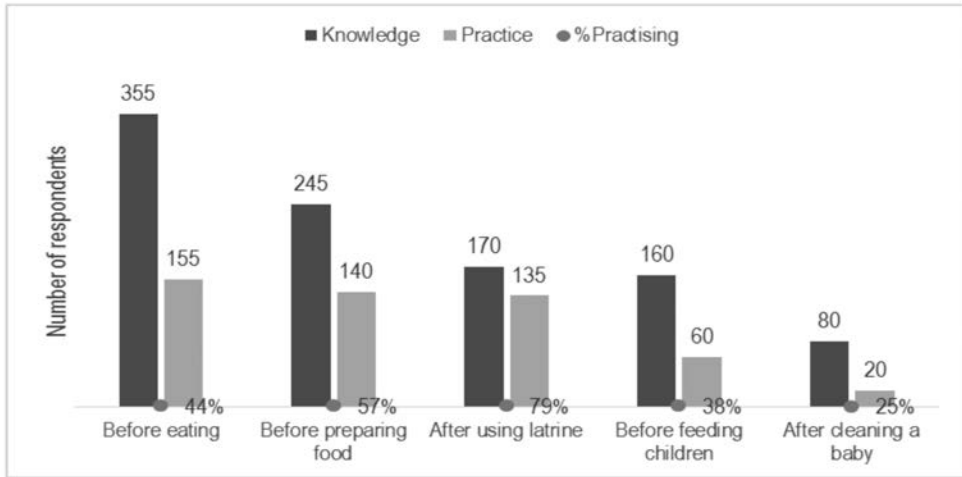


Figure 3. Handwashing knowledge and practice.

to wash hands during critical moments compared with Polisi village (Figure 3 and Table 4).

Factors affecting WASH in slums. Chi-square test of association was performed to test the association between the potential predictor variables and outcome variables (use of latrine and handwashing practices). Residence (village), type of sanitation facility, size of household, level of education, level of income and gender segregation of sanitation facilities were associated with consistent latrine use. On the other hand, washing hands during at least three critical moments was associated with residence, cost of water, household size and income, level of education and presence of soap in the household. The association between presence of a handwashing facility, presence of soap and running water at the handwashing facility and the actual handwashing was not statistically significant (Table 5).

Table 4.
HYGIENE AND HANDWASHING PRACTICES IN
MATHARE SLUMS

Variable	Village				Overall
	Mtoni	Polisi	Mabatini	Mashimoni	
Handwashing facilities in latrines					
Facility present	20(15.4%)	30(39%)	5(8.8%)	25(21.6%)	80(21.1%)
Running water	20(100%)	30(100%)	5(100%)	25(100%)	80(100%)
Soap or detergent	0(0%)	0(0%)	0(0%)	15(60%)	15(18.8%)
Towel or cloth	0(0%)	0(0%)	0(0%)	10(40%)	10(12.5%)
Water in basin	0(0%)	0(0%)	5(100%)	15(60%)	20(25%)
Important moments to wash hands (Knowledge)					
Before eating	120(92.3%)	77(100%)	52(91.2%)	106(91.4%)	355(93.4%)
Before preparing food	76(58.5%)	16(20.8%)	57(100%)	96(82.8%)	245(64.5%)
After using a latrine	55(42.3%)	12(15.6%)	47(82.5%)	56(48.3%)	170(44.7%)
Before feeding children	35(26.9%)	1(1.3%)	44(77.2%)	80(69%)	160(42.1%)
After cleaning/changing baby	21(16.2%)	5(6.5%)	29(50.9%)	25(21.6%)	80(21.1%)
After eating	45(34.6%)	1(1.3%)	43(75.4%)	66(56.9%)	155(40.8%)
Knows at least 3 critical moments	65(50.0%)	12(15.6%)	52(91.2%)	86(74.1%)	215(56.6%)
Mean	2.36	1.44	4.02	3.13	2.66
Median	2.50	1.00	4.00	3.00	3.00
Mode	1.00	1.00	5.00	4.00	1.00
SEM	0.11	0.09	0.13	0.11	0.07
SD	1.29	0.75	1.01	1.19	1.39
Variance	1.67	0.57	1.02	1.42	1.94
Moments when hands are washed with soap (Practice)					
<i>Soap present</i>	110(84.6%)	32(41.6%)	52(91.2%)	116(100%)	310(81.6%)
Washing clothes	100(90.9%)	32(100%)	47(90.4%)	111(95.7%)	290(93.5%)
Bathing	80(72.7%)	32(100%)	42(80.8%)	106(91.4%)	260(83.9%)
Before eating	50(45.5%)	6(18.8%)	49(94.2%)	50(43.1%)	155(50%)
Before preparing food	41(37.3%)	6(18.8%)	52(100%)	41(35.3%)	140(45.2%)
After using a latrine	36(32.7%)	1(3.1%)	42(80.8%)	56(48.3%)	135(43.5%)
Before feeding children	6(5.5%)	0(0%)	34(65.4%)	20(17.2%)	60(19.4%)
After cleaning children	5(4.5%)	0(0%)	10(19.2%)	5(4.3%)	20(6.5%)
Washes at least 3 critical moments	26(20.0%)	0(0%)	49(86.0%)	20(17.2%)	95(25.0%)
Mean	1.06	0.17	3.28	1.48	1.34
Median	1.00	0.00	3.00	2.00	1.00
Mode	0.00	0.00	3.00	2.00	0.00
SEM	0.11	0.05	0.11	0.10	0.07
SD	1.26	0.41	0.82	1.06	1.37
Variance	1.58	0.17	0.67	1.12	1.89

Table 5.
FACTORS AFFECTING WASH IN SLUMS

Outcome	Predictor	Chi-square	(p-value)
Consistent use of latrine	Village	10.30	.016
	Size of household	29.15	<.0001
	Level of education	9.06	.029
	Level of income	21.59	<.0001
	Type of facility	65.47	<.0001
	Distance of the toilet	69.34	<.0001
	Toilet location	90.58	<.0001
	Sharing facility	51.02	<.0001
	Gender segregation	6.42	.040
	Treating drinking water	13.84	<.0001
Washing hands at critical moments	Village	144.11	<.0001
	Size of household	36.64	<.0001
	Level of education	7.65	.054
	Level of income	22.01	<.0001
	Presence of hand-washing facility	2.11	.146
	Presence of soap at hand-washing facility	0.58	.45
	Presence of water at hand-washing facility	2.11	.15
	Presence of soap in the household	28.60	<.0001
	Knows critical moments	114.93	<.0001
	Cost of water	151.74	<.0001
Amount of water used per day	42.71	<.0001	

Discussion

Informal settlements are generally overcrowded and Mathare is no exception. It has on average five people living in a 12-square-meter dwelling. This area was not covered by the Nairobi Water and Sewerage Company (elsewhere in Nairobi, the utility company providing these services at a fee) possibly due to the fact that majority residents did not have formal land titles. In addition, only a minority of households met the minimum requirements to obtain a metered connection, namely an applicant's plot number, a landlord's certification of residence, and application fee. The residents paid more for the water (KES 3.3 [US cents 4.1] for 20 liters) while the official rate for water provided by individual piped connection was 0.4 KES (US cents 0.5) per 20 liters. These low-income households were thus paying over eight times the official price. This corroborates the United Nations Development Program (UNDP) findings that low-income households pay an average of 15.3 (6.0–30.3) times the standard price charged by the City Council. This means that water is unaffordable for these households. Over half of them earn less than \$1.5US a day and spend 20% of their income on water which is above the

catastrophic spending threshold of 10%.^{12,23} Generally, no household should spend more than 3% of household income on water.

The mean water consumption per household in Mathare was 69.25 liters per day. With an average of 4.5 members, this translates to 15.4 liters per capita per day. The World Health Organization recommends a daily per capita consumption level of 20 liters for drinking, cooking, and hygiene purposes as the minimum quantity of water needed to sustain a human being. Thus, majority of households fall below this water-poverty threshold which predispose them to water borne diseases. Furthermore, for every 1 KES (1.25 US cents) increase in the cost of water, the household water consumption was reduced by 1.8 liters.

Water was poorly stored as a large proportion of households store it on the floor in open wide-mouthed containers. Uncovered containers that were not elevated from the ground and from which water was drawn by dipping pose a threat of water contamination at household level. In addition, majority of households did not treat their water, further exposing them to water borne diseases. A study in one Nairobi informal settlement isolated fecal coliforms from 35% of standpipes and 95% of in-house storage containers,¹³ indicating possible contamination during storage.

Most households had access to sanitation facilities with majority using flush toilets (64%) illegally connected to the sewer lines, and simple pit latrines (16%). Even though large numbers of Kenyans (73%) access pit latrine for fecal disposal, this method is illegal in the urban areas.⁷ Only 5% of households in Mathare habitually practiced open defecation, and this is fourfold lower than the national average of 20%.^{7,14} However, 30% of Mathare residents occasionally practice open defecation. In one informal settlement in India, 44% of residents practiced open defecation.¹⁵ In Uganda, in contrast, less than 1% of slum dwellers were found to defecate in the open.¹⁶

A majority of households shared sanitation facilities with an average of 13 households, which translates to approximately 65 people per facility. This is grossly inadequate and makes it difficult to maintain the level of standard to prevent transmission of pathogens. The Joint Monitoring Program of UNICEF and WHO considers any sanitation facility shared by two or more households to be *unimproved* sanitation. Sharing of sanitation facilities is common in sub-Saharan Africa with an average of 18% households. Sharing is reported to be common in Ghana at 59% and Congo and Gabon (both at 34%). The minimum standards prescribed for populations in humanitarian crisis is a maximum of 20 people per sanitation facility which translates to four households in Kenya.^{4,18,19} In essence, sanitation standards in the study population miss the mark by over 16 times the minimum prescribed for humanitarian crisis, even though this population was surveyed in non-humanitarian situation. In other words, refugees living in a refugee camp are likely to have more sanitation facilities per population than residents of Mathare slums.

A quarter of households could not access a sanitation facility at night. This was due to limited gender-designated facilities and facilities being far from dwellings. Walking to such a facility at night is considered unsafe especially for women and children.²⁰ This often makes the residents resort to use of a so-called *flying toilet*—defecating in a paper bag and throwing it on the roof of a neighboring house.²¹ In addition, over half of the households with children younger than five years (53%) disposed children's excreta into an open drain, which empties into a nearby river through storm water,

further leading to pollution of the river where some water vendors and food kiosk operators obtain their water. The sanitation facilities despite being cleaned almost daily are poorly maintained, with structural defects. The pit latrines are often not emptied when full and they tend to overflow. A majority of households face problems associated with sanitation facilities, importantly including foul smell and lack of privacy. In a Ugandan informal settlement, residents had easy access to sanitation, though most such facilities were shared and majority of residents were not satisfied due to cleanliness and over-demand.¹⁶

For effective prevention of diarrheal diseases, hands should be washed during the following critical moments: before eating, before preparing food, after using a latrine, before feeding a child, and after cleaning or changing a baby. Over half (57%) of the respondents knew at least three critical moments when hand-washing should be practiced. However, only 25% washed hands during at least three critical moments. Though soap was present in 82% of the households, it was mainly used for laundry and bathing, with only 50% using soap for washing hands before eating. Furthermore, few sanitation facilities have inbuilt handwashing facilities, which in a way is a barrier to handwashing. A majority of those who knew hands should be washed after visiting a latrine did actually wash them indicating the influence of knowledge on practice. Further, it was noted that access to sanitation and clean water was associated with residence, level of education, size of household, and income. This signifies the role of socioeconomic determinants on healthy behaviors. The positive association between the level of education and social service uptake has been previously documented in Mathare.²⁵

The drinking water and sanitation ladders present access to drinking water and sanitation as four-step ladders as shown in Box 1.²² Based on these ladders, Mathare residents can be grouped into the 4th step of the drinking water ladder since 84%

Box 1.
WATER AND SANITATION LADDERS

Ladder	Rung	Description
Drinking-water	I	Proportion drinking water directly collected from surface water sources
	II	Proportion using other unimproved water sources
	III	Proportion using “improved” sources other than piped household connections
	IV	Proportion benefiting from household connections in a dwelling, plot or yard
Sanitation	I	Proportion practicing open defecation
	II	Proportion using unimproved sanitation facility
	III	Proportion using a shared sanitation facility of acceptable technology
	IV	Proportion using an improved sanitation facility

depend on water from nearby public standpipes, and 3rd rung of the sanitation ladder (only 9.2% are not shared).

Conclusion. People who live in slums are the most vulnerable to environmental health-related conditions due to poor living conditions. Unfortunately they also pay more for public utilities than do those with greater purchasing power. This places them in a vicious cycle that requires government intervention to break. Just as the sanitation-related MDG targets were missed,² Kenya and other similar developing countries are likely to miss the health-related Sustainable Development Goals (SDGs) as well unless deliberate efforts are made to improve water and sanitation situation among slum residents. One way is through upgrading of infrastructure through provision of water, sanitation, garbage collection services, storm water drainage, access roads, and street lights irrespective of security of their land tenure. A limited but consistent body of evidence suggests that slum upgrading may reduce the incidence of diarrheal diseases and water-related expenditure.⁵ With only 45% of households properly disposing of children's feces, it is imperative that health awareness is created to ensure proper disposal of all fecal matter. Gender and the safety of sanitation facilities should be considered when making decision on the site of the facilities. Communities should also be sensitized to the importance of washing hands especially during the critical moments. Further, efforts should be made to bring down the cost of water and use of sanitation facilities. In addition, efforts to address social determinants of sanitation should be accelerated. Box 2 summarizes the policy investments required to improve water and sanitation

Box 2

POLICY INVESTMENT NEEDED TO IMPROVE WATER AND SANITATION STATUS IN SLUMS

Policy aspect	Description
Water	<ul style="list-style-type: none"> • Promote harvesting of rain water through roof catchment • Subsidize water storage tanks • Encourage public private partnerships and investment in the slums • Establish water and sanitation management committees • Sinking of more boreholes • Regulate water user fee
Sanitation	<ul style="list-style-type: none"> • Implementation of Urban Community Led Total Sanitation (uCLTS) strategy • School led total sanitation in slums • Incentivize Open Defecation Free (ODF) movement in the slums • Public awareness on importance of sanitation and hygiene through social and mass media • Slum lighting to improve use of sanitation facilities at night • Implementation of Child to Child strategy

(continued on p. 334)

Box 2. (continued)

Policy aspect	Description
Hygiene	<ul style="list-style-type: none"> • Enact a legal requirement for all residential houses including rentals to provide sanitation facilities for tenants and separate them for each sex • Regulate sanitation facility user fees • Encourage innovative sanitation technologies in the slums e.g. EcoSan • Creating awareness on critical moments for handwashing • Install tippy taps outside all sanitation facilities • Holding of global sanitation and hygiene days in the slums e.g. World Toilet Day; Global Handwashing Day etc • Awareness that child fecal matter is more dangerous than adult's • Promotion of cheaper detergents for handwashing e.g. home-made soap
Cross cutting	<ul style="list-style-type: none"> • Implementation of child-to-child strategy • Advocate for Alternative Provision of Basic Education and Training • Enact social protection and safety nets for the most vulnerable

status in slums. Further research is required to identify barriers to application of the residents' high level of knowledge regarding handwashing.

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