Health Promotion International Advance Access published November 24, 2014

Health Promotion International
doi:10.1093/heapro/dau100

Informal settlements and a relational view of health in Nairobi, Kenya: sanitation, gender and dignity

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SUMMARY

On an urban planet, slums or informal settlements present an increasing challenge for health promotion. The living conditions in complex informal settlements interact with how people navigate through their daily lives and political institutions to shape health inequities. In this article, we suggest that only a relational place-based characterization of informal settlements can accurately capture the forces contributing to existing urban health inequities and inform appropriate and effective health promotion interventions. We explore our relational framework using household survey, spatial mapping and qualitative focus group data gathered in partnership with residents and non-governmental organizations in the Mathare informal settlement in Nairobi, Kenya. All data interpretation included participation with local residents and organizations. We focus on the inter-relationships between inadequate sanitation and disease, social, economic and human rights for women and girls, who we show are most vulnerable from poor slum infrastructure. We suggest that this collaborative process results in co-produced insights about the meanings and relationships between infrastructure, security, resilience and health. We conclude that complex informal settlements require relational and context-specific data gathering and analyses to understand the multiple determinants of health and to inform appropriate and effective healthy city interventions.

Key words: informal settlements; place and health; social determinants of health

INTRODUCTION

Global urbanization and a lack of political responses by national and municipal governments are contributing to the persistence of urban poverty, slums or informal settlements, and health inequities in cites of the global south (Unger and Riley, 2007). Worldwide, an estimated 828 million people currently live in slum conditions (~45% of population in the global south), but this is expected to reach over 2 billion by 2020 with close to 85% of slum settlements in cities of the global south (Habitat/WHO, 2010). Among cities in sub-Saharan Africa with a million or more population, between 50 and 80% of the urban population lives in informal settlements (UN Habitat, 2014). In other words, informal settlements are the norm, not the exception in large portions of the global south. While urbanization can be beneficial for health, the increase in urban informal settlements represents a significant challenge for promoting more healthy cities in the global south, since informal settlements are also the location of persistent health inequities.

We acknowledge that there is no one definition of urban informal settlement and in particular that 'slum' is both an absolute term measuring human deprivation but also a relative concept that differs from city to city according to social class and culture, and often changes over time. UN Habitat has defined an informal settlement as an area with 'inadequate access to safe water,

inadequate access to sanitation and other infrastructure, poor structural quality of housing, overcrowding, and insecure residential status'. The UN also defines a slum as a household or group of individuals in an urban area that lack:

- Durable housing of a permanent nature that protects against extreme climate conditions.
- Sufficient living space which means not more than three people sharing the same room.
- Easy access to safe water in sufficient amounts at an affordable price.
- Access to adequate sanitation in the form of a private or public toilet shared by a reasonable number of people.
- Security of tenure that prevents forced evictions.

In this paper, we focus on informal settlements and health in Nairobi, Kenya, and acknowledge that the 2014 Kenyan National Slum Upgrading and Prevention Policy defines a slum as 'a human settlement characterized by dilapidated housing structures, overcrowding, abject poverty and unemployment, high insecurity incidences, insecure land tenure, exclusion of physical development, inadequate infrastructural services and often located in an unsustainable environment' (Government of Kenya, 2014).

The challenge of urban slums is particularly acute in Kenya and its capital city Nairobi, where over 65% of the capital's almost 3.2 million people live in informal settlements occupying <10% of the land area (Cities Alliance/SDI, 2010; Obeng-Odoom, 2010). Slum dwellers in Nairobi experience poorer health than their better off urban counterparts: in one study, child mortality rate in Nairobi was found to be 62 per 1000 births, but 151 per 1000 in the city's slums (Emina *et al.*, 2011). Approximately 33% of Nairobi's slum dwellers reported that their children had diarrhea compared with less than one in five in other areas of the city (APHRC, 2002). HIV/AIDS prevalence in Nairobi's Kibera informal settlement is 14%, double the national prevalence (Umande Trust, 2007). Yet, most of these analyses focus on one disease, risk factor or treatment regime and fail to account for the multiple and related environmental, social and political forces that influence health in these communities (Amendah *et al.*, 2014).

In this paper, we use a range of data collected by and with slum dwellers in the Mathare informal settlement of Nairobi to highlight the importance of a relational approach to health equity analyses and intervention design. By a relational approach, we mean that rather than just focusing on static variables of people and/or places, we aim to highlight how the characteristics in places interact with one another, how political and cultural institutions shape these interactions, and the role that local people and their knowledge can play in defining and interpreting action-oriented place-based research (Cummins *et al.*, 2007). We explore the relational idea in more detail below. Our process and findings are important as slum dwellers, non-governmental organizations (NGOs), global health practitioners and others grapple with how to promote healthy and equitable cities in the global south that recognize and value the often contested, gendered and variegated characteristics of urban informal settlements.

A relational view of slum health

As an alternative to the static, fixed variable view of place offered by some slum health research, we employed a relational view of slum health in this study. In the relational view, place is understood as having physical and social characteristics, but that these characteristics are shaped by and given meaning through their interactions with politics and institutions, with one another and, most importantly, with the people living in a place. The relational interplay between place characteristics and their meaning-making for health is often contingent and contested, particularly in informal settlements as new groups with new cultural orientations move into a place. The relational view of place is crucial for promoting health equity because social processes, such as power, inequality and collective action, are often revealed through the construction and reconstruction of the material forms and social meanings of places (Corburn, 2009).

A relational view of place and health demands research and analysis that combines multiple ways of characterizing and understanding places, including resident narratives, systematic observation, spatial mapping and quantitative and qualitative measures of the location and accessibility of resources (Figure 1). For health promotion, this means not just documenting if a health-promoting resource exists, but also the opportunities and barriers different population groups might face in utilizing that resource. We suggest how a relational view of place can differ from a built environment and health view in Table 1. In the relational view, geographic scales must explore the interactions

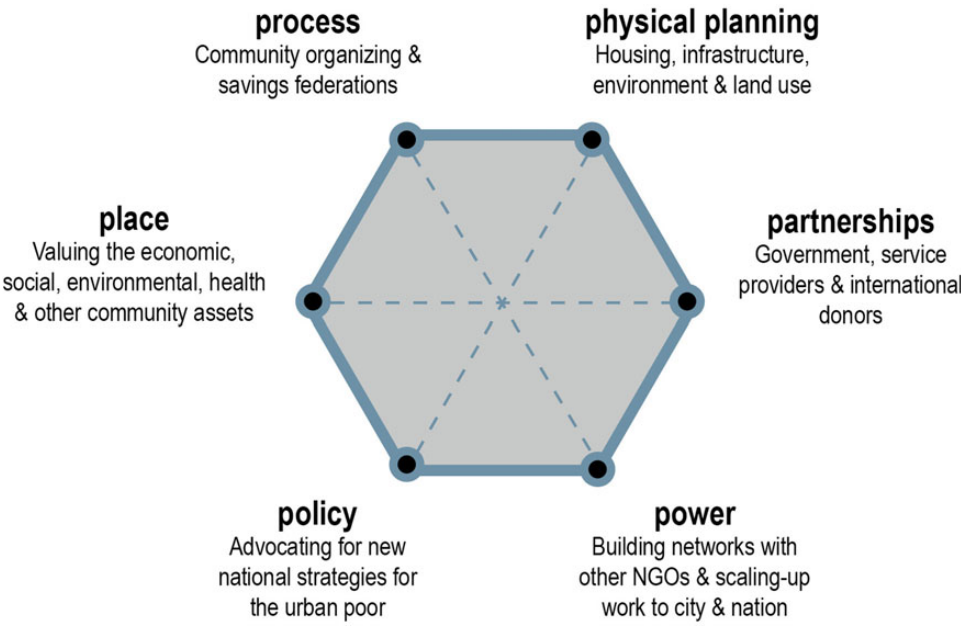

Fig. 1: A relational model for slum health promotion.

between local and global decisions, not just static administrative boundaries. Too often in public health, such as in neighborhood-effects research, the most proximate scale is used because relatively easily accessible data are available (Macintyre *et al.*, 2002). However, forces outside the neighborhood or local place, such as national and international policies, can influence local access to a health promoting good, such as affordable food. Distance under the relational view ought to include physical and social relations and view populations and places embedded within networks. This concept of distance is important for health promotion because the poor might not use a resource, such as a service or healthcare, that is physically close to them, especially if they perceive that service as not being culturally appropriate, affordable and if traveling far away from one's home might reduce the chances of being stigmatized for being treated for a disease in one's community (Agarwal *et al.*, 2008).

Importantly, in a relational view of place, population groups are not treated as static, with fixed characteristics, but rather as dynamic and heterogeneous so that they are understood as having multiple and constantly evolving features. In this way, intersectionality is a central feature of the relational view, which implies that, for instance, the male slum dweller in Nairobi's Kibera settlement is not assumed to be afflicted by the same health stressors as their neighbor in an adjacent village or a young female slum dweller in the Mathare settlement on the other side of town. The biographies of people and the histories of places matter for understanding and acting to improve health in the relational view. Importantly, governance and political power are essential features that are investigated, analyzed and incorporated in the relational approach, not 'controlled for' as confounding or ignored in urban health research and practice. What all this means is that urban health promotion is not simply a matter of the right interventions, or even having necessary resources in places. Rather, how distributive decisions are made and by whom also matters. This is what we mean by the term governance and governance influences the social structures that can sort people to unequal health outcomes by upholding existing distributions of resources like power, money and knowledge. Thus, participation in place-based governance should be understood as a positive social determinant of health (Burris *et al.*, 2007). However, a major challenge to employing this relational approach to health and place is the lack of local data, particularly in urban slums.

Table 1: A built environment and relational view of health and place

	Built environment	Relational view of place
Geography	Boundaries at specific scale (i.e. census tract); usually one scale	Local, regional and global scales considered and how these interact
Distance	Fixed physical distance	Physical and social location, such as economic status and power hierarchies; networks
Populations	Static in time and space; focus on differences between (i.e. slum dweller versus non-slum dweller)	Contingent and mobile; focus on differences among and between groups (i.e. slum dwellers in the same village/ settlement and non-slum dwellers)
Resources	Physical and social in specific locations; culturally neutral	Physical and social plus culturally specific meanings assigned to resources by local people
Political Power	Not addressed	Governance—or how decisions are made and by whom—is recognized as a form of power

METHODS AND DATA

In this study, we focus on the Mathare informal settlement in Nairobi, Kenya, which is located ~6 km from the city center and comprises 13 different villages: Mashimoni, Mabatini, Village No. 10, Village 2, Kosovo, 3A, 3B, 3C, 4A, 4B, Gitathuru, Kiamutisya and Kwa Kariuki (Figure 2). All data are the result of a collaboration between the NGOs Muungano wa Wanavijiji (Muungano) and Muungano Support Trust (MuST, 2014) and the University of California, Berkeley and University of Nairobi. The University of California, Berkeley and the University of Nairobi were invited to partner with Muungano and MuST to support the data gathering, analyses and planning processes described here.

We report results from multiple data gathered in Mathare from 2009 through 2012. First, we report results of a household survey from over 650 households randomly stratified across all 13 villages in Mathare in August 2011. We also report on spatial data gathered by residents and MuST from 2009 to 2011, where every village and structure was mapped along with water access points, toilets, lighting, roads, drainage, commercial activity and environmental hazards, such as garbage dumps. Importantly, survey and environmental mapping data were reviewed, discussed and validated with residents using unstructured interviews.

We acted as participants and observers, while Muungano leaders facilitated over 22 community planning meetings and focus groups with Mathare residents between 2010 and 2012. We include select narratives from these meetings that discussed health-related topics such as: land tenure, housing construction, women's access to safe toilets; water and electricity access; childcare; food access; economic opportunities; and, general security and safety. The Institutional Review Board for the Protection of Human Subjects at UC Berkeley approved our survey questions and focus group protocols, as well as data-sharing processes.

A relational profile of an informal settlement and health

History and context of Kenyan slums

A first step in taking a relational approach to slum health is to understand the history of the place and the biographies of the people that live there. As Fox (Fox, 2013) has noted, living conditions—and we suggest health conditions—in Nairobi's slums today cannot be separated from colonial era planning and policy decisions and post-independence governance. For example, British colonialist policies racially segregated Africans and Indians living in Nairobi to the most marginal and risky land to the east and south of the City Center, often justified as protecting Europeans from exposure to 'native diseases' (K'Akumu and Olima, 2007). The few African settlements that were allowed in Nairobi were designed for a fixed number of sojourners and did not accommodate for population growth (Home, 1997). The British also refused to finance basic services such as water and sanitation to reach the areas where Africans lived and instead infrastructure was built for resource and commodities extraction, not intra-city services or mobility (Obudho, 1997; Achola, 2001).

Post-colonial Kenya adopted a centralized governance system that left Nairobi City Council virtually powerless to the central government. Until the 2010 Kenyan Constitution instituted a

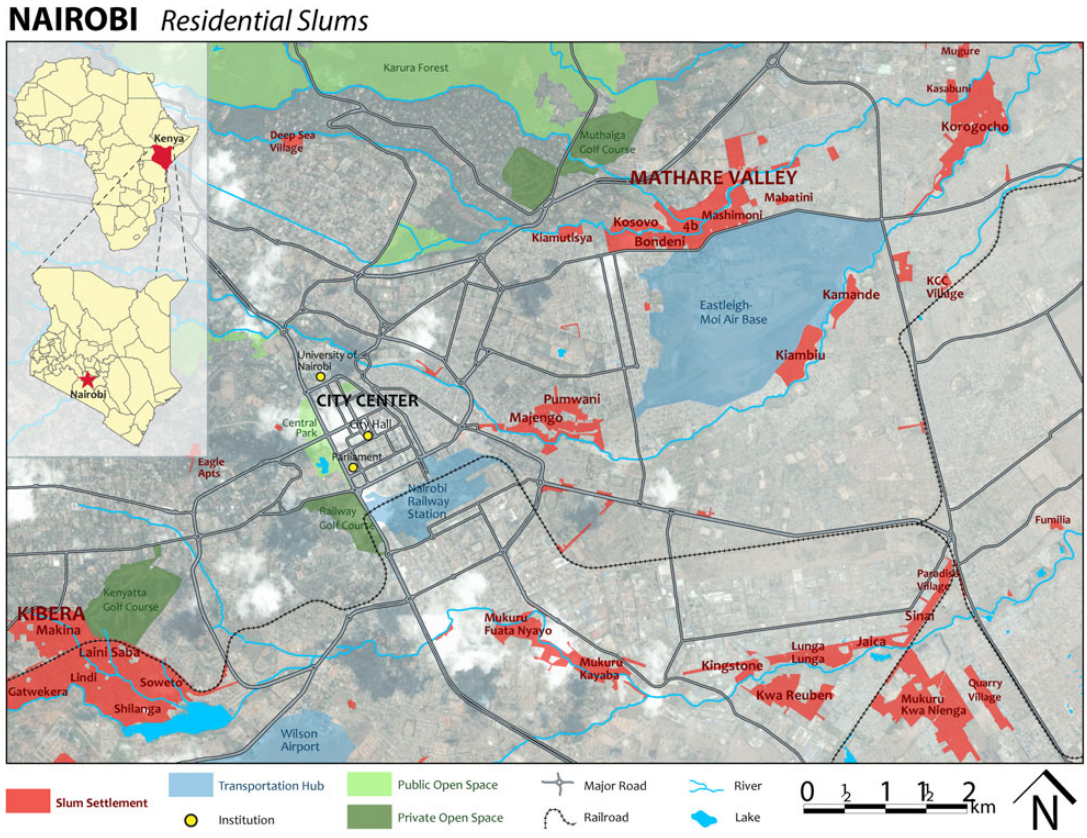

Fig. 2: Mathare informal settlement, Nairobi, Kenya.

devolved system of governance, the central government used their authority over urban land, taxation and infrastructure development for political patronage (Wrong, 2009). Further, Nairobi's slums were lucrative business for those, like government officials, that controlled land, collected rents and received payments from cartels that provided informal services such as water in the absence of the state (Syagga *et al.*, 2002).

Findings: infrastructure, gender and health

Using our relational framework, we offer some examples of how place-based living conditions can be understood using a range of data to best inform health equity promoting interventions. We focus on sanitation and highlight how this seemingly technical and physical characteristic can be understood and analyzed in a relational way. We reveal the intersecting social, economic and dignity dimensions of sanitation in the Mathare informal settlement and suggest how this approach can highlight often overlooked gendered health impacts in urban informal settlements.

Sanitation and health

Spatial distributions

In Mathare, more than half the residents live in a structure with a dirt floor and 80% did not have permanent walls. More than 83% of residents rely on a shared toilet and most pay 5 KSh per use, which can present a significant economic burden on the poor. We found that over two-thirds of our respondents continue to use flying toilets (a flying toilet is when one defecates into a plastic bag and throws the bag into a waste dump) and/or open defecation due to cost and availability of more dignified sanitation options (Table 2).

We mapped community toilet blocks across Mathare and found that almost none were connected to the municipal trunk sewer (Figure 3). Figure 3 depicts the number and distribution of public toilets in all 13 of Mathare's villages.

Table 2: Select demographic and infrastructure data for all villages in Mathare slum, Nairobi

Name of Mathare village	Population (from 2009 Kenyan census)	Tenants or renters (%)	Monthly income >10 000 KSh (% Yes)	Avg. monthly expenses (Kenyan Shillings)	Avg # households per shared toilet	Avg # people sharing toilet	% of HHs within 50 m functioning toilet
3A	4059	85	39	13 104	64	169	15
3B	7433	92	48	16 112	84	232	20
3C	5316	94	27	13 564	16	44	46
4A	18 776	71	39	11 795	18	60	32
4B	5681	88	50	12 665	32	101	23
Gitathuru	3737	90	55	14 762	11	32	36
Kiamutisya	5825	90	20	12 250	37	91	34
Kosovo	8085	74	56	11 933	19	55	41
Kwa Kariuki	9024	89	29	13 833	29	94	50
Mabatini	1160	80	40	17 364	6	17	24
Mashimoni	5153	85	48	13 447	22	58	33
No. 10	2594	82	87	14 206	28	72	10
Village 2	7875	82	34	12 220	63	175	8
All Mathare	84 718	85	42	13 635	24	70	29

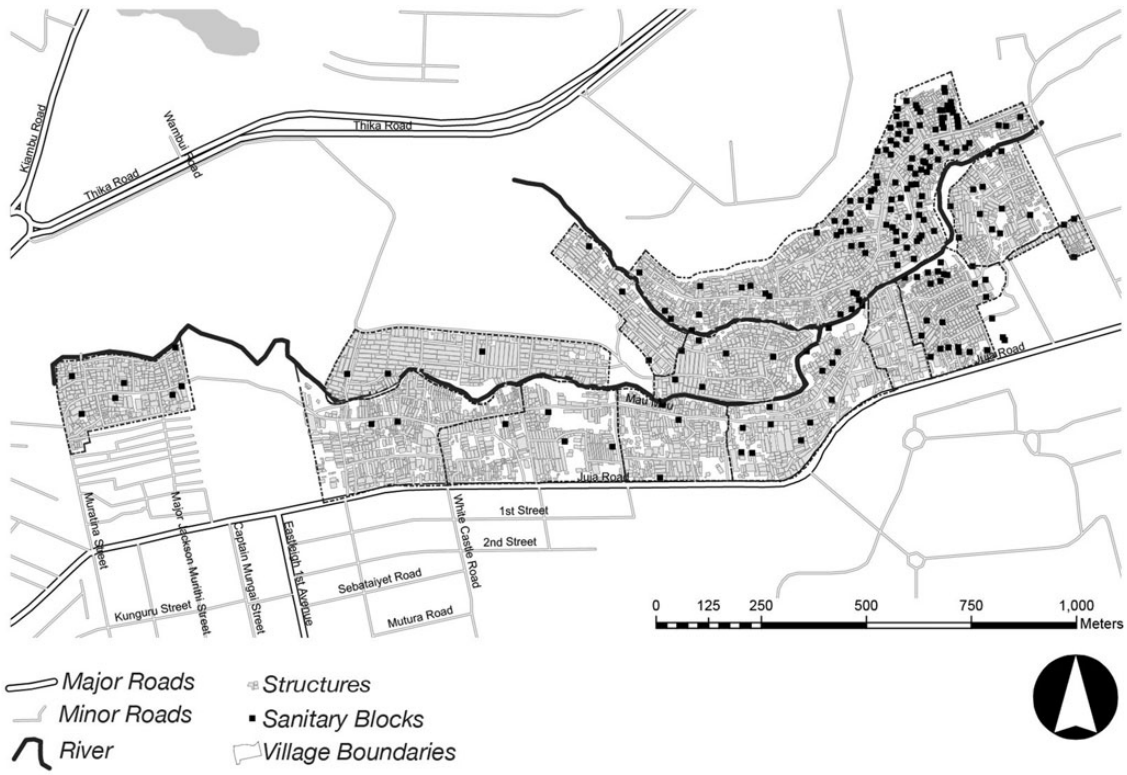

Fig. 3: Map of sanitary blocks across all villages in Mathare.

Human waste is often concentrated around the communal toilets and drains openly into streets, pathways and frequently into homes.

We compared our findings of access to toilets with the Sphere Humanitarian Standards. The Sphere Humanitarian guidance is one of the most widely known and internationally recognized sets of common principles and universal minimum standards in life-saving areas of humanitarian response (Sphere, 2011). Given the lack of universally

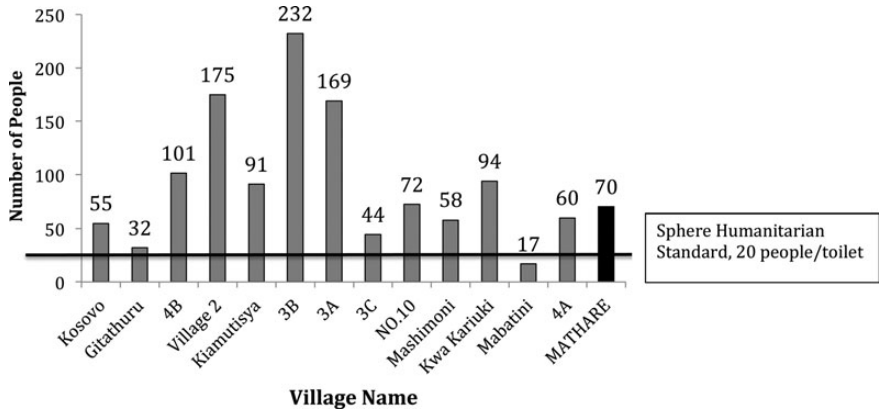

Fig. 4: People per functioning latrine in Mathare.

accepted indicators for comparing slum conditions, we referenced the Sphere Standards to put our findings in Mathare in a broader, comparative context. For instance, Sphere suggests a maximum of 20 people per latrine, but in Mathare we found everyday chronic conditions across the villages of between 17 people per toilet (Mabatini) to 232 per toilet (Village 3B) (Figure 4).

Our mapping of public sanitary or ablution blocks, where groups of usually three to six toilet are located, revealed that over 71% of Mathare residents had to walk more than 50 m to reach a toilet. The spatial distribution is especially problematic at night since few toilets have adequate lighting. As we describe in greater detail below, the distribution of and general lack of sanitary infrastructure in Mathare disproportionately impacts the physical, social and cultural determinants of health for women (Amnesty, 2010).

Infectious and chronic disease

Inadequate sanitation in Mathare contributes to a disproportionate burden of infectious and chronic diseases on the population, but particularly for women and girls. According to Cheng *et al.* (Cheng *et al.*, 2012), close to 90% of diarrhea in urban slums is from fecal contamination in drinking water and food. Our survey found that over 26% of women and girls reported an episode of diarrhea in the past month, compared with ~13% for all Nairobi and 17% for all Kenya, as reported in the Kenyan Demographic and Health Survey (DHS, 2010). Our focus groups also revealed the pathways between inadequate toilets and exposure to pathogens that contribute to diarrhea. One women noting:

> The children are often playing in the streets where the waste [human] drains from toilets. There is no sewer here that works. There is no place for hand washing and clean water is another cost. The cost of each toilet use [about 5 KSh] means our children cannot use them. I have four children and I can't pay for each to use a flash toilet a few times a day. They come home and touch food and me and I worry this is spreading disease.

Diarrheal diseases caused by inadequate sanitation puts children at multiple risks leading to vitamin and mineral deficiencies, malnutrition and stunting. Sustained or long-term exposure to excreta-related pathogens—including helminths or worms—in early life limits cognitive or brain development and lowers long-term disease immunity. As inadequate slum sanitation contributes to the cascading impacts on children of waterborne illness, malnutrition and, in turn, stunting, this can result in poorer cognitive development and performance in school for young people in Mathare (Niehaus *et al.*, 2002).

Restricted toilet opportunities for women have shown to increase the chance of urinary tract infections (UTIs) and chronic constipation by 80% (Cheng *et al.*, 2012). According to our focus group, women face challenges during menstruation from a lack of a private and hygienic toilet, as one women recalled:

> During my monthly period I can't urinate in the tin so I have to wait until morning. Sometimes some drops of blood can remain in the tin and everyone uses the tin so it's embarrassing. The Always sanitary pad makes some crackly noise when changing so when I have a visitor, I feel embarrassed to remove it. I therefore have to wait until morning to

> change. If I had a private toilet, I would have been able to change the pad anytime.

The lack of adequate toilets also disproportionately impacts women living with HIV, and Madise *et al.* (Madise *et al.*, 2012) have shown that women in Nairobi's slums had 38% higher HIV prevalence than men. People living with HIV/AIDS are particularly vulnerable to intestinal parasites, since they tend to suffer from more frequent diarrheal episodes than those with stronger immune systems. When frequent diarrhea leads to insufficient nutrient absorption and weight loss, intestinal parasites can be lethal for people living with HIV (West *et al.*, 2012). Frequent diarrhea can reduce the efficacy of antiretroviral (ARV) drugs that can reduce mortality from HIV. According to our focus groups in Mathare, women with HIV faced inter-related health stressors of accessing medication, preventing exposure to disease and affording food, with one women noting:

> I don't have any childcare or work, so food is hard for me and my baby. I skip meals everyday and many in a week to feed him [baby]. I can't buy cooking fuel, so I get some credit with vendors for prepared foods. When credit runs out, I am forced to be with men. My child was hungry for two days, so this man came with 200 bob [shillings] and I couldn't tell him no because I needed that 200 bob to eat. When I told him to use a CD (condom), he said no and I had no choice. My boy was hungry. I know I'm HIV positive and can get medicines from the clinic, but without food I can't take them. I can sell the pills for food sometimes. This is what I must do now to survive.

Education and economic burdens

As noted above, a Mathare resident typically spends ~5 KSh per toilet use and according to our survey data, this represents ~3–7% of their total monthly expenditures. The high cost often means fewer visits to a toilet and being forced to use a 'flying toilet', open defecation or using a can inside one's structure. In our focus groups, we heard more details on the related economic and social costs of inadequate and costly toilets and the prevalence of diarrhea. We frequently heard that girls were more likely than boys to miss school due to sanitation-related illness and lack of safe, private and hygienic toilets at their school. A lack of adequate toilets in schools decreases the attendance of girls, especially during their menstrual cycle. One school-girl noted:

> As girls, when we don't have a toilet in school, we are forced to stay with one pad for a whole day. I know many girls who just do not come to school during those days. Even if we have a toilet at school and we have to share them with boys, girls will avoid them and stay home. We do not have a bath place so I know when you have your period you do not want to smell in school, so us girls avoid it.

Freeman *et al.* [(Freeman *et al.*, 2012), p. 386] found that improving sanitation for the poor in Kenya resulted in a 58% reduction in the odds of 2-week absence from school for girls.

During focus group discussions about the burdens from diarrheal disease, women described the extra costs for transportation to a clinic and paying for oral rehydration therapy and other medications. Avoidance costs for diarrhea included paying extra for additional water and toilet use, bathing facilities and fuel to boil water. Women also described being forced to take time away from jobs and home-chores when either caring for an ill child or being sick themselves.

Using our interview and focus group data, we generated estimates of the economic costs from sanitation-related diarrheal disease for a typical household in Mathare. We estimated direct medical care costs, avoidance costs, lost family wages and, after monetizing the value of household chores, homemaker productivity costs for a typical 4–10 day diarrheal episode. To ensure that only chores that were foregone are included, women were asked to report if these chores were actually not carried out or they were completed with free help from another person or simply delayed in the day or week. The opportunity cost was then the product of the forgone number chores and the cost to hire a person to complete that chore using the hypothetical maid and urban replacement cost. We used conservative estimates that each Mathare household would experience six diarrhea episodes in 1 year (e.g. at least one household member experiences sanitation-related diarrhea six times in year). Our results are displayed in Table 3, and suggest the relational-impacts of inadequate sanitation on household economic status.

We estimate that each diarrhea episode costs a household ~1150 and 6900 KSh per year. With the average Mathare household having a monthly income between 10 000 and 13 000 KSh, diarrhea alone can account for 9.5–11.5% of monthly expenditures. Combined with the 3–7% of monthly household expenditures on toilet access noted

Table 3: Estimated economic burdens from Diarrhea in Mathare, Nairobi

	Household cost per episode (KSh)
Direct costs (oral rehydration; medication; transport to clinic; clinic fees)	300
Avoidance costs (extra water; more toilet visits; additional fuel to heat water/cook)	130
Lost wages (lost from missed work outside home)	600
Homemaker productivity loss (foregone chores monetized)	120
Total estimated household cost per episode	1150
Annual estimated household costs (6 episodes/year)	6900

above, inadequate sanitation can represent a significant economic burden on slum households and contributes to keeping slum dwellers in poverty.

One HIV-positive women described how disease vulnerability relates to her economic status:

> People around here know of my HIV positive status and this impacts my informal business selling *sukuma wiki* [kale]. I frequently get diarrhea because I am more vulnerable to contaminated water and food. When I am sick, I either can't sell or if I do, people will say to my face they won't buy from me because they think my food will make them sick too.

Women's dignity and security

We also heard in focus groups with Mathare women about the indignity they endure from a lack of private, safe, well-lit, near-by toilets. One woman noted:

> Past eight, we can't go out to use the toilet. There is no lighting and the men drinking Chang'aa [local alcohol] on that side, get violent with us, even girls. We are forced to use a bucket…a bucket in one room in front of your children, fathers and brothers. Can you imagine? Sometimes we use the 'flying toilets' at night but your neighbors don't like this. Without any garbage collection, I wake up at dawn and sneak away to empty the bucket or dispose the bag. There is no dignity in our toilet situation.

Another women noted:

> The toilet I used to go to was made out of wood planks. I could see someone from inside and the person outside could also see me. It was really stressful going for a short or long call as I would feel eyes watching me. Once I was raped there but I couldn't tell anyone. The police don't do anything about this and you are just ashamed in your own community.

According to a recent study in Nairobi's Kibera slum (Swart, 2012) and the Kenyan Demographic and Health Survey, over 36% of slum dweller women report being physically forced to have sex, while 14% of all Kenyan women reported the same. Also in Kibera, over 30% of women reported being forced to perform other sexual acts, while 4.3% of Kenyan women reported this same experience. Thus, building more communal toilets without attention to women's security and dignity is not an adequate health promotion strategy in Mathare and other informal settlements in Nairobi. For women in Mathare, toilets are an issue of adequate infrastructure, safety, economic opportunity, stigma, dignity and human health.

From research to action

Our findings on the relational aspects of toilet infrastructure and health contributed to a number of actions in Mathare since 2010. First, our coalition of residents, the Muungano NGO and academics worked together to draft an infrastructure upgrading plan for the villages of Kosovo, 4B, Mabatini and Mashimoni. These four villages were targeted since they are on government-owned land and our coalition learned through meetings with the Nairobi City Council that the local government would support improvements on their land if a plan was developed and endorsed by residents. After completion of this plan, the Athi Water Board and the Nairobi Water and Sewer Company adopted our proposal for piped water service, financed the project and began construction in Kosovo, Mathare. The Kosovo Water Project now provides over 20 000 slum dwellers with piped water, and for the first time in a Nairobi informal settlement, residents can get a household water connection with a meter. This means that Mathare residents do not have to walk to community water taps and this is also reducing the likelihood of gang control of water access in Mathare (WSTF, 2010).

A study by the University of Nairobi found that the Kosovo Water project helped reduce self-reports of water-related diseases in the community from 67 to 26%. This same study noted a 36% increase in Kosovo, Mathare, residents reporting having access to a private toilet after

the water project, and 62% of these toilets were flash or non-pit latrines [(Munyao, 2013), pp. 55–56]. This was due, at least in part, to the increase in in-home water connections and the ability of households to invest in a private in-home toilet now that they had a reliable water source for removing waste.

Another action from the Mathare research was the drafting of the Mathare Zonal Plan, or an integrated upgrading plan for the entire informal settlement (SDI, 2012). The Mathare Zonal Plan documented living conditions and proposed improvements to water, sanitation, electricity, transportation and health infrastructures, as well as addressing land use, open space, housing and land rights issues. The Mathare Zonal Plan was the first such plan for an entire informal settlement in Nairobi, and was adopted by the Nairobi City Council in 2012. The World Bank is also using the analyses and recommendations within the Mathare Zonal Plan to upgrade and build a new municipal sewer that serves the entire settlement under the Bank's Kenya Informal Settlement Improvement Project (KISIP). UN-Habitat has also adopted the Mathare Zonal Plan for its 2014 project that will develop new recreation and play spaces for youth in Mathare.

DISCUSSION

Taken together, our survey, narrative and spatial mapping results help suggest a method for constructing a relational view of health with residents of informal settlements. Clearly, this is still an incomplete picture and additional data over time and space would help more accurately capture physical and social exposures. Additional disease outcome data for specific populations in Mathare could also help clarify who is suffering from which communicable and non-communicable diseases. However, most of our survey findings on disease burdens and risk factors in Mathare are consistent with those from other studies in Nairobi's informal settlements (i.e. Emina *et al.*, 2011; Amendah *et al.*, 2014).

Perhaps most importantly, our findings suggest the need for more complex and multi-sectoral approaches to urban informal settlement health planning, informed by residents' local knowledge, that considers the interactions between multiple types of services and living conditions. Our Mathare Zonal Plan is one example of this type of integrated improvement strategy for promoting well-being in urban informal settlements. Our relational approach highlights the potential limits of intervention strategies and slum upgrading focused on one service, disease or behavioral risk factor at a time. As we have shown, participatory research approaches are essential for generating accurate data for healthy informal settlement planning and development, yet slum residents too often are ignored or seen as passive recipients in urban public health and planning initiatives (Harpham, 2009). These strategies might encourage planners and health promoters in the global south to move from a 'health in cities' approach (i.e. intervening on one disease or risk at a time) to the more holistic, healthy cities approach [(de Leeuw, 2011), p. 226; Lawrence, 2005].

As we have emphasized, inadequate slum sanitation has a particularly disproportionate impact on women and girls and the gender inequity dimensions of our findings are of particular urgency for health promotion. Improvements in urban sanitation in Kenya have consistently been shown to improve child and maternal health by enhancing nutrition, reducing morbidity and curtailing fatal diarrheal outbreaks (Rheingans *et al.*, 2012). As this study and others have shown, improved sanitation is also fundamental for what ought to be a human right of privacy, dignity and hygienic conditions for menstruating women and girls (Sommer *et al.*, 2013). Our work is also consistent with others from Kenya revealing that improving water and sanitation for the urban poor significantly reduces girls' school absenteeism (Freeman *et al.*, 2012). Finally, but surely not the least, adequate and dignified sanitation is vital for women with HIV/AIDS, who are especially susceptible to diarrhea or opportunistic infections, and who bear the added burdens of caring for those with HIV/AIDS (Madise *et al.*, 2012).

Kenya's national policies now recognize that safe, hygienic and dignified sanitation is a right for all. For example, Kenya's 2010 Constitution protects the inherent dignity of every person in Article 28; Article 43(1)(b) grants every person the right to accessible and adequate housing and to reasonable standards of sanitation; Article 56(e) imposes an obligation on the state to formulate affirmative action programs to ensure access to water, health services and infrastructure for marginalized communities (Government of Kenya, 2010). Kenya's National Slum Upgrading and Prevention Policy [(Government of Kenya, 2014), p. 15] states that some of the core aims of the policy are: 'to provide an integrated

framework for slum upgrading & prevention to meet the standard of adequate housing, reasonable levels of sanitation and other relevant rights provided for in the Constitution'. Kenya's National Water Services Strategy (NWSS) for 2007–2015 states as a guiding principle that 'sustainable access to safe water and basic sanitation is a human right' and Kenya's National Environmental Sanitation and Hygiene Policy (Kenya, 2007) states that 'all Kenyans should enjoy a quality of life with dignity in a hygienic and sanitary environment and be free from suffering any ill health caused by poor sanitation'. As we have shown, an integrated approach to health promotion is necessary to fulfill the commitments to slum dwellers made in these and other Kenyan policies.

CONCLUSIONS

Promoting greater health and equity in urban informal settlements remains a challenge for civil society, professionals, governments and others in cities around the world. The complex physical, social and political environments of urban informal settlements demands consideration of integrated and relational approaches to knowledge generation and intervention strategies. Strategies that only focus on single diseases, hazardous exposures or narrow treatment regimes may miss the connections between different factors and forces contributing to health inequities in urban slums. Ultimately, more work needs to be done to clarify the data collection, reporting and translation processes that characterize the relational approach in urban informal settlements, but we hope our work in Mathare inspires others to build trusting partnerships with communities to more accurately capture their circumstances and inform more integrated and effective actions for health equity.

FUNDING

This work was funded by The Rockefeller Foundation grant number 2010SRC146.

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