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Pervasive Exposure to Fecal Contamination in Low-Income Neighborhoods in Accra, Ghana

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Abstract

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By Jacqueline Hurd

BACKGROUND: Globally, diarrhea contributes to about 800,000 fatalities in children under five each year, and is a primary cause of mortality in developing countries. Rapid urbanization in low-income countries has led to a growing sanitation crisis. A need exists for more effective WASH interventions in low-resource urban environments that can minimize the transmission of feces and reduce the rate of diarrheal illnesses. Effective interventions require evidence-based research that highlights risk behaviors and perceptions of fecal contamination risk in people's daily lives.

METHODS: This study examines the context of fecal contamination during daily activities among residents in low resource urban settings of Accra, Ghana. Qualitative data were collected through 16 focus group discussions to understand the daily behaviors that place people at risk of fecal contamination. Data were collected and analyzed using a grounded theory approach to develop a conceptual framework of the context of fecal contamination in low-income neighborhoods of Accra. MaxQDA10 software was used for data analysis.

RESULTS: Results show that latrine use is low in these neighborhoods leading to a range of alternative methods of fecal disposal (e.g. take aways, chamber pots, hawker's containers, and open defecation) that contribute to fecal contamination throughout neighborhoods. Feces were further spread through refuse dumping, poor refuse collection systems, recreational activities, and occupational tasks of residents. Fecal contamination also occurred between public and private domains contributing to pervasive fecal contamination throughout the study neighborhoods.

DISCUSSION: This study is unique in describing in detail the range of fecal disposal methods used by residents in their daily lives, and how feces are transmitted between public and private domains throughout low-resource urban neighborhoods. The context of fecal disposal and contamination throughout neighborhoods suggests that people may be frequently exposed to feces through regular daily activities, which may lead to a high frequency of fecal transmission overtime.

CONCLUSION: These pathways of fecal contamination underscore the pervasiveness of risk for fecal contamination throughout low-income urban neighborhoods, suggesting the need for multi-pronged interventions that target multiple pathways of feces transmission.

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Abbreviations

AMCOW	African Ministers' Council on Water
EPA	The United States Environmental Protection Agency
GDP	Gross Domestic Product
JMP	Joint Monitoring Report
MDG	Millennium Development Goals
UN	United Nations
UNICEF	United Nations Children's Fund
WASH	Water, Sanitation, and Hygiene
WHO	World Health Organization

TABLE OF CONTENTS

I. INTRODUCTION.....	1
A. Causes and Mitigation Factors of Diarrhea.....	2
B. Significance of Study.....	3
II. LITERATURE REVIEW	4
A. Risk of Exposure to Diarrheal Diseases.....	4
B. Transmission of Enteric Pathogens.....	5
C. Urbanization and Sanitation.....	6
D. Risk of Fecal Contamination due to Infrastructure.....	8
i. <i>Sanitation Systems</i>	8
ii. <i>Water Infrastructure</i>	9
iii. <i>Access to Water Sources</i>	10
iv. <i>Access to Latrines</i>	11
E. Behavioral Risk of Fecal Contamination.....	11
i. <i>Public vs. Private Domains</i>	11
ii. <i>Public Vs. Private Latrines</i>	12
iii. <i>Blocked Drains</i>	13
iv. <i>External Contexts Affect Behavior and Exposure</i>	14
F. Risk of Exposure to Fecal contamination due to daily activities.....	14
i. <i>Education and Children’s Exposure to Fecal Contamination</i>	15
ii. <i>Household activities affecting contamination</i>	15
iii. <i>Water Storage and Hygiene in the Home</i>	16
iv. <i>Behavior Change Interventions</i>	16
III. METHODS.....	19
A. Study Design.....	19
B. Study Sites.....	19
C. Table 1: Summary of qualitative data collected in study neighborhood.....	20
D. Key Informant Interviews & Transect walks.....	21
E. Focus Group Discussions.....	22
F. Data Analysis.....	23
CONCEPTUAL FRAMEWORK (Figure 1)	25
IV. RESULTS.....	26
A. Latrine Use.....	26
i. <i>Private Latrines</i>	26
ii. <i>Public Latrines</i>	28
B. Transmission of Feces	30
i. <i>Fecal Disposal Methods</i>	31
ii. <i>Feces in the Environment</i>	35
iii. <i>Refuse Disposal</i>	39
iv. <i>Choked Drains</i>	42
C. Pervasiveness of Fecal contamination	45

V. DISCUSSION/CONCLUSION	49
A. Overview	49
B. Latrine Use.....	49
C. Fecal Disposal Methods.....	50
D. Pervasiveness of Fecal Contamination in Daily Activities.....	51
E. Fecal Transmission into the Household.....	53
F. Study Limitations.....	54
G. Conclusion	54
VI. PUBLIC HEALTH IMPLICATIONS/ FUTURE RESEARCH.....	55
VII. REFERENCES.....	57
VIII. APPENDIX.....	63
A. Appendix A: Protocol and Focus Group Guides.....	63
B. Appendix B: Codebook.....	77
C. Appendix C: IRB approval letter.....	85

Introduction

For several decades many developing countries have experienced rapid urbanization, which has led to the current condition, where over half of the world's population lives in an urban setting. As urbanization increases in developing countries, access to sanitation facilities and services has rapidly decreased (Henderson 1986, Hopewell and Graham 2014). Access to sanitation facilities is an essential component in reducing diarrheal diseases (Cairncross, 2010). In developing countries, diarrheal illness is the second leading cause of death among children (WHO 2013), and a major cause of morbidity (Nasrin, Wu et al. 2013). Almost 90 percent of deaths due to diarrhea are caused by insufficient sanitation infrastructures, unsafe water, or poor hygiene practices (Black, 2003). The population in sub-Saharan Africa is expected to continue to increase at a rapid rate, from 414 million in 2012 to 1.2 billion in 2050 (UN, 2012), further decreasing access to sanitation facilities (AMCOW, 2012). As the urban population in sub-Saharan Africa rises, those who use open defecation as a primary sanitation method have increased from 16 to 25 million. Furthermore, the number of people who utilize unsafe water, such as untreated surface water, has increased from 5 to 9 million (AMCOW, 2012).

Since 2000, the Millennium Development Goals (MDG) have highlighted the need for interventions to improve the health of populations in developing countries, including improvements in water, sanitation, and hygiene (UN, 2010). MDG goal 7c focuses on providing safe sanitation facilities and aims to “halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation.” MDG four focuses on reducing under-five child mortality by two-thirds (UN, 2013), a project that would necessitate reducing diarrheal disease burden. Despite these goals there has been little improvement in sanitation in

low-resource urban settings in sub-Saharan Africa (AMCOW, 2012). To meet these goals, more research is needed to understand how fecal pathogens are transferred, and how they could be mitigated in low-resource urban settings.

Causes and Mitigation Factors of Diarrhea

In order to mitigate diarrheal diseases it is important to understand what causes diarrhea. Diarrhea is caused by infections (bacterial and viral), parasites, and helminthes found in the environment. Fecal excreta containing these pathogens are spread throughout the environment by the mechanism known as the “fecal-oral pathway” (Carlton et al., 2012). The fecal oral pathway describes primary (feces), and secondary sources (water, fomites, food mouth, soil, etc.) of fecal contamination (Pruss, 2002). Although we understand the broad causes of diarrheal illnesses, little is known about how to mitigate transmission of feces at the household level.

Currently, studies have shown how to decrease diarrheal illnesses through community interventions. Water, sanitation, and hygiene (WASH) interventions targeting water quality, water supply, hygiene, sanitation, and excreta disposal are the most commonly implemented practices (Fewtrell, 2005; Cairncross, 2010). Others, such as hand hygiene education, water treatment to improve water quality, installation of community water supply (e.g. hand pump), and implementation of latrines (Cairncross, 2010) target specific barriers of the fecal-oral pathway to help mitigate the transmission of feces throughout the environment (UN, 2010). All of these programs help to increase the mitigation methods in low-resource urban settings, but it is still unknown if people use these methods during critical times during the day.

Today, we understand causes of diarrhea (enteric pathogens, poor sanitation, etc.) and ways to mitigate fecal transmission, but we are unaware of how fecal contamination is spread in urban settings, or its pervasiveness in people's daily lives.

Significance of Study

A need exists for more effective WASH interventions in developing countries that can minimize the transmission of feces in low resource urban settings, and therefore reduce the rate of diarrheal illnesses in these environments. Effective interventions require evidence-based research that highlights risk behaviors and perceptions of fecal contamination risk in people's daily lives. Therefore, it is important to analyze behavioral data to assess perceptions of risks of fecal contamination in low resource urban settings to understand where people believe they are exposed to fecal contamination, and what interventions would be most effective. The purpose of the study is to understand the context of fecal contamination in low resource urban settings in Accra, Ghana.

The central question that this study aims to answer is, what is the context of fecal contamination in daily activities within low resource urban settings? This study will also address the following sub-questions:

1. How do women and children become exposed to fecal contamination through their daily activities?
2. How does public latrine use contribute to fecal contamination among low-income residents?
3. How are the risks of fecal contamination mitigated? (WASH practices)

Literature Review

Risk of Exposure to Diarrheal Diseases

Diarrhea is the leading cause of morbidity of all ages (Walker and Black, 2010) and is a major public health problem (WHO, 2012). Globally, diarrhea attributes to over 800,000 fatalities in children under five each year (Kotloff et al., 2013), and is the second leading cause of death in children in developing countries (Sinmegn Mihrete, 2014). In sub-Saharan Africa, 36 percent of deaths in children under five are due to diarrhea (Gupta, 2012, Mbonye, 2004). Almost 90 percent of deaths due to diarrhea are caused by insufficient sanitation infrastructures, unsafe water, or poor hygiene practices (Black, 2003). Specifically, Ghana is at risk for all of these causes of diarrhea and is ranked as the fifth most cholera endemic country in the world by the World Health Organization (WHO, 2012). Recently, in *Health News*, the Director of Public Health in Ghana stated that behavioral water sanitation and hygiene (WASH) interventions are needed to reduce diarrheal diseases (Health News, 2011), and are a cost-effective approach to reduce the burden of diarrhea (Kumar and Subitha, 2012). Therefore, research in the risk of diarrheal disease is not only critical in Ghana, but findings from Ghana could be transferrable to other developing countries.

In response to the Millennium Development Goals, organizations around the world (e.g. UNICEF, WHO) are implementing strategies to reduce the mortality rate of children under five (UN, 2013). However, these strategies have been insufficient, therefore the sanitation targets for 2015 are still out of reach for many regions —most notably sub-Saharan Africa and southern Asia. In sub-Saharan Africa only 30 percent of people have improved sanitation facilities (UN, 2013). Without improved sanitation facilities, children under five are more likely to be exposed

to fecal contamination and to experience diarrhea due to an infectious disease. Fecal contamination causes serious health problems among children under five that could be prevented with proper resources. One such way of improving sanitation conditions is by providing safe and sustainable means for people to remove feces in their environments (UN, 2013). However, 37% of the world's population is still without access to improved sanitation facilities (WHO/UNICEF, 2012). This means that over 2.6 billion people are still disposing of their feces improperly either through public garbage systems or open defecation around their neighborhoods and local public facilities, which increases chances of fecal exposure during daily activities (Walker and Black, 2010).

Transmission of Enteric Pathogens

In developing countries, poor sanitation and hygiene lead to elevated levels of enteric pathogens on surfaces and increase the risk of transmission of fecal contamination in the population Pickering et al. (2011). Diarrheal disease spreads through contact with enteric pathogens. Exposure to and subsequent infection with an enteric pathogen depends on the infectious dose and virulence factors of the organism, its ability to multiply in the environment, the host susceptibility factors and the mode of transmission (Moe, 2007). There are several ways that enteric pathogens can be transmitted in urban settings. For example, enteric pathogens can be transmitted to aquatic environments (e.g. water sources for humans) through feces. Once in aquatic environments, if they are not properly treated at a wastewater treatment plant, humans can come into contact with enteric pathogens through food, water, soil and surfaces (Moe, 2007). Additionally, enteric pathogens can be transmitted person to person by contact with another individual's feces or indirectly with a contaminated fomite—an inanimate object capable of

transmitting disease. Populations living with poor sanitation have an increased risk of developing diarrheal diseases through their daily activities because pathogenic *E.coli* levels are 10 to 100 times higher on fomites in developing countries (Julian et al., 2013, Laborde et al., 1993). Disinfection and good hygiene can mitigate contamination with feces but relies heavily on individual behavior. A long-term solution for reducing fecal transmission requires improvements to sanitation infrastructure. In order to decrease the transmission of enteric pathogens in developing countries, it is important to develop proper sanitation infrastructure that keeps up with the rate of urbanization (Jenkins and Cairncross, 2010).

Urbanization and Sanitation

Over the past several decades, rapid urbanization has occurred in developing countries (Henderson, 1986). Today, over half of the world's population lives in an urban setting. As urbanization increases in developing countries, the number of people per household is decreasing, thus increasing the total number of households worldwide (Potts and Fotso, 2007). The numbers of households are expected to triple from 1.3 to 3.6 billion from 1990 to 2050 (Jennings et. al, 2004). As the number of households continues to increase at a rapid pace, sanitation coverage rates are declining; today over 2.6 billion people currently lack access to sanitation worldwide as mentioned above (Black and Fawcett, 2008). In cities where rapid urbanization is occurring in sub-Saharan Africa, improved sanitation facilities cover less than one-third of the population – far worse than other parts of the world. In Ghana, urbanization is increasing at an annual rate of 4.2%, and over 50% of the population currently lives in urban settings (GSS, 2005). Many believe this low sanitation coverage is due to the lack of political power and human resources to appropriately develop sanitation plans and interventions in local

settings as populations continue to increase (Drewsky and Kunzmann, 1991, Yiougo et al., 2011).

The lack of priority of allocating financial resources to improving sanitation facilities is emphasized in Ghanaian government; despite the government's pledge to increase funding for sanitation, only 0.1% of the GDP budget in 2011 went towards improvements in sanitation (WaterAid, 2012). Currently, one-third of the population in and around Accra, Ghana lives in slums (UN, 2014). Consequently, in these slums, poor sanitary practices, such as disposal of human excreta in public places, can lead to contamination of water and consequently waterborne diseases (Opisa et al., 2012). Therefore, it is important that political systems allocate appropriate amounts of their sanitation budgets to covering the increasing population living in developing cities.

The Millennium Development Goals (MDG) are composed of eight health aims that highlight the need for interventions to improve the wellbeing of populations in developing countries (UN, 2010). MDG goal 7c focuses on providing safe sanitation facilities and aims to “halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation” (UN, 2013). In 2012 UNICEF and The World Health Organization (WHO) joined forces to evaluate the progress of goal 7c in the Joint Monitoring Program (JMP) report. In the JMP report, improved sanitation is defined as “access to a private toilet that is connected to a sewer or septic tank, a pour-flush or ventilated improved pit latrines, a composting pit latrine, or a pit latrine with a concrete slab” (Pickering 2012; WHO/UNICEF, 2012). Using this definition for improved sanitation the JMP report revealed that globally urban dwellers gained access to 1.2

billion sanitation facilities from 1990 to 2012 (WHO/UNICEF, 2012). However, the proportion of the population in sub-Saharan Africa with improved sanitation facilities grew by only 4% (Pickering 2012). Additionally, most likely due to the substantial increase in the urban population from 1.82 to 2.76 billion during this time, the number of urban dwellers using unimproved sources actually increased from 109 to 130 million (WHO/UNICEF, 2012). Therefore, as the urban population continues to rise more improved sanitation sources are needed.

IV. Risk of Fecal Contamination due to Infrastructure

Sanitation Systems

As urbanization continues worldwide, more sewage systems are needed to manage human excreta. Proper infrastructure of latrines is an essential component of improving sanitation conditions because it allows for the appropriate disposal of feces. In the coastal city of Accra, Ghana, which houses more than 3.9 million people (UN, 2012), 41.3 percent of the population rely on public latrines as their main sanitation facility (GSS, 2005). Shared facilities are very prevalent in the population of Accra: 23% of residents use flush toilets (e.g. toilets discharged to sewers, septic tanks or sewage to open drains), 11% use improved pit latrines, 11% use unimproved pit latrines, 9% use neighbor's toilets, 28% use public toilets, 10% use bucket latrines, and 10% practice open defecation. Although pan and bucket latrines officially became illegal in January of 2010, many people still use this system (SWITCH, 2009). The World Bank suggested that almost one third of the urban population of Accra reported using pan/bucket latrines, and 4 percent used take-aways [plastic bags used for defecation], or defecated in open settings such as a gutter (Farvacque-Vitkovic et. al., 2008). As a result open drains in Accra are

highly contaminated with enteric pathogens throughout many different neighborhoods. Each neighborhood in Accra utilizes different drainage network systems, and has unique behavioral risks and demographic compositions, but all open drains are highly contaminated with enteric pathogens (Gretsch, 2013). Overall, open defecation and the improper disposal of feces threaten health in urban Accra.

Water Infrastructure

Poor water infrastructure contributes to fecal contamination in the home. In “informal” settlements or communities with improperly sited latrines groundwater can be easily contaminated during rainstorms (Giles and Brown, 1997). Moreover, abandoned wells can cause fecal contamination due to wastes leaching into aquifers that serve as drinking supply wells (EPA, 2012). Water can also be contaminated near the surface due to leaks in piped systems or salt-water intrusion (Giles and Brown, 1997). Therefore, it is important that water infrastructures are properly built and maintained to decrease fecal contamination of water for household use.

Water can be contaminated with enteric pathogens in the household as well. In general, water stored in the home (point-of-use water) is more contaminated with enteric pathogens than water directly from a source (Pickering, 2011, Reynolds et al., 2008). Water in the home is more contaminated with enteric pathogens because of contact by human hands and incorrect storage (Momba and Kaleni, 2002). A layer of biofilm can form over time on the surface of stagnant water, which creates an ideal environment for microorganisms to live and grow (Momba and Kaleni, 2002). Re-contamination of water due to storage containers in the home is a public health risk (Trevett et al., 2005). Currently, JMP estimates a 92% coverage level of point-of-use water

sources in Ghana suggesting the need for improved sources for clean water in urban settings (WHO/UNICEF, 2012). Furthermore, there is no infrastructure for the removal of grey water—wastewater from baths, cooking, and laundry—throughout urban Accra (Verhagen et al., 2010). The lack of proper water infrastructures for clean and dirty water thus creates more risk for fecal contamination in urban neighborhoods throughout Accra.

Access to Water Sources

Access to safe water sources is an important determinant for fecal contamination exposure (Clasen, 2012). Studies have shown that areas without access to improved water sources have an increased risk of diarrheal disease (Clasen, 2012), a higher child mortality rate and increased risk for dehydration (Bartram, 2008, Lozano et al., 2012). Access to clean water not only affects health, but also the education level of children. In sub-Saharan Africa it has been shown that children who do not have access to clean water in their households spend more time fetching water and less time in schools (UNICEF, 2006). Since 1990 over 2 billion people worldwide have gained access to safe water sources, but there are still over 130 million people in urban settings without access to safe water (WHO/UNICEF, 2012).

Access to water sources affects fecal contamination directly and indirectly by influencing hygiene practices. For example, distance from a household to a water source affects the amount of water used for hygiene purposes in the household (Curtis et al., 2000); the greater the distance from the water source the less water a household will use for hygiene purposes (Curtis et al., 2000, Prost and Negrel, 1989). Many latrine options require water to operate.

Access to Latrines

Improving sanitation, and reducing feces throughout urban settings, is affected by proper hygiene and access to latrines. Several household indicators are correlated with a population's access to a latrine: the number of people per latrine, population density, distance to the closest latrine, and hygiene conditions (Roma and Pugh, 2009). The number of people per latrine is a basic indicator of the amount of time someone has to use the latrine throughout each day. For instance, if there are 50 people per latrine each person will have less time to access the latrine due to crowding. Furthermore, if there is not a latrine within 50 meters of an individual's household they are more likely to use other means for defecation (Roma and Pugh, 2009). Therefore, it is important to understand if the population has access to latrines in order to reduce fecal contamination throughout these settings.

V. Behavioral Risk of Fecal Contamination

Public vs. Private Domains

Today, there are many studies that look at problems associated with the infrastructure of private or public latrines in rural settings (Jenkins and Cairncross, 2010). In the private domain, such as the home or neighborhood there are single-family latrines, shared latrines which 1-3 families use the latrine, and public toilets, which are used at a cost by everyone in the neighborhood (Awoke and Muche, 2013). On the other hand, in the public domain, which includes the beach, market, school or religious place of worship, there are few private toilets (Boot and Scott, 2009) and the population relies on public latrines (WHO/UNICEF, 2012). A recent study in urban Brazil looked at fecal contamination in the public and private domains. They determined that a city-wide sanitation program could affect fecal contamination in the public domain (e.g. outside of

the household) (Barreto et al., 2007). There are few studies that deal with problems associated with public or private latrines in urban settings and even less that look at both public and private latrines together.

Public Vs. Private Latrines

In Accra, Ghana one third of the population has access to a shared latrine, and two thirds have private latrines in their homes (World Bank, 2010). Still, over one-third of urban residents in Accra utilize the pan/bucket system, and four percent use polyethylene bags or practice open defecation in gutters or open areas, all of which contribute much more to fecal contamination in the community than proper latrine use (World Bank, 2010). The populations who utilized a private latrine or water source were satisfied with the latrine 86 and 69 percent of the time respectively. On the other hand, those who relied on public latrines or water supplies outside of their home for sanitation purposes were only 30 and 40 percent satisfied respectively (World Bank, 2010). Not only are residents less satisfied, but in urban slums 64 percent of the population also are required to pay for the use of latrines. Each resident pays “between 10 and 20 pesewas (US\$0.07–0.14)” each time they use a latrine (Arku et al., 2011). It has been suggested that residents are more likely to use the bucket/pan latrine system when they are unsatisfied with the current latrine system that is available in their neighborhoods, but this hypothesis remains to be tested.

Additionally, studies have looked at a correlation between perceptions of latrine use in developing countries. Two recent studies looked at perceptions of household latrine use in Orissa, India and Northern Ghana (Barnard et. al., 2013; Rodgers et. al., 2007). In these studies

participants reported on advantages of public latrines such as health benefits, safety and security, cleanliness, convenience and privacy (Barnard, 2013; Rodgers, 2007). However, over 40 percent of the population that owned a latrine still practiced open defecation because they preferred open defecation, latrines lacked privacy or the latrine was not completely built (Barnard, 2013). Moreover, studies have looked at perceptions of public latrines in developing countries. A study in Kumasi, Ghana determined that people were dissatisfied with public latrines because of the latrines were unclean, there was a lack of privacy, and they were inconvenient to access (Whittington et. al., 1993). Overall, people were dissatisfied with private and public latrines in developing countries.

Blocked Drains

Drains are an important infrastructure for a neighborhood because they safely remove unwanted water from surrounding households. A recent study suggests that many households complain of environmental problems, such as flooding, throughout their neighborhoods because drains are “choked with refuse” (World Bank, 2010). Although drains are available in the city of Accra for over 76 percent of households, 24 percent of households express that “drains are not large enough to deal with water flows” (World Bank, 2010). Drains are predominantly uncovered; 70 percent of people say this is a concern to them because they are not kept clean. Moreover, 84 percent of households in urban Accra are concerned that the drains “attract mosquitoes, flies and rodents” and “cause health problems” (World Bank, 2010). Although the removal of grey water and rainwater from neighborhoods is due to the structure of drains, it is unknown whether human behavior, such as improper disposal of refuse, can affect drains and the overall risk of fecal contamination throughout urban Accra.

External Contexts Affect Behavior and Exposure

Today, 70 percent of residents in Accra perceive the city as dirty and 80 percent attribute the uncleanliness of the city to improper disposal of garbage. Refuse is collected from fifty percent of households through individual waste containers, or private companies (World Bank, 2010). Garbage is picked up daily, twice per week, or once per week depending on the company the household uses for waste collection. However, more than 50 percent of households described their garbage pick-up as unregulated – especially surrounding the private company Zoomlion (Oteng-Ababio, 2010). Moreover, fifty percent of households in Accra must dispose of their garbage through communal waste containers or at dumping sites. Households are dissatisfied with refuse collection; 52 percent of households were dissatisfied with refuse collection from their home and 64 percent of households were dissatisfied with refuse collection outside their home (World Bank, 2010). Although it has not been confirmed, it seems that dissatisfied residents who turn to alternatives for refuse disposal create a greater health risk for the population exposed.

VI. Risk of Exposure to Fecal contamination due to daily activities

In order to develop strategies and programs to decrease mortality rates among children due to diarrheal illnesses the sources of fecal contamination must be accurately identified. The risk of fecal contamination varies based on people's daily activities and behaviors (Jenkins, 2005). It has been shown that populations who come in contact with human sewage contamination are considered at very high-risk for disease (Bosch, 1998, Lodder, et al., 1999, Field & Samadpour, 2007). By identifying these sources of fecal contamination in people's daily activities the potential risk to humans in certain exposures can be identified (Jenkins et al., 2009).

Education and Children's Exposure to Fecal Contamination

School-aged children who lack access to clean water and sanitation infrastructures may have an increased risk of contact with feces through routine domestic activities. Interviews in neighborhoods around the urban city of Accra determined that health and environmental dangers are present among children in the following daily activities: “(a) waste disposal, including human excrement, (b) water collection, (c) food preparation and sale and (d) the care of infants” (Grieco, 2009). Furthermore, this study described a higher risk of fecal contamination among school-aged girls due to the different gender roles as maidservants. As servant-girls they perform distasteful domestic activities that are said to increase their risk of fecal contamination and decrease the time available to devote to their studies (Grieco, 2009). This lack of education at a young age can affect sanitation knowledge in future households. For example, it has been shown that a mother's education level is directly linked to hand-washing habits that can reduce a family's risk of fecal contamination; thus, mothers with a tertiary level of education are four times more likely to wash their hands with soap than mothers with no education (Benneh et al. 1993; Boadi and Kuitunen 2005).

Household activities affecting contamination

Household water handling and hygiene practices can also increase the risk of fecal contamination during daily activities. Specifically, contamination by hand-to-surface contact and contact with domestic animals in the household has been shown to be predominant causes of declining water quality (Eshcol et al., 2009). Pickering et al. describe how bacterial hand contamination among Tanzanian mothers varies depending on the activities performed each day. They looked at the following activities: sitting, cleaning a latrine, urinating, cleaning dishes, sweeping, bathing,

cleaning children's feces, defecating, and food preparation/eating (Pickering, 2011). The highest levels of fecal contamination on hands were found during food preparation/eating, defecation, and cleaning children's feces. However, other nontraditional activities such as doing dishes and going outside were also shown to increase levels of fecal contamination on women's hands; whereas other activities were shown to be protective such as bathing oneself or a child, and doing laundry (Pickering, 2011).

Water Storage and Hygiene in the Home

Furthermore, behavior also affects the quality of drinking water through transport and storage (Rufener et al., 2010). Rufener et al. found that the practice of open storage of drinking water creates an environment for fecal contamination inside the household (Rufener, 2010). Contamination can occur not only through the storage of water, but also by extracting drinking water using a small cup, a ladle, decanting water or touching the water (Harris et al., 2013). Identification of fecal sources also allows the potential risk to human health following the consumption of or exposure to contaminated food or water to be estimated. Although Pickering estimated the actual risk of fecal contamination, no study has looked at the perceived risk of fecal contamination in an urban setting. This data would be useful in understanding interventions and education to make women and children more aware of contamination risks.

Behavior Change Interventions

To reduce the risk of fecal contamination improved infrastructure is not enough—behavior change is also needed. A recent study looked at people's perceptions and attitudes on diarrhea in northern Ghana. Overall, “mothers had a low-level of knowledge about the causes and effects of

diarrhea in children” (Osumanu, 2008). The women they studied associate diarrhea with many fallacies: children should stop eating and drinking when they have diarrhea, diarrhea without vomiting is caused by hot foods, hunger and teething are not life-threatening, and diarrhea is caused by the ingestion of dirty foods (Osumanu, 2008). Therefore, even if sanitation structures continue to improve, such fallacies can continue to contribute to the role of infection in causing diarrhea in communities in Ghana. However, it has been shown that behavior change interventions are cost-effective and have a great impact on decreasing the risk of diarrhea due to fecal contamination (Osumanu, 2008). For example, Jenkins has shown that combining infrastructure and behavioral changes improves the management of human excreta (Jenkins and Curtis, 2005).

Furthermore, several behavioral studies on hygiene behaviors and practices found that perceptions of hygiene risk can affect exposure to fecal contamination. In her recent book, she discussed the seven types of disgust--what people avoided because they had a profound disapproval or found it to be offensive (Curtis, V., 2013). She determined that different cultures are more disgusted with certain unhygienic practices than others. For example, some people find it disgusting to put a dirty cloth on the counter, while others do not (Curtis, V., 2013). In lines with perceptions of disgust affecting hygiene behaviors, she has also looked at frequency of infant-mouth contact of potential fecal-oral vectors (Ngure et. al, 2013). In this study, the researchers determined that food, baby’s hands, baby’s cup and spoon, toys, etc. were all potential vectors for fecal contamination. Therefore, there is evidence on vectors of fecal contamination within the home, but still little is known on how feces are transmitted within the household from public locations.

It is important to know the activities associated with a higher risk of fecal contamination and behavioral perceptions regarding these risks. Studies in the past have tended to look at activities within compartmentalized domains such as the home, market, beach, school, etc. By dividing the activities in this manner we do not know the order and frequency of these activities, or how they are interconnected. Therefore, it is important to analyze focus groups or in-depth interviews of women and children's daily activities in order to understand the order of activities and how sanitation practices are affecting women and children's risk of fecal contamination.

Methods

Study design

This study is part of a larger project at the Global Center for Safe Water at Emory University. The SaniPath project utilized a mixed methods research design to collect quantitative microbial data, and qualitative data through focus group discussions, key informant interviews, and transect walks. It was important to both measure fecal contamination through the microbial measurements and to understand the exposure pathways and perceptions of risk from the qualitative data. All these methods were chosen for epistemological reasons – to gain multiple worldviews of the population in urban Accra. This paper specifically focuses on analysis of the qualitative data from the SaniPath study.

Key informant interviews and transect walks were used together with findings from peer reviewed literature to inform topics for focus group discussions. Focus group discussions were most suitable because of their ability to generate a range of perspectives and to identify community perceptions, social norms, and beliefs on the study issues.

Study Sites

For this portion of the project, the study took place in Accra, Ghana. Accra is the capital of Ghana and the largest urban city in the country. Accra consists of dense populations of urban slums, which are characterized by poor road conditions, open drainage systems, lack of improved sanitation facilities and clean drinking water. One-third of the population of Accra does not have access to a private latrine and rely on other forms of fecal disposal. This study focuses on six low resource urban neighborhoods in urban Accra (World Bank, 2010).

Six study sites were selected to represent specific cultural, (religion, prevalence of immigrants), social (occupation), geographic (coastal vs. inland neighborhoods, flooding), and infrastructure (locality to refuse dumping sites, accessibility to private and public latrines, and squatter settlements) characteristics determined to be key risk issues for sanitation issues raised from key informant interviews. Residents in these neighborhoods greatly relied on communal latrines and open defecation for sanitation practices. All neighborhoods were considered low resource with low SES levels. The data was collected from October 2011 to May 2012. The Institutional Review Board at Emory University approved this project (IRB00051584 – approval letter found in Appendix C).

Table 1: Summary of qualitative data collected in study neighborhoods.

Topic	Neighborhoods	Study Participants	Quantity
Transect walks and community leader Interviews	Alajo, Nima, Shiabu, Old Fadama, Bukom, and Madina	Community and NGO leaders	12 Transect Walks & 12 key informant interviews**
Neighborhood opinions and daily routines	Alajo, Nima, Shiabu, Old Fadama, Bukom, and Madina	Mothers with children <12	6 Focus Group Discussions*
Water, sanitation and hygiene Practices	Alajo, Nima, Shiabu, Old Fadama, Bukom, and Madina	Mothers with children <12	6 Focus Group Discussions*
Opinions and practices regarding public toilets	Bukom & Old Fadama	Mothers & fathers with children <12	4 Focus Group Discussions**

*One focus group was conducted in each of the corresponding neighborhoods.

**Two focus groups were conducted in each neighborhood

Key Informant Interviews & Transect walks

Key-informant interviews & transect walks were conducted with community leaders, assemblymen, and local non-governmental organization leaders. Twelve community leaders were chosen to understand the major problems associated with failing sanitation facilities in the study neighborhoods. Two field assistants were trained to conduct the key-informant interviews through a weeklong training session. The field assistants had previous experience conducting interviews, were familiar with the SaniPath project and understood the culture/local language to easily communicate with each key-informant during the interview. Interviews were conducted with an interview guide that was developed with collaborators, and from literature searches to identify high-risk sanitation issues in low resource settings, sanitation facilities, and WASH practices (See Appendix A for interview guide). The instrument was pilot tested and changes were made to create questions more culturally relevant to the context of Accra. Interviews were conducted in English or a local language, as preferred by participants, and recorded digitally. Following the interviews, trained research assistants conducted simultaneous translation and transcription of interviews. Transect walks were conducted with four SaniPath team members and a research assistant throughout the six study sites. The community leaders discussed sanitation issues surrounding the neighborhood by pointing issues first-hand by walking through the study site. These transect walks specifically targeted public locations such as public latrines, refuse dumping sites, markets, beaches and schools. All transect walks were data generating, but due to a high level of background noises in transect walk recording numerous interviews could not be used for data analysis.

Focus Group Discussions

Focus group discussions were chosen to learn more about local residents daily routines and identify contexts where people are exposed to fecal contamination in their daily life. Sixteen focus group discussions were conducted with mothers and fathers of children less than 12 years of age: 6 focus groups focused on daily activities, 6 on WASH practices, and 4 on latrine use. A community-based sample of women with children less than twelve were chosen for study population because this population is known to be at the greatest risk for mortality due to diarrhea. Purposive sampling was used to obtain a sample of 6-8 women with a variety of number of children, and diverse ages for each focus group. The numbers of focus groups were determined to be the estimated number needed to reach saturation for each study concept. Community leaders from study neighborhoods recruited participants from different households to obtain diversity in-group selection. Following recruitment, participants were asked about the number of children they had, age, and place of residence to confirm they met study requirements. Field assistants in the local study sites mentioned above conducted all focus groups.

Six field assistants were chosen to conduct focus groups in the local languages of Ga, and Twi in the study sites. Field assistants were chosen based on their education, language skills, and cultural background. All of the research assistants completed CITI training online and attended a weeklong training program on techniques for conducting focus groups. Focus group guides were pilot-tested and the questions were refined to further capture the research question. Each guide asked a variety of questions on the following topics: special characteristics of neighborhood, daily activities of mothers and children, activities in Specific Places and Risk of Fecal Contamination, water sources/storage, and sanitation, defecation and hygiene practices. The

complete focus group discussion guides can be seen in Appendix A. The focus groups were recorded digitally, but there was a note-taker present to take notes in the case the recorder failed. Field assistants conducted focus groups in the local language Ga, and conducted transcription and translation simultaneously.

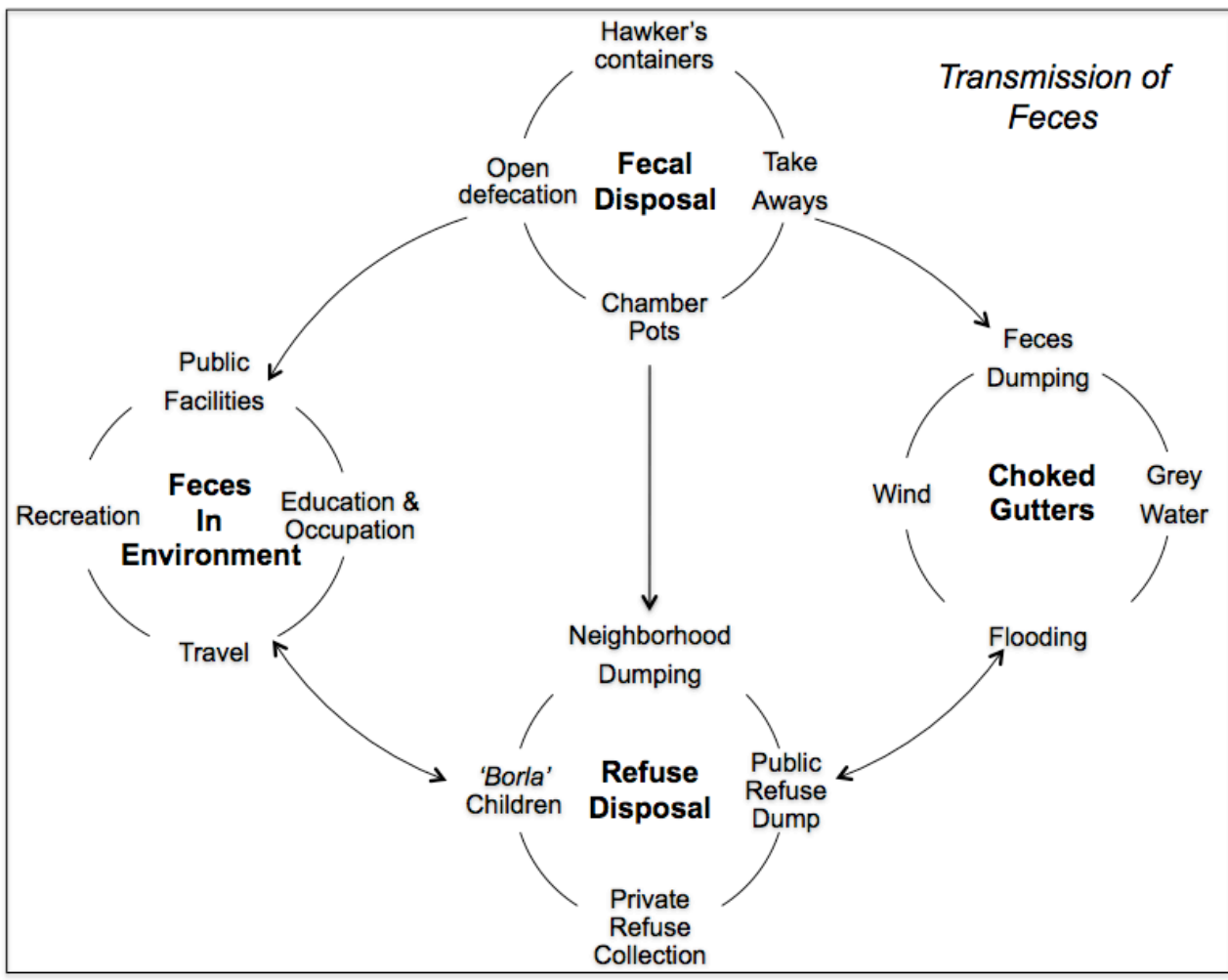
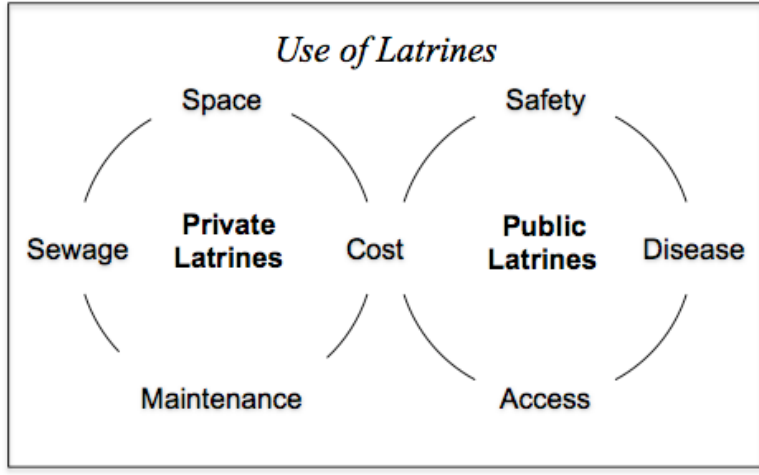
Data Analysis

Data were digitally recorded, transcribed verbatim and translated into English. All transcriptions were de-identifying for ethical purposes. Data were further prepared through memos, and the creation of a codebook based on prominent themes seen throughout all transcripts. The codebook contained deductive codes from the interview guides (structural codes, activities, places, and people) and literature review (WASH practices, risk perception, risk mitigation), and inductive codes were taken from themes found in the text (feces dumping, private refuse collection, refuse dumping) (See Appendix B). After the codebook was constructed, intercoder agreement via MaxQDA (Rettie, 2008) was completed to verify consistency in the coding process. The codebook was revised to encompass more specific definitions for several inductive codes. All data were then coded with themes from the codebook.

Data was analyzed following the grounded theory process (Strauss and Corbin, 1990) and using MaxQDA10 analysis software (Rettie, 2008). Grounded theory was selected because the theory developed can be implicitly transferable to other urban populations with similar sanitation problems. First, timelines were created that depicted activities that warrant risk for fecal contamination among women, school aged children and children under five. Key themes were then analyzed individually including perceptions of risk, gutters, feces, take aways, private

latrines, public latrines, and open defecation. Then, overlapping key segments of text, described by two or more themes, were analyzed to determine the interconnectivity between each key theme. After each intersection was looked at in detail main themes were compared and categorized to create a conceptual framework of the theory that evolved (Figure 1). The conclusions were validated through an iterative process of grounding the theory from the text. The major study limitation for this project is that is confined to an urban population and the results may not be transferable to a rural population

Figure 1: Context of Fecal contamination in Accra, Ghana



Results

Overview

Figure 1 shows a conceptual framework portraying the context of fecal contamination in Accra, Ghana. The results section is structured to describe each of the six key components of the framework in turn, then to describe their interconnectedness. The top part of the conceptual framework describes the problems with latrine use in the study setting, which lead to a range of alternative methods for fecal disposal. The context of this fecal disposal and how they lead to fecal contamination throughout residential neighborhoods is shown in the bottom half of the framework. Together, all components of the framework underscore the pervasiveness of fecal contamination in people's daily lives in low resource urban neighborhoods.

Latrine Use

Participants distinguished two types of latrines in the study setting, public and private latrines, each of which have different deterrents to their use (see Figure 1). Private latrines are available in some households, schools or within a commercial shop for staff use. Public latrines are fee-per-use facilities that are present in some neighborhoods for the use of local residents, or in public places such as a market or beach. Participants reported that private latrine ownership was low and there were significant deterrents to use of public latrines, as described below.

Private latrines

Private latrines are uncommon in the study sites, and, where present, participants described issues with using their private latrines. The small proportion of participants who owned a private latrine reported the high cost of maintaining their latrine due to the cost of cleaning products and

need for a constant supply of water to use the latrine. Participants describe that water supply was scarce and costly in the dry season, and described this as a “time of suffering” and “a big problem” when residents had to walk long distances to find water. During the dry season water use was prioritized for food preparation and drinking and was not a priority for sanitary purposes such as latrine use. In addition, private latrines require constant maintenance and sewage removal. Sewage removal was costly and parts for latrine maintenance were hard to find or too expensive, therefore, many private latrines were not used regularly or were in disrepair due to ongoing maintenance issues and costs. In study sites, sewage from private latrines passes into a septic tank adjacent to the household and is covered by a manhole. Sewage tanks need to be emptied routinely, which large truck access to empty the sewage tank via a manhole. Sewage trucks are costly and can have difficulty accessing sewerage tanks in densely populated neighborhoods. They often arrive later than requested, leading to non-use of the latrine at this time. One female participant from a densely populated neighborhood described how manholes often overflow in her neighborhood:

“But there are some [manholes] there, you will see that they are never emptied so those ones when it starts raining, if they like [...] they open them [...] so you will see that it [sewage] is flowing. It is disturbing us in the area and we are always complaining but we can’t get anybody to say that he will correct [this problem].”

As described above, owners of private latrines find sewerage disposal in this manner incessant task, and a deterrent from using private latrines in their homes.

The cost of building a private latrine was also a significant deterrent for owning a private household latrine. Participants mentioned competing household demands (such as feeding their

children), therefore could not afford to build a private latrine. The high population density in low-income neighborhoods meant there was little space to construct a private latrine or install a septic tank in a household, school or in private commercial premises (e.g. shop). Within households, participants noted the cramped living conditions whereby adding a latrine meant losing valuable living space. One father from a highly populated coastal neighborhood expressed his view of the land problem associated with building private latrines:

: “[...] I [would] like to have my own [toilet]. I quite remember telling the people around that I will like to own my own toilet they asked whose backyard will be your toilet. You see they ask [whose] backyard is [it] because here we do not have a well-planned area to build [the latrine]. Anyhow, there is no space for you to build your toilet.”

As the participant described, even if money was not an issues, there may not be a space available to build a private latrine in a household due to insufficient land in densely populated urban neighborhoods.

Public Latrines

Although public latrines were available in some study neighborhoods, their use was limited in low-income neighborhoods. Residents were deterred from using public latrines because of the reoccurring costs associated with their use. Participants described the cost of a public latrine to be 15-50 pesewas [\$0.06-\$0.18] per use depending on the latrine type. Flush toilets were the most expensive type of public latrine, followed by block and cement latrines. The cost of using public latrines was particularly costly when a family member had diarrhea, or for large families (>4 children) because of the high number of public latrine visits per day. One woman from an inland neighborhood described how public latrines use was unaffordable for her family:

“Please, I have five children and if all of them have to use the latrine every morning at 20 pesewas [\$0.07] each including me, then we will be spending close to 2 cedis [\$0.75] while we have not eaten so they should rather improve the services [of the public latrine] and reduce the price as well.”

Another issue amongst public latrines was lack of regular cleaning and maintenance. Residents believed public latrines were a high-risk area for contracting diseases; therefore regular sanitary cleaning was critical. Women, in particular women described the high-risk of contracting diseases from public latrines, such as *candidemia* (a yeast infection), from touching a ‘dirty’ toilet seat. As one mother with children five years and older described her qualms with public toilets in her low-income highly dense inland neighborhood:

“The wood and block [toilet] types give us diseases because someone can have candidiasis and squat on it and if you also go to squat on it and the causal agent [candidiasis] enters your private part you will also get the disease. That is why we want the flushing toilet [because] you flush after use and that carries all your feces away. If some else squat at the same position, it is neat for her. [...]”

Additionally, low-income residents perceived the foul smell of public latrines to be a health risk. After using a foul-smelling latrine participants expressed the need to change their clothes and/or bath themselves. Many participants preferred other forms of fecal disposal because this was a time-consuming and costly process. Parents not only feared disease, but also feared for their children’s safety when using a public latrine. The fear of their children’s safety stemmed from their children’s small size and falling into the latrine, or their inability to keep a mindful watch over their children – leading to mischief, improper hygiene practice, and mistreatment from adults.

Participants also expressed problems with accessing public latrines that prevented their use. In study neighborhoods, many participants complained of long lines at the public latrines in the morning when they urgently needed to use the facilities. Due to their inability to wait for a latrine, they would seek other forms of fecal disposal. In public locations, such as the beach and the market, participants described how the public latrine was too far away and used other forms of fecal disposal for their convenience. Accessibility is not exclusively an issue for adults-children also have to wait for a latrine. One woman describes her experience with her child waiting for a latrine and using alternative forms of fecal disposal:

“There is a public latrine for the children. But sometimes when you take them there, there may be too many kids waiting to use the place so you will have to return home and look for a bag for the child to defecate into it, and combine it with your rubbish”

Due to the lack of private latrines and low use of public latrines there is a greater risk of transmission of feces to residents of low resource urban settings due to an increase in alternative methods of fecal disposal.

Transmission of Feces

Due to the problems with both public and private latrines, four alternative methods of fecal disposal were used by residents in low income urban settings: 'take aways', open defecation, chamber pots and hawker's containers. Participants described how these methods of fecal disposal led to fecal contamination in their neighborhoods through three mechanisms: increased feces in the environment, fecal disposal in public gutters, and feces distribution via refuse collection.

Fecal Disposal Methods

Of the four methods of fecal disposal, using ‘take aways’ in private and public settings was the most common. ‘Take aways’ refers to defecating in plastic bags, also known as rubbers or polyethylene bags, which are then tied and discarded. Participants can buy the plastic bags to use as ‘take aways’ for 5-10 pewasas [\$0.02-\$0.04 cents] from local latrine attendants, or in bulk at the market. Participants stated that ‘take aways’ are typically used to dispose feces when in public settings (e.g. beach, market, streets, etc.), but are also used for fecal disposal in private settings, such as a household. Participants described using ‘take aways’ in the household mainly due to convenience and cost. They described that using a ‘take away’ was more convenient when they had diarrhea, to avoid walking to a public latrine late at night (because they were afraid for their safety), and it was cheaper than using a public latrine. ‘Take-aways’ may be disposed in a household’s private latrine or refuse container, but more typically were disposed in public places, such as in gutters, streets, or in garbage containers of other residents. One participant described the use of ‘take aways’ in her neighborhood:

“They tie [the take away] and put it in their rubbish, but such people do not allow the rubbish to stay for long. Anytime at all, the child shit she pours it in a polythene [bag], ties it up, and places it in the refuse [container] anytime she is going to toilet she carries it and throws away. But it is only few people who do this. Majority [of people] pour it in the gutters. But if there is a latrine in the house they pour it in there. But majority pour it in the gutter.” (woman, low income, densely populated inland neighborhood)

As described above, many participants dispose ‘take aways’ directly into open gutters in the neighborhood. In addition, female participants described using ‘takes aways’ to wrap children’s diapers or feminine pads before disposing these into a public gutter or refuse container.

A second method of fecal disposal was open defecation. Open defecation refers to defecating on the ground in any open area in the neighborhood, such as streets, gutters, behind buildings, in the sand or water at the beach, and rail tracks. Participants state that open defecation was ‘convenient’ because they could relieve themselves at any location, did not need to walk far to a latrine, and did not have to wait for other people- such as the public latrine. Furthermore, open defecation was an ‘inexpensive’ alternative to latrine use and buying polythene bags to use for ‘take-aways’. Men in particular described open defecation as ‘freeing’ because they could avoid the cramped, pungent smelling public latrines, and it was cost-free. One man from a highly dense coastal neighborhood described open defecation practices at the beach:

“Yes there are many places [to defecate] as you can see behind us is the beach, some go to the beach while others use the rocky area at the beach and under the bridge area at the beach. It is because we do have the little money to go pay for the public toilet also the fresh air at the beach make you feel free.”

Defecating on the beach was common practice amongst residents in neighborhoods adjacent to the beach, particularly among men and children at night when no one is around. At this time, participants also felt free because of the cool ‘air-conditioning air’ that surrounded them, and were alone to defecate in the open. However, recently open defecation has become an illegal method of fecal disposal in Accra. Therefore residents now need to seek more concealed areas for open defecation to avoid consequences from local authorities. Another common site for open defecation was railroad tracks, particularly for men before or after work. One woman described how men open defecate on the railway tracks after work.

“In rows, as soon as they finish [hawking], “away” he goes. When you get to the rails, there is a big gutter there in an alley. You will see the men; all of them upon reaching

there, they just remove their pants to defecate. One squats here, another squats there, a third person squats there in that order after that they finish will leave.”

Male participants defecated directly into gutters and were not intimidated by other residents defecating nearby. Open defecation was not exclusive to men; women and children also practiced open defecation in the study sites. Participants described how children defecated into gutters or streets in corners of the market, in the rocky areas or under a bridge at the beach or within their household compound – if they were not trained to use a latrine. One woman described how ‘untrained’ or unsupervised children defecated on the ground in a household:

“Someone may let her child defecate in the house. Someone too may not have trained her child in using the chamber pot, so when the mother is not around or even at times when she is at home, when the child says ‘mum, I will go to toilet’, she will say ‘go and spread a paper on the ground and shit’, and after that, she will ask the child to pick the feces to dispose it. So in this area, when you see a child with take away the child is on his way to throw the toilet away”

Children also used chamber pots in the household if they were not trained, or were too small, to properly use latrines. Mothers described how three or four year old children were too young to use a latrine even if there was a private latrine in their household. One mother described how her children use a chamber pot and dump the feces in a private or public latrine:

“Anyone who will allow her three year old child to go to the public toilet, then excuse me to say that person has no sense because a child of about three years is still very young. You must get a small chamber pot for the child and if you have a toilet at home you pour it inside but if you do not have, you cover it neatly and you go pay and pour it inside [the public latrine].”

Elderly adults also used chamber pots in the household due to difficulties in walking or joint discomfort did not enable them to squat for open defecation or walk a long distance to a public latrine. Therefore, most elderly rely on their children and grandchildren to help out with many daily tasks including refuse disposal and collection in the household. One female participant describes how the elderly using chamber pots:

“For someone who is very old he would be allowed to defecate into a chamber pot. Others would have a chair made with a hole in the middle. A chamber pot is put under the hole so when he sits on the chair and defecate into it, they can take it to the toilet and flush it.”

In addition to the elderly and children, adults also use chamber pots, but for different reasons. Adults described using chamber pots because they were ‘convenient’ and ‘quick’ especially in evening or in the early morning when they are ‘afraid’ to use the public latrine. One female participant describes how her fear to leave her household at night compels her to use a chamber pot and dispose of feces in the morning:

“Maybe someone has an upset stomach at night and the gutter is nearer,... by the time they get to the toilet too late, so unless every household gets a latrine ... that is when all this will stop. Because when it happens you are even afraid to go out at night to toilet, you will use the chamber pot when daybreaks you pour in your toilet in the gutter... If it gets full and not yet collected, the public toilet is there once you start you will get used to it.”

Although women practiced open defecation, they often preferred alternative methods of fecal disposal. For example, women working in the market described using small containers placed under a market stall so that they did not need to go far from their stall to defecate and lose

customers. They would defecate in these containers and cover them until the end of the day when they dumped them into refuse containers in the market or in public gutters or streets. This form of fecal disposal was not as common as other methods mentioned above, but was used frequently amongst market and street vendors.

Feces in the Environment

Participants described how the alternative methods of fecal disposal, described above, contributed to fecal contamination in their local environment. Feces are spread in the environment through four main mechanisms: recreational activities, occupation/education duties, traveling between locations and using public facilities. These four mechanisms occur in a wide range of daily activities, such as attending schools, beaches, streets, markets, public bathhouses, and railway tracks among adults and children.

Recreational activities contribute to the spread of feces in the environment, as described above, many participants practice open defecation on the beach because public latrines are far away and often expensive for residents. Participants complained that there were always feces on the beach, and they would commonly have to avoid stepping on fecal matter. Children also came into contact with feces on the weekend while swimming at the beach. Participants described that both children and adults defecate into the water while swimming, and also come into contact with feces while playing on the sand or swimming in the water. Therefore, participants described the beach as a particularly high-risk area for fecal transmission and believed they could easily contract diseases from this setting. After school, participants described how children walk through feces in the neighborhood as they play on the streets, and thereby bring feces into the

home on their shoes. Mothers were distressed as they described how their children's shoes brought an unpleasant smell throughout the entire household.

Feces are also spread through the environment by occupation/education duties, particularly for children who attend school, and occupational tasks performed by fishermen and truck drivers. . As described above, children commonly open defecate in public places, such as in the streets or into gutters when there are no latrines available in the household or school. However, children are often ashamed of defecating in the open, and frequently have accidents after eating meals that upset their stomachs. Mothers described how children often defecated into their pants at school because they were obliged to eat the food from the feeding program, which caused diarrhea. For example, this woman explained a discussion on defecation at school with her school-aged daughter.

“Yes, when I asked her what the little children do when they need to attend to the toilet she says the little children go and squat near the big gutter and ease themselves there.”

(Woman, low income, densely populated inland neighborhood)

The feces were also spread through the sand at the beach when fishermen drag their nets over the sand to make repairs, or to areas where fish is sold. Dragging nets across the sand spreads feces over the beach, contaminates fishing nets and the fish inside these, thus putting fisherman, beach-goers and customers at risk of fecal contamination. The following extract describes how people come into contact with feces at the beach after fishermen spread feces on the beach.

“Reaching the beach you will see feces all over. Unknowingly he steps in the feces; sometimes people dig holes and shit inside it and unknowingly he steps on it and it splashes on his sandals so he will need to use the seawater to wash the toilet away.

Secondly the fishermen are also to blame [...] because when they go to sea and return, when the net is in the canoe it's difficult to pull the canoe ashore. It's the same human beings who bring the net out of the canoe and sometimes you see them dragging the net on the ground through the feces to take the fish [up] the hill." (Woman, medium populated, immigrant, inland neighborhood)

Occupational risk is not limited to fishermen. Feces are also spread in residential neighborhoods when trucks drive over 'take aways' that are discarded in the streets or from overflowing garbage bins, resulting in feces splashing over streets, walkways and pedestrians. One woman described her experience with the transmission of feces walking on the streets in between the beach and her household:

"Along the road you would see a rubbish bin[s] overflowing with rubbish and if there is toilet in it can fall off the [bin] and the driver unknowingly drives over the toilet, he doesn't know that there is toilet lying there, and splashes it. So if you happen to be around there, it splashes on you. When you [smell] it you will realize that it is toilet."

Participants were very concerned about truck drivers splashing them with feces because they believed this fecal transmission carried feces in the home thus increasing their risk of disease.

A further method of fecal transmission in the environment is attributed to people traveling through and between contaminated areas of the neighborhood. For example, feces are spread when residents step on garbage that contains 'take aways,' and then walk through the neighborhood or into their homes. Participants noted that the streets were not clean, and that there was garbage in the streets and nearby gutters that overflowed onto their walking path—especially during the rainy season. In the rainy season choked gutters overflow and wash refuse

onto the surrounding roads. Furthermore, during rainstorms septic tanks can overflow through the manholes and contribute to fecal transmission in surrounding streets. Therefore, it is nearly impossible for residents to avoid walking through the streets without coming in contact with feces. One female participant described her experience with manholes in a low-income inland neighborhood during a storm.

“But there are some [manholes] there you will see that are never emptied so those ones when it starts raining, if they like, they open them...so you will see that it is flowing. It is disturbing us in the area and we are always complaining, but we can't get anybody to say that he will correct [the problem].”

Participants were also exposed to feces in the environment while hawking (e.g. selling good in the market) by the roadside or in the market. When residents go hawking they have to pass through contaminated rail tracks, thus spreading feces further onto roads - especially after heavy rains or wind (discussed later). After reaching the market participants are further exposed to feces in the environment from choked gutters. Sellers often step in gutters or come in contact with refuse containing ‘take-aways’ when they were wandering soliciting customers.

Finally, feces are spread in the environment through the use of public facilities, in particular bathhouses. When using the public bathhouse residents would often defecate in the shower stalls while bathing, because they did not want to pay for latrine use in addition to their bathing costs. After using the public bathhouse many residents did not discard their feces, therefore exposing others to their feces. In addition to defecating in the bathhouses participants also described using ‘take-aways’ and disposing them into a bucket inside the bathhouse. For example,

“Yes if the people goes to the washer [public bathhouse] they buy the rubber bags and shit into it, there is a bucket there, though not for collecting toilet, he can place it there. Also if some is having a running tummy and has been to the toilet five times, he will buy the take away [rubber bag], and shit inside because they can’t pay at all times.”

Participants described how feces in their environment from during daily activities contributed to an increased risk of fecal contamination in study sites.

Refuse Disposal

In addition to feces in the environment, private and public refuse disposal contributed to fecal contamination in low-income urban neighborhoods. Refuse not only contained unwanted waste material (e.g. food, plastic bags, etc.), but participants also dumped feces into refuse containers from ‘take aways’, diapers, chamber pots, and market containers (as described above). Therefore, wherever refuse was present in the neighborhood, feces were most likely present as well. Since refuse was not exclusively disposed in refuse bins, but also in gutters, neighbor’s refuse bins, public refuse dump, and illegally behind buildings (if they could not afford to pay for refuse collection). This meant that feces were also being distributed throughout the neighborhood.

Figure 2: Refuse disposal in Accra, Ghana



Photo Courtesy of Habib Yakubu

Private refuse collection services also contributed to the spread of feces in neighborhoods due to their unreliable collection schedule. Zoomlion, a private refuse collection company in Accra, collects garbage from private refuse bins that they provide to customers at a fee. However, some residents could not afford to buy private refuse containers from Zoomlion, and discretely disposed of their garbage in a neighbor's refuse bins, often causing refuse bins to overflow onto the streets. In study sites participants complained that Zoomlion's collection schedule was unreliable, often arriving three or four days after scheduled pickup date. Therefore, garbage bins were left on the streets for extended periods of time and began to overflow. However, when Zoomlion only collected garbage that was inside the bin leaving any overflow on the streets.

Zoomlion's inconsistency exacerbated the garbage issue in study sites and frequently annoyed participants. One participant described her frustration with Zoomlion:

“Now the dustbins that are being provided, that is, the Zoomlion; not everybody has money. As for me, in my house, I have the big and small one but it is not everybody who has [a bin]. [...] For me before I wake up some people would put rubbish behind my store and I have to add it to mine [her refuse bin]. Also this Zoomlion people if dustbins are full and they came today, say Wednesday, it may happen that they will not come the following Wednesday but Saturday so by all means when they come and their collection schedule is over due by five days and we have put the excess rubbish boxes beside our main bin, they will collect the main bin and leave the others.” (Women, inland, medium dense immigrant neighborhood)

Other private refuse collection involved, paying ‘borla’ (garbage) children a small amount, 20-70 pesewas, [\$0.07-\$0.25] to take household refuse to the public refuse dump. However, ‘borla’ children often keep the money for themselves, and dumped the refuse in the neighborhood or would never pick up the garbage at all. For example:

“They [borla children] have taken the money, but left the rubbish. Where we are there is a gutter there and the young men [pick it up] for us so we give them money, at times they charge ten cedis [\$0.04] and we contribute and pay then they will tell you to just go... The young boys who claim to be collecting rubbish are those who are mainly doing this. They [pick up the] rubbish from elsewhere and leave it right in front of your house.” (Woman, inland, highly dense immigrant neighborhood)

Participants described how ‘borla’ children would often use the money for their own activities (e.g. games) and to buy goods in the market (e.g. candy). ‘Borla’ children rarely bring the refuse

to the public refuse dump, but some residents take their refuse directly to the public dump themselves for refuse that contained a large amount of feces.

“And also for me because I have babies who use diapers, whenever I remove it I don’t put it in the rubbish, I tie it in polythene and take it to the refuse dump straight. But for rubbish like sweeping, and so on I pile it for three days and pay kaya borla to throw it away for me for seven thousand (seventy pesewas).” (Woman, low-income, highly dense inland neighborhood)

Household refuse was rarely taken straight to the refuse dump, especially for those who lived far from the refuse dump, residents usually used private refuse collection bins, ‘hired borla’ children or dumped refuse into neighbor’s refuse bins. However, residents who lived close to the public refuse dump took their garbage directly to the public refuse dump site after their children defecated into chamber pots, or diapers. Participants believed heaps of fecal excreta in their home would attract insects such as flies and mosquitoes in their home, and lead to an increase in disease in their household. In spite of this belief, many participants could not afford to bring their garbage to the public refuse dump and threw their garbage into gutters (e.g. open drains).

Choked Drains

Participants were exposed to fecal matter that was dumped in public drains, in takeaways, grey water, or when it was spread by the wind or rain. Fecal transmission from public drains was considered a ‘high risk’ problem for participants because they were constantly exposed to drains throughout their daily activities.

Figure 3: Choked drains in Accra, Ghana.

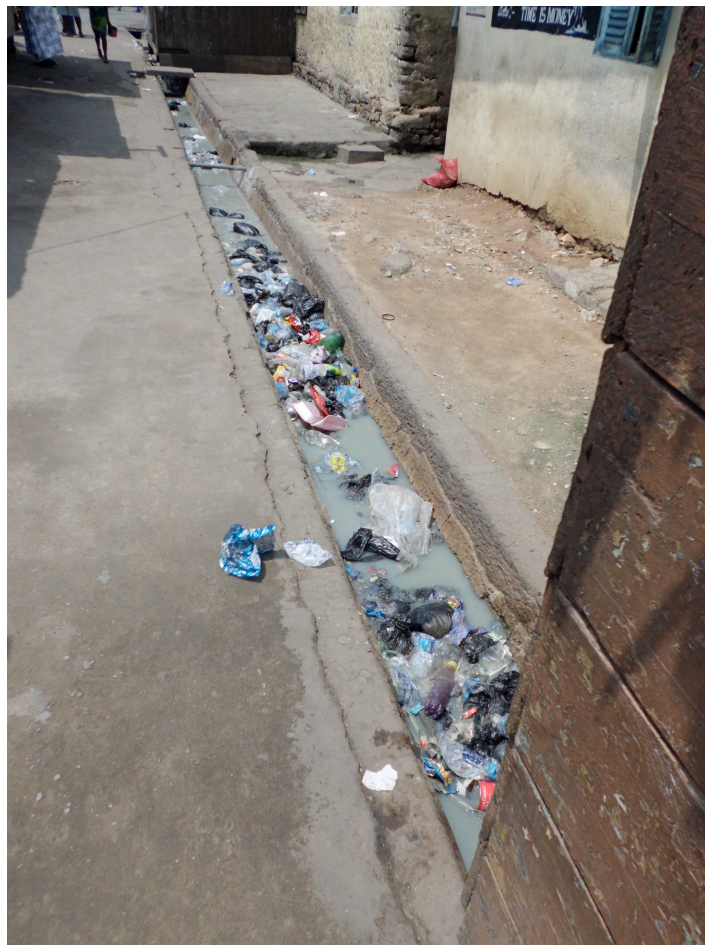


Photo Courtesy of Habib Yakubu

Participants described how they were easily exposed to contents in drains during their daily activities. Stepping in a choked drains increased transmission of feces because drains often contained refuse where participants disposed their feces (e.g. take aways). Children unknowingly walked through uncovered drains during afterschool games or in transit to and from school. Although children are unaware of the heightened risk surrounding drains, adults are often hyperaware of the risk of walking through choked drains. Adults were particularly concerned with contact with choked drains when someone had an open wound (e.g. cut). Additionally, residents perceive this exposure to increase fecal contamination from choked

drains and increase transmission of disease among children. One woman describes how children are exposed to feces when defecating into gutters:

“Yes they squat by the big gutter and ease themselves into it. Sometimes some of the children even fall into the gutter.” (Woman, low-income, inland neighborhood)

In addition to dumping excreta, participants also mentioned dumping ‘grey water’ from the household in choked drains. Grey water is wastewater produced from household chores such as cooking, cleaning, washing, sweeping and bathing. Participants mixed other household wastewater (e.g. sweeping the floor), and poured all of the contents into the drain. Drains often contained other waste from feces dumping practices (e.g. take aways), which blocked the drains and prohibited water to flow directly through the pipe. Grey water would often overflow onto surrounding roads where the drains were choked and consequently transfer feces to surrounding areas. Furthermore, participants combine their refuse with grey water in the household and often removed fecal containers (e.g. take aways) with their hands before pouring grey water into the drain. This increased transmission of feces from participants touching this waste. One participant mentioned her neighbor pouring grey water into a choked drain, and how it overflowed onto the surrounding roads.

“Please, you will see toilet [in the gutter]... so the person who lives close the gutter has [been] blocked [on] both sides. This prevents the water from flowing directly through the gutter so it flows through another direction and if you have to pass by [the gutter], then you will pass through the mud [from the gutter] to wherever you are going to” (Woman, highly dense, low income, coastal neighborhood).

Furthermore, environmental conditions, such as heavy wind or flooding, cause drains to become blocked with refuse from the streets. Participants described how rain could contribute to the

transmission of feces through in two ways. First, the wind can blow contaminated refuse from choked drains into surrounding streets and into households. Once in the household, women remove garbage by sweeping it into a pile, often touching the refuse to dump it back into the drain or in their private refuse bin. Secondly, wind can carry refuse into the drains from private refuse bins. Thus, increasing the abundance of refuse in drains and chance of transmission of feces when participants travel between locations, especially in the rain. In heavy rains, when the drains are choked with refuse, the waste can even spillover onto someone's doorstep. One participant describes her experience of contents from a choked drain:

“In my area...there is a small gutter lying there. By daybreak when you wake up, it is full [with feces] and nasty. When this happens and the rains come, all the things land at your doorstep and it is not a nice thing to see.” (Female, low income, densely populated coastal neighborhood)

All of these mechanisms associated with choked drains increase the risk of fecal contamination among low-income urban residents. The transmission of feces caused by feces dumped, feces in the environment, refuse collection and choked drains are not limited to the locations mentioned above. Each component of fecal transmission contributes to the pervasiveness of fecal contamination throughout all locations in the neighborhood.

Pervasiveness of Fecal Contamination

Fecal contamination occurred through the mechanisms described above but also between each of the domains described above, contributing to pervasive fecal contamination throughout the study neighborhoods. The four circles of fecal contamination shown in figure 1 are also interconnected

thus contributing to the pervasiveness of fecal contamination throughout low-income urban settings. The interconnectivity between the circles is described below.

There is a two-way link between refuse disposal and choked gutters that exacerbates fecal contamination in each circle. For example, the overflow of refuse often flows into public gutters causing them to become blocked, but choked gutters also increase the refuse in the neighborhood from wind and rain (hence the double arrow between these two circles in Figure 1). This interconnectivity increases fecal contamination among low-income urban neighborhoods. Refuse collected in private refuse bins often overflowed because of the inconsistency of Zoomlion's collection schedule (as described above), leading to overflowing refuse from the private refuse bins is often carried into open gutters during the storms (e.g flooding) and/or strong winds. Through this pathway and in combination with other fecal dumping methods listed above, public gutters become choked. Thus leading to fecal contamination as described above in the choked gutters section. Inversely, choked gutters can lead to issues with refuse dumping. For example, refuse from choked gutters are occasionally de-silted by young men around households. After de-silting gutters full with refuse young men dump refuse into private refuse bins, or they put them in bags for 'borla' children to collect. Therefore, refuse is dumped in the environment (hence arrow referring to feces in the environment to refuse dumping) after de-silting gutters and consequently increases the risk fecal contamination in and around households as described in the refuse disposal section above.

Refuse disposal methods can also increase feces in the environment and increase the risk of transmission to residents and visa versa (refer to double arrow between refuse disposal and feces

in the environment in Figure 1). Participants mentioned not being able to use the private refuse collection company, Zoomlion, because they had to leave before the vehicle picked up the garbage in the morning – therefore they hired ‘borla’ children to pick up their garbage. However, as mentioned above, ‘borla’ children were inconsistent in collecting garbage from households, and/or dumped the garbage in front of other households, in alleys or in streets. Therefore, garbage from one part of the neighborhood was transferred to another domain. Participants described how this garbage contained ‘take aways’ and contents of chamber pots were deposited back into the environment and through the migration mechanism described above.

“Also there are others who leave the house early before the vehicle come so there are some children who move about requesting to dispose of the rubbish for a fee. Such children they take the money and collect the rubbish and when they get to an alley and there is nobody watching them, they drop it there and run away. The vehicles are not many because we have been asked not to dispose of rubbish at where we used to dump it. We are saying that the vehicles take money but the skips are not enough for us in this area.” (Woman from an indigenous, low-income, inland neighborhood)

Once feces in the environment after being dumped behind buildings by ‘borla’ boys (hence the arrow from refuse disposal to feces in the environment) participants described how adults and children came in contact with feces in the environment (e.g. alley-ways and streets) by traveling to other locations. On the other hand, feces in the environment (e.g. in markets, streets, etc) led to increased use of refuse disposal methods, because residents wanted to rid of fecal contents around their household. This increased in refuse disposal amplified fecal transmission among low-income residents as described in the refuse disposal section above.

The final interlinked pathway is seen at the top double arrow in Figure 1 between the latrine use and transmission of feces components. The lack of latrine use caused participants to use alternative fecal disposal methods, but some participants dumped feces from fecal containers into latrines. Participants mentioned pouring feces from chamber pots and hawker's containers into private latrines or public latrines for a small fee (5-10 pesewas) [\$0.02-\$0.04 cents]. Excreta from chamber pots, especially for children and elderly adults, were stored in the household (immediately to days later), and then disposed of in the public and private latrine. Storing feces in the household contributes to transmission of feces in this setting because the longer it is in the household the more likely participants are to be exposed to the feces. Moreover, participants mentioned that transferring feces to the toilet and cleaning the pot afterward exposed them to feces – especially if they did not wash their hands after disposing of feces.

“In chamber pots with cover so they will first pour water into it and shit then cover it then you take it to the toilet and throw it away carry your small container with water to clean the pot afterwards.” (Woman, immigrant, low income, inland neighborhood)

On the contrary, participants use of latrines to dump their feces in from fecal containers (e.g. chamber pots) inhibited access to latrines by creating a longer line for public latrine use, and increased resident's perception of risk of disease when using a latrine. Thus increased use of alternative fecal disposal methods (e.g. open defecation) and led to an increased transmission of feces through feces in the environment, refuse disposal problems, and choked gutters. The circles interconnectivity, described above, shows the pervasiveness of fecal contamination in low-income urban settings in Accra, Ghana.

Discussion

Overview

This study shows that despite some availability of public and private latrines, they are not used consistently, leading to a range of alternative methods of fecal disposal. We identified the alternative methods of fecal disposal and how feces is further spread throughout the neighborhood by refuse dumping, poor refuse collection systems, recreational activities, and occupational tasks of residents. Together these pathways of fecal contamination underscore the pervasiveness of fecal contamination in low-income urban neighborhoods, and the widespread risk of contamination for residents in conducting their daily activities. In addition, there is an unclear distinction between the private and public domains in low-income neighborhoods, which enables fecal contamination between these domains. Overall, this study presents a more detailed examination of fecal contamination that shown elsewhere and shows the pervasiveness of fecal contamination throughout low-income neighborhoods.

Latrine use

Results show that even where private and public latrines are available they are not always used for fecal disposal. One of the main reasons participants did not use public latrines was because they were perceived as high-risk areas for fecal contamination. This perception of latrine is also reflected in the Miasma theory presented by Johnson (2007), which shows how residents believed they contracted disease from the presence of “bad air” or smells during the mid-1800s cholera epidemic in London (Johnson, 2007). However, perception of risk of fecal contamination was not the only reason participants in our study did not use public latrines. Participants also used other forms of fecal disposal. A recent study in Orrisa, India examined the impact of

providing household latrines in areas where residents preferred open defecation. They determined that an increase in availability of latrines did not lead to a decrease in open defecation practices because residents preferred open defecation. About one-third of residents who that had a functioning household latrine did not use it because they practiced open defecation (Barnard et al., 2013). In parallel, our study found similar results on private latrine use, but our study is unique in that it distinguishes barriers to use of each type of latrine (public and private) and details why other forms of fecal disposal methods are used in place of latrines. There are very few studies that examine the use of both private and public latrine together. One study that looked at both public and private latrines in urban Brazil determined that the implementation of private latrines can influence fecal contamination in the public domain due to lack of proper sewage systems (Barreto et al., 2007). However, our study went a step further to understand if people use public and private latrines as well as other fecal disposal methods. In general, most studies that examine both private and public latrines only report on satisfaction level of residents who use the latrines or level of access (WHO/UNICEF, 2012, Tumwebaze et al., 2013). Whereas our study does not exclusively focus on the use of both private and public use, but also other forms of fecal disposal methods. By understanding the use of other forms of fecal disposal (E.g. take aways, open defecation, chamber pots, hawker's containers) we can further understand the pervasiveness of fecal contamination throughout low-income resource settings.

Fecal Disposal Methods

This study is unique in describing in detail the range of fecal disposal methods used by residents in their daily lives, and how feces are transmitted between public and private domains

throughout low-resource urban neighborhoods. Most previous literature specifically focuses on one form of fecal disposal method (e.g. open defecation). However, a recent study in Orissa, India, discussed different disposal methods of children's feces (open defecation, chamber pots, diapers, and latrine use), but was limited to household disposal and to children (Majorin et al., 2014). Comparably, our study discusses a broader range of alternative methods of fecal disposal: Take aways, open defecation, chamber pots and hawker's containers, but for both children and adults. Furthermore, we also describe disposal methods in public locations and how they are disposed of in private refuse bins, gutters, and in the environment. Additionally, our study depicts how the spread of feces occurs in low-income urban neighborhoods. The transmission of feces occurs through environmental factors, such as the wind and the rain, within public bathhouse, during recreational activities, traveling between domains, etc. Previous studies typically describe how hands and water are vectors for diarrhea (Mattioli et al., 2013), but are limited to one source of fecal disposal (e.g. latrines, take aways, open defecation) and are often compartmentalized within the confines of a single location (as described above) (Ngure et al., 2013). These studies are informative in describing how to implement specific interventions by compartmentalizing fecal transmission within specific locations, but do not depict if and how this problem may translate into other locations. This being said, our study portrays the context of fecal contamination, how it is transmitted within each domain as well as between domains, and the interdependency of fecal contamination in urban settings.

Pervasiveness of Fecal Contamination in Daily Activities

The context of fecal disposal and contamination throughout neighborhoods suggests that people may be frequently exposed to feces through regular daily activities, which may lead to a high

frequency of fecal transmission overtime. Previous work highlights where fecal contamination exists within a single domain or one location (e.g. the household) (Badowski et al., 2011, Julian et al., 2013), but does not depict fecal contamination throughout multiple settings in people's daily lives. Badowski determined that within the household feces were spread through contaminated water, and hands in food during specific household activities. The most common activities that contributed to the spread of fecal contamination included cooking and eating through contaminated fomites (Julian, 2013). Most participants in Bodowski's study were aware of how they could mitigate the spread of feces through common household practices such as hand washing, and safely storing drinking water. However, carrying out mitigation methods (hand washing) after contact with feces (using the facilities, changing a child's diaper, etc.), was not evident into everyday activities (Badowski, 2011). Our study shows how fecal contamination in the household may be at low risk, but due to the frequent exposure people may be at a higher risk of transmission, not only because they are exposed to feces multiple times a day in the household, but also externally in public domains.

Fecal contamination is not limited to the household, but can be transferred within and between other domains. Previous studies depict how a direct relationship exists between recreational beach activities in the sand and enteric illnesses (Heaney et al., 2012) and between recreational activities in swimming in contaminated waters (e.g. water that contains sewage) (Haile et al., 1999). This study describes a broader context of fecal contamination across multiple domains and between private and public domains. For example, children can come into contact with feces at a public setting (e.g. sand at beach, gutter at market) and walk through the street into their home. Therefore, transferring the feces with there shoes on the road and fomites within their

household. As far as we know, there is little to no data showing the pervasiveness of fecal contamination in urban settings such as between the beach and the household.

Fecal Transmission into the Household

This study describes how feces are spread from public areas in the neighborhood into private households as well as spread inside the private domain (e.g. household). For example, adults bring feces into the home after visiting the market or they can be contaminated with feces from choked gutters, and overflowing refuse around the household. Previous studies depict how people are contaminated in the household through household chores (e.g. cooking, cleaning), such as in the example above (Pickering et al., 2011), but do not discuss the transmission of feces from outside sources. This study depicts three transmission pathways of fecal transmission in the household: transmission exclusively within one domain (e.g. a household), from public domain to household (e.g. beach to household), and from the household to the public domain and back (e.g. household to school to household.). These transmission pathways together depict pervasive fecal contamination throughout low-income urban settings.

Given the pervasiveness of fecal contamination, multiple interventions would need to be implemented in low-income neighborhoods in order to stop the transmission of feces within and between domains and thus reduce the burden of diarrhea in these settings. It is the hope of our research team to use the context of fecal contamination to understand how to effectively mitigate the risk of fecal contamination in low-income urban neighborhood in the most cost-effective and timely manner.

Study Limitations.

This study was conducted in an urban setting in Accra, Ghana. Therefore these results may not be transferrable to rural settings.

Conclusion

The use of public and private latrines is low in low-income neighborhoods leading to a range of alternative methods of fecal disposal, which are shown to contribute to fecal contamination throughout neighborhoods. This study is unique in describing in detail the range of fecal disposal methods used by residents in their daily lives, and how feces are transmitted between public and private domains throughout low-resource urban neighborhoods. Feces were further spread through refuse dumping, poor refuse collection systems, recreational activities, and occupational tasks of residents. These pathways of fecal contamination underscore the pervasiveness of risk for fecal contamination throughout low-income urban neighborhoods, suggesting the need for multi-pronged interventions that target multiple pathways of feces transmission.

Public Health Implications

As urbanization continues to increase at a faster rate than sanitation it is important to understand where fecal contamination is occurring in low-income urban settings. Therefore this conceptual framework (Figure 1) is useful in determining where to implement multi-pronged interventions in low-resource urban settings to help mitigate the transmission of fecal contamination.

1. **Plan for private and public latrines in new housing and neighborhood developments.** Given the lack of space, and low access to private and public latrines, improved neighborhood strategies could help increase the availability of latrines and create more space for a growing population.
2. **Mandating covered drains in low-income neighborhoods.** Given that feces are spread throughout the neighborhood via wind, rain and dumping, mandating covers be placed on public drains may reduce spread of feces in the neighborhood.
3. **Mandate consistencies in refuse collection times in low-income neighborhoods.** Inconsistent refuse collection times leads to an increase of feces in the environment and choked gutters, which contributes to transmission of fecal contamination in low-income resource settings.
4. **Educate adults on the risk of fecal contamination in high-frequency areas.** Given residents may be frequently exposed to feces through regular daily activities this may lead to a high frequency of fecal transmission overtime. Therefore, by educating residents

on the pervasive transmission of fecal transmission overtime they can understand how to mitigate the risk of contamination.

5. **Mandate latrine availability in schools for children.** Given many children had to defecate in the open at schools due to low availability of public latrines increased their risk to fecal contamination and to other in the household. By mandating latrines in schools we can help improve sanitation among children and decrease fecal transmission into the home.

Future Research

- Through this research we understand how fecal contamination is spread through low resource urban settings, but we do not understand how this compares to the actual risk of fecal contamination in these settings. Therefore, it would be appropriate to compare how participants perceive fecal contamination to be spread throughout low-resource urban settings and the actual risk to determine where WASH health education is most appropriate.
- Furthermore, it would be interesting to conduct a similar study in rural settings to understand if the conceptual framework would be transferable to this setting or if there would be any distinctions between the two settings.

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Appendix A – Protocol and Focus Group Discussion Guides

PROTOCOL

Purpose of the Focus Group Discussion

This focused group discussion is part of a broader study intended to learn more about daily routines and identify environments where people may be exposed to fecal contamination in the home and neighborhood. The group discussion will provide information on experiences and opinions of those who use communal latrines. This data will be combined with communal latrine observation data and exit interviews of users to develop a well-rounded picture of communal latrine use.

Participants

Criteria: Eligible participants will be fathers and mothers of school-aged children who reside in the neighborhood (not visitors from outside the neighborhood) and whose primary defecation site in a public latrine. Discussion will be conducted with fathers and mothers in separate groups (there will be no mixed gender discussion groups). A **total of six** fathers and mothers should be recruited for each discussion in each neighborhood. *Language:* All participants should be able to communicate comfortably in the same language.

Recruitment

Participants should be recruited from their households. To provide some diversity among participants, they should be recruited from different households/compounds and streets. If possible, half the participants should be recruited from one part of the neighborhood and half from another part of the neighborhood. None of the participants should come from the same household. Although the discussion group size will be six, 6-8 participants should be recruited to be part of the discussion as some who are recruited may ultimately decide not to participate. If fewer than 6 participants arrive, additional eligible participants should be recruited; however the group size should be kept to a maximum of 8 participants.

Venue

A quiet and private venue is needed to reduce interruptions and enable good quality recording. The *Slum Dwellers Association* building maybe a good example of such a venue. Moderators and notetakers should arrive an hour before the beginning of the discussion to familiarize themselves with venue, set up the space where the discussion will take place and review key discussion points. Recording devices must be tested in the venue prior to the arrival of group discussion participants.

Conduct of Discussion

The group discussion should be conducted by a male or female moderator and a male or female note taker, according to the gender make-up of the discussion group. The moderator will lead the discussion using the guide questions. The note-taker should get consent from each participant prior to start of discussion, note key points during the discussion, help keep time, manage the recording, any distractions, provide refreshments, etc. The note-takers role is important as the recording device may fail or be refused by the participants. The moderator should give an introduction about the project and the purpose of the group discussion (as included on the discussion guide). Ensure that all participants give consent to record the discussion before turning on the recorder. Participants will be provided with light refreshments. The moderator will follow the questions on the discussion guide as well as explore additional issues raised by participants – this will be described in the briefing session.

Data Recording and Transcription

The group discussion should be recorded with a digital recorder using an omni-directional microphone to capture all voices in the group clearly. After the group is completed, the recording should be translated and transcribed verbatim, exactly as is said. Each speaker should be identified by a number eg P1, P2, etc and the moderator's speech identified as M: We will provide an example of the transcription format required.

Consent to Participate in a Focus Group Discussion

Title: Assessment of Fecal Exposure Pathways in Low-Income Urban Settings

Principal Investigators:

Prof. George Armah, PhD
Head of Regional Rotavirus Reference Laboratory
Electron Microscopy & Histopathology Department, NMIMR
University of Ghana, Legon

Dr. Christine Moe, PhD
Professor of Global Health and Epidemiology
Rollins School of Public Health, Atlanta, GA

General Information about the Study

My name is XXX and I am working with Noguchi Memorial Institute for Medical Research at the University of Ghana and the TREND Group on a research study about the cleanliness of the environment in several neighborhoods in Accra.

In this study, we want to learn more about more about life in this neighborhood, especially about sanitation needs and practices. The goal of the study is to figure out what types of improvements in sanitation would be most beneficial.

I would like to invite you to take part in a group discussion with an interviewer. During the discussion you will be asked questions about your life here and about domestic activities, occupational activities and childcare. If you agree, the discussion will be recorded using a micro cassette recorder. The entire discussion should take no more than one and a half hours and will be held at a convenient place.

We will write reports about things we learn from this discussion and other discussions like it here and in other neighborhoods in Accra. The reports may contain quotes of what is said during the group discussion; however, the reports will not contain any names or any other information that would make it possible to identify the people who took part in the discussion or what a specific person has said.

Participation in the study is entirely voluntary. If you choose to take part you do not have to answer any questions that you don't want to answer and you are free to leave the discussion at any time without having to give a reason. You will not be penalized in any way for leaving.

Risks and Discomforts

Participating in the study will not cause you any risks or discomfort, aside from possibly being a little bit embarrassed when I ask you some questions about your toilet specifically. This is necessary because we are trying to understand the cleanliness of this neighborhood and toilets can be a big problem.

Benefits

By participating in this study, you will help policy makers learn about the problems in your neighborhood and decide how to help. We will provide refreshments during the discussion and a small gift.

Confidentiality

The information we collect will be kept confidential and your name will not be associated with any of your responses. Your answers will not be traced back to you specifically.

Notification of Significant New Findings

We will be meeting with policymakers to tell them about the results of our study. We will write reports about things we learn from this survey. The reports will not contain any names or any other information that would make it possible to identify you. At the end of the study we will hold a durbar in your neighborhood to tell everyone here about what we learned.

Your rights as a Participant

This research has been reviewed and approved by the Institutional Review Board of Noguchi Memorial Institute for Medical Research (NMIMR-IRB). If you have any questions about your rights as a research participant you can contact the IRB Office between the hours of 8am-5pm through the landline 0302916438 or email addresses: nirb@noguchi.mimcom.org or HBaidoo@noguchi.mimcom.org . You may also contact the chairman, Rev. Dr. Ayete-Nyampong through mobile number 0208152360.

Thank you for taking the time to read or listen to this information. You will be given a copy of this consent form to keep.

Is there anything you would like to ask me about the study?

Volunteer Agreement

The above document describing the benefits, risks and procedures for the research titled *Assessment of Fecal Exposure Pathways in Low-Income Urban Settings* has been read and explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate in the Focus Group Discussion.

Name and Signature or Mark of Volunteer

Date Time

Signature of Person Conducting Informed Consent Discussion

Date Time

If volunteer cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

Date

Name and Signature of Witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

Date

Name and Signature of Person Obtaining Consent

FOCUS GROUP DISCUSSION GUIDE – DAILY ROUTINES

Introduction – 10mins

Thanks to everyone for coming to this discussion group today.

My name is _____ and we are conducting research to assess environmental cleanliness in Accra.

We are particularly interested to hear the opinions of women with young children, which is why you have been invited to the discussion today. We are conducting similar group discussions with women in different neighborhoods in Accra so that we can hear a variety of experiences. We would like to talk today about *your* neighborhood in particular and hear your views and concerns about the cleanliness of your neighborhood. Even if you don't think you have much to say on this topic your views are still very valuable to us, so please don't feel shy to contribute to this discussion. There are no right or wrong answers and we are most interested in your own experiences and opinions, so please feel free to share your views here today.

As we have already told you, your participation today is voluntary. Whatever we discuss today will be kept confidential and only used for this research project. During our discussion ___(name of note taker)___ will be taking notes, but she cannot write as fast as we speak so we would also like to record our discussion today. The reason for recording is so that we don't miss anything that is said and so that the rest of the research team can also hear your views exactly. The recording will only be used for this research project to improve environmental cleanliness in Accra. ***Is it Ok for us to record the discussion today?*** (Confirm that everyone agrees).

As we are a group of people, it is important that only one person speaks at a time so that we can clearly capture what you say on the recording. We won't be going around the group, so just join in when you have something to say. Remember we want to hear as many different opinions as possible, so feel free to disagree with what someone else has said and give your own views too. Our discussion today will last approximately 90 minutes and we have some refreshments for you. ***Are there any questions before we begin?***

As an introduction, let us each introduce ourselves and tell everyone the number and ages of your children

Special Characteristics of Neighborhood – 15 mins

I would like to start our discussion by learning about your feelings about this neighborhood. What do you think about this neighborhood?

1. What do you think are good things about living in this neighborhood? (*probe for issues relating to education, crime, poverty, etc.*)
2. What things would you most like to change about this neighborhood? (*probe for issues relating to education, crime, poverty, etc.*)
3. What makes this neighborhood different from others in Accra? (*probe: is this neighborhood cleaner/dirtier? Why?*)

Daily activities of mothers and children - 40 mins

I would now like to understand the daily routines of mothers and children in this neighborhood. To do this, I would like for you to think about your entire day-from when you first wake up until you lay your head to sleep at night. Let's think about these activities as morning activities, afternoon activities and evening activities.

4. In general, what are the morning activities of **mothers** in this neighborhood (*probe: types of jobs, vendors, and market shopping, childcare, home duties*)?
 - a. DISPLAY THE TEMPLATE AND CONSTRUCT THE TIMELINE FOR MOTHERS (refer to the instructions) Probe for:
 - i. Morning activities
 - ii. Afternoon activities, and
 - iii. Evening activities
 - iv. Summarize
 - v. Are these activities different for different types of mothers (*e.g. vendors, office workers, house mothers, etc*)
 - vi. Do these activities differ on the weekends? How? (mark on timeline)

5. Now, let's do the same for **your children**. We want to know about the activities of your pre-school and school-aged children. What are the morning activities of these children (*probe: play times, school, chores, etc.*)?
 - a. ADD TWO SEPARATE TIMELINES FOR **PRE-SCHOOL** AND **SCHOOL-AGED CHILDREN**.) Probe for:
 - i. Morning activities (*probe: where they do these things, who helps them with these activities eg grandparents, nannies, siblings?*)
 - ii. Afternoon activities, and
 - iii. Evening activities
 - iv. Summarize
 - v. Do these activities differ on the weekends? How? (mark on timeline)

Activities in Specific Places and Risk of Fecal Contamination – 25 mins

Now that I know a little more about your neighborhood and certain activities, I would like for us to speak more in depth about particular places and your opinions on some of the things that happen there.

6. How often do you or people in your family go to the beach (*probe for specific numbers for terms like a lot, a little, etc*)? Who goes? Which ones do they go to? Is this all year round or certain times of year? When you/they go, how much time, do you spend there?
 - i. Markets (*probe: how often, who goes, which ones, how long to they spend there*)
 - ii. Summarize

7. Now, let's look at all the activities on the timelines---particularly the ones for women and children. Are there some activities that put you and your children's health at risk? Which ones? Why?
8. (If, feces not previously mentioned) Do any of these activities mean you are in contact with feces in your environment?
 - a. How does this happen?
 - b. Do you ever do things to try and prevent this from happening?
 - c. Which of these activities pose the greatest risk of this?
 - d. Do you do anything to minimize your children's risk? If so what?

Summary

We are now coming to the end of this discussion; you have made great contributions.

9. Let's now refer back to the timelines. Are there any other activities that put you at risk of coming into contact with feces that we haven't already mentioned?

I would like to **thank you all very much for contributing** to our discussion today. Your experiences are very valuable to help us identify how to improve the cleanliness of your neighborhood.

FOCUS GROUP DISCUSSION GUIDE – WASH

Introduction -10 mins

Thanks to everyone for coming to this discussion group today.

My name is _____ and we are conducting research to assess environmental cleanliness in Accra.

We are particularly interested to hear the opinions of women with young children, which is why you have been invited to the discussion today. We are conducting similar group discussions with women in different neighborhoods in Accra so that we can hear a variety of experiences. We would like to talk today about *your* neighborhood in particular and hear your views and concerns about the cleanliness of your neighborhood. Even if you don't think you have much to say on this topic your views are still very valuable to us, so please don't feel shy to contribute to this discussion. There are no right or wrong answers and we are most interested in your own experiences and opinions, so please feel free to share your views here today.

As we have already told you, your participation today is voluntary. Whatever we discuss today will be kept confidential and only used for this research project. During our discussion ___(name of note taker)___ will be taking notes, but she cannot write as fast as we speak so we would also like to record our discussion today. The reason for recording is so that we don't miss anything that is said and so that the rest of the research team can also hear your views exactly. The recording will only be used for this research project to improve environmental cleanliness in Accra. ***Is it Ok for us to record the discussion today?*** (Confirm that everyone agrees).

As we are a group of people, it is important that only one person speaks at a time so that we can clearly capture what you say on the recording. We won't be going around the group, so just join in when you have something to say. Remember we want to hear as many different opinions as possible, so feel free to disagree with what someone else has said and give your own views too. Our discussion today will last approximately 90 minutes and we have some refreshments for you. ***Are there any questions before we begin?***

As an introduction, let us each introduce ourselves and tell everyone the number and ages of your children

Neighborhood Water – 20 mins

I would now like for us to spend the coming hour and twenty minutes talking about water, sanitation and hygiene issues in this neighborhood. Let me first begin by asking about water.

1. Water Sources

- a. What is the most common water source? Why? (*probe: other sources, which ones people like most/least, why*)
- b. Is it ever a problem to get water? Why?
- c. Thinking about all the places you get water, are some cleaner than others? Why/Why not? (*probe: hygiene, proximity to open drains, defecation areas, latrines etc*)

2. *Water Storage*
 - a. Where do you store your water, once you have it? Why?
 - b. What is it normally stored in? Why?
 - c. Is this the same for drinking water? What kind of containers are drinking water stored in?
3. Let's think about the water that becomes dirty from cooking and cleaning. How do you dispose of this waste water (*e.g. from washing and cooking*) at home?
 - a. Is there adequate drainage for waste water in/around your homes?
4. Does this neighborhood flood? (*probe: why, when, how often*)

Sanitation and Defecation Practices – 45 mins

I would now like to discuss sanitation practices in this community. I would like to ask about the full range of sanitation issues from garbage to latrines and defecation areas in the neighborhood.

5. How do people dispose of household refuse in this neighborhood? (*probe: sites, collections, frequency, who is responsible*)
6. Where do people in this neighborhood defecate? (*probe: latrines, open, bath/washrooms, refuse dumps, etc*)
 - a) Which is the most common place to defecate? Why?
 - b) Are these places generally clean or dirty? How are the cleaner places maintained?
7. Do people defecate in the open in this neighborhood?
 - a. Do many people do this? Why/why not?
 - b. Has the situation with open defecation changed in recent years? (*probe: how?*)
 - c. Is open defecation a problem? Why/why not?
 - d. If problem, how might it be reduced?
8. At what age do children start to use the latrines?
 - a. Where do they defecate before they are able to use latrines?
 - b. What is done with their feces? (*probe: thrown in latrine, garbage, left on ground*)
 - c. Do children defecate in the same places as their parents?
10. Are there latrines on beaches? Are there latrines in markets? If so, do you use them? Why/why not?
11. What do adults do when they are at places, such as beaches and markets, and there is no latrine for defecation? Is this the same for children?
12. Have you ever heard of the term “flying toilets”? (if not mentioned already). What are they?
 - a. What are the advantages of using them?

- b. What are some disadvantages of using them?
- c. When do people use ‘flying toilets’ in this neighborhood? (*probe: explain their use at home, work, vendors*)
- a. How are ‘flying toilets’ disposed?

13. Where would people prefer to defecate, ideally? Why?

Hygiene Practices – 15 mins

I would now like to know a little about hygiene practices in this community.

- 14. When do people in your family normally wash their hands?
- 15. How do they wash their hands?
- 16. What do they typically use to wash hands?
- 17. Where do people in your family wash their hands at home? Does everyone wash hands in the same place?
- 18. Is it possible to keep soap and water where people defecate?

Summary

We are now coming to the end of this discussion; we have talked about the sanitation condition in neighborhood and you have made great contributions.

Is there anything else you’d like to tell me about the status of sanitation in your neighborhood?

I would like to **thank you all very much for contributing** to our discussion today. Your experiences are very valuable to help us identify how to improve the cleanliness of your neighborhood.

FOCUS GROUP DISCUSSION GUIDE – COMMUNAL LATRINE

Introduction – 10mins

Thanks to everyone for coming to this discussion group today.

My name is _____ and we are conducting research to assess environmental cleanliness in Accra.

We are particularly interested to hear the opinions of people who use communal latrines, which is why you have been invited to the discussion today. We are conducting similar group discussions with men and women in different neighborhoods in Accra so that we can hear a variety of experiences. We would like to talk today about *your* neighborhood in particular and hear your views. Even if you don't think you have much to say on this topic your views are still very valuable to us, so please don't feel shy to contribute to this discussion. There are no right or wrong answers and we are most interested in your own experiences and opinions, so please feel free to share your views here today.

As we have already told you, your participation today is voluntary. Whatever we discuss today will be kept confidential and only used for this research project. During our discussion ___(name of note taker)___ will be taking notes, but she/he cannot write as fast as we speak so we would also like to record our discussion today. The reason for recording is so that we don't miss anything that is said and so that the rest of the research team can also hear your views exactly. The recording will only be used for this research project to improve environmental cleanliness in Accra. ***Is it Ok for us to record the discussion today?*** (Confirm that everyone agrees).

As we are a group of people, it is important that only one person speaks at a time so that we can clearly capture what you say on the recording. We won't be going around the group, so just join in when you have something to say. Remember we want to hear as many different opinions as possible, so feel free to disagree with what someone else has said and give your own views too. Our discussion today will last approximately 90 minutes and we have some refreshments for you. ***Are there any questions before we begin?***

As an introduction, let us each introduce ourselves and tell everyone how long you have lived in this neighborhood.

A. Sanitation Options in Community – 20 mins

There are several sanitation options in Accra so let's start by talking about what people in this neighborhood use.

1. Can you describe all of the options available? Where do adults typically defecate? (*probe for public latrines, chamber pots, flying toilets, etc*)
2. Of all these options in your community, which are used most? (*identify the top three options*)
3. Why do adults prefer these? (*probe for each option: cost, safety, convenience, cleanliness, etc*)

4. You have described some sanitation options as being used more because they are “convenient.” (*probe for the meaning of the characteristics named*)
 - a. When we say a defecation place is “convenient”, what does that mean?
 - b. When we say a defecation place is “clean”, what does that mean?
 - c. When we say a defecation place is “safe”, what does that mean?

B. Accessibility of Communal Latrines -15 mins

Now, I want us to focus on just one of the sanitation options named: public latrines. You all use public latrines regularly in this neighborhood and in other parts of Accra. I would like to learn more about these experiences. Let’s begin with access to public latrines.

1. Who owns the latrines in this neighborhood? (*probe: individuals, government, community*)
2. Can anyone use any latrine that they want at anytime?
 - a. If No, why not? (*probe: for whether latrine is seen to belong to some group more than another*)
3. Is it easier for some people to use public latrines than others? (*probe: for meaning of easy ie payments, accessibility, etc*)
 - a. If Yes, for who? Why? (*probe: for meaning of easy ie payments, accessibility, etc*)
4. Is it more difficult for some people to use public latrines than others?
 - a. If Yes, for who? (*probe: for meaning of difficult ie accessibility, payment, cleanliness, etc*)
 - b. What do these people do when they can’t use the public latrine?

C. Children’s Communal Latrine Use - 15mins

We have spoken about adult defecation options. I now want to ask about where school age children (above age 5) typically defecate.

1. Can you tell me all of the places where your children defecate? (*probe: schools, open areas, public latrines, flying toilets*)
2. Which of these options do they use most? Why?
3. Which of these options do they use least? Why?
4. Do children typically use the same communal latrines as adults?

D. Paying for Communal Latrine Use -15 mins

I now want us to talk about what it costs to use public latrines and how you arrange for this.

1. How much does it cost to use the public latrine by your home?
2. Are there ever times when people don’t have to pay to use a public latrine?
 1. If yes, when and why?
3. Should everyone have to pay the same amount? (*Probe: Are there some people who don’t pay? Who are they? And Why?*)
4. What do you think about the quality of service given the payments you make? (*Probe: would you be willing to pay more for better service*)

E. Preferences for Communal Latrine Use – 25 mins

You have had many experiences with the public latrines. I am sure some of these experiences have been good, some not so good and some are somewhere in between. I want to learn more about these experiences and what made them good or bad.

1. Let's start first with a good experience. I would like you to think about good public latrine experience. This can be one particular time or several times. What made these experiences at the public latrine "good"? (*Probe: the way they are treated by attendants, how long they had to wait, availability of cleansing materials, cleanliness, behavior of other customers, government latrine vs privately owned*).
2. Of all these reasons, which two are the most important?
3. How often would you say you have a "good" public latrine experience?
4. Now let's switch to think about bad experiences you have had at the public latrine. You can think of a particular time or several times. What makes a visit to the public latrine "bad"?
(*Probe: the way they are treated by attendants, how long they had to wait, availability of cleansing materials, cleanliness, behavior of other customers, government latrine vs privately owned*).
5. Of all these reasons, which two are the most important?
6. How often would you say you have a "bad" public latrine experience?
7. What would make a public latrine completely intolerable?
8. If you could change anything about public latrines you have used, what would it be?

F. Future plans for Sanitation- 10 mins

Finally, I want us to think in general about all the forms of sanitation you have in this community—public latrines, households latrines, chamber pots, etc. How satisfied do you think people are with these options?

1. Are the sanitation options in this neighborhood enough? Why/Why not?
 - a. If no, which one would you want more of if given the opportunity?
2. How important do you think it is for people to own their own latrine?
3. Do any of you have plans to own your own latrine? Why/ Why not?

Summary

We are now coming to the end of this discussion; you have made great contributions.

10. Let's now think back on what you have said. Is there anything else you would like to say about public latrines?

I would like to **thank you all very much for contributing** to our discussion today. Your experiences are very valuable to help us identify how to improve the cleanliness of your neighborhood.

APPENDIX B – CODEBOOK

Code	Code definition/application
<u>TIME/PEOPLE</u>	
Morning women	Any mention of women’s activities in the morning during the weekdays (E.g. mother’s bathing children, cooking breakfast, and sweeping). Do not use this code to refer to women’s activities other times of the day or on the weekends. (Use the code afternoon women for the afternoon, evening women for the evening and weekend women for the weekend).
Afternoon women	Any mention of women’s activities in the afternoon (between 12-5pm) during the weekdays (E.g. women doing laundry, hawking, and doing laundry). Do not use this code to refer to women’s activities other times of the day. Use the code morning women for the morning, and evening women for the evening.
Evening women	Any mention of women’s activities in the evening (between 5pm-5am) during the weekdays. (E.g. cooking dinner, helping their children with homework). Do not use this code to refer to women’s activities other times of the day. Use the code morning women for the morning, and afternoon women for the afternoon.
Weekend women	Any mention of women’s activities during the weekend (Saturday and Sunday). (E.g. going to church, cleaning thoroughly, and cooking). Do not use this code to refer to women’s activities during the weekdays. Use the code morning women for the morning, and evening women for the evening.
Morning School age children	Any mention of school-aged children’s (>5 years but <18 yrs old) activities in the morning during the weekdays (E.g. Eating breakfast, going to school, and doing chores). Although the Childs age may not be stated the context of the comment may indicate their age e.g. “In the morning he goes to school” or “when the children come back from school” Do not use this code to refer to school aged children’s activities other times of the day (Use the code afternoon school age children for the afternoon, evening school age children for the evening and weekend school age children for the weekend).
Afternoon School age children	Any mention of school-aged children’s activities (>5 years but <18 yrs old) in the afternoon during the weekdays. (E.g. Attending school, hawking, playing table tennis, sweeping etc.) Although the child’s age may not be stated the context of the comment may indicate their age e.g. “In the morning he goes to school” or “when the children come back from school.” Do not use this code to refer to school-aged children’s activities other times of the day (Use the code morning school age children for the morning, evening school age children for the evening and weekend school age children for the weekend).

Evening School age children	Any mention of school-aged children's (>5 years but <18 yrs old) activities in the evening during the weekdays. (E.g. Doing homework and sleeping. Although the child's age may not be stated the context of the comment may indicate their age eg "In the morning he goes to school" or "when the children come back from school." Do not use this code to refer to school-aged children's activities other times of the day (Use the code morning school age children for the morning, afternoon school age children for the afternoon and weekend school age children for the weekend).
Weekend School age children	Any mention of school-aged children's activities (>5 years but <18 yrs old) during the weekend (Saturday and Sunday). (E.g. Attending child-naming ceremonies, playing football, etc.) Although the Childs age may not be stated the context of the comment may indicate their age e.g. "In the morning he goes to school" or "when the children come back from school." Do not use this code to refer to school-aged children's activities during the weekdays. (Use the code morning school age children for the morning, afternoon school age children for the afternoon and evening school age children for the evening hours).
Morning Children Under 5	Any mention of children under 5 years' activities in the morning during the weekdays. (E.g. breastfeeding, sleeping and eating) Do not use this code to refer to school children or children under 5 years' activities other times of the day (Use the code afternoon children under 5 for the afternoon, evening children under 5 for the evening and weekend children <5 for the weekend).
Afternoon Children under 5	Any mention of children under 5 years' activities in the afternoon during the weekdays. (E.g. Taking a nap, eating, and playing outside). Do not use this code to refer to school children or children under 5 years' activities other times of the day (Use the code morning children under 5 for the morning, evening children under 5 for the evening and weekend children <5 for the weekend).
Evening Children under 5	Any mention of children under 5 years' activities in the evening during the weekdays. (E.g. Sleeping, eating, and bathing). Do not use this code to refer to school children or children under 5 years' activities other times of the day (Use the code morning children under 5 for the morning, afternoon children under 5 for the afternoon and weekend children <5 for the weekend).
Weekend Children under 5	Any mention of children <5 years' activities on the weekends (Saturday and Sunday). (E.g. A child is eating, sleeping or bathing). Do not use this code to refer to school children or children under 5 years' activities during the weekdays (Use the code morning children under 5 for the morning, afternoon children under 5 for the afternoon and evening children <5 for the evening during the weekdays).

<u>LOCATIONS</u>	
Beach	Use this code for any comments related to the beach (e.g. a woman buys fish at the beach, children play on the beach, someone defecating on the beach).
Market	Use this code for any mention of a market. (E.g. a woman is shopping at the market, someone is hawking at the market or passing through a market, or a specific market such as the Nima market, Malata market, makola market, slaha market or Agboglobloshie market).
Household	Use this code in reference to a household or home. This could refer to inside a home, around the parameter of a home, what the house is made of (wooden/cement) or other people's home. Do not use this code for a group of households, use the neighborhood code.
Neighborhood	Use this code for any reference of a neighborhood. This can refer to a neighborhood inside or outside someone's residence.
School	Use this code for any mention of school (E.g. children going to school, children who do not attend school, woman taking their children to school). Do not use this code in reference to schoolwork outside of school, or education/schooling instead use the homework and education codes respectively.
Religious Place of Worship	Use this code for any mention of a place of worship such as a church or mosque. (e.g. we go to church on Sunday, the children prayed at the mosque). Do not use this code in reference to prayer or Arabic School, instead use the Prayer and Arabic school codes respectively.
Funeral	Use this code if someone mentions going to a funeral, activities at funerals etc.
Weekend Ceremonies	Use for a reference to any mention of child naming ceremonies, or wedding ceremonies. Also use for mention of Suna or den-to (in-vivo terms for child naming ceremony).
Hospital	Use this code in reference to a hospital or a clinic.
<u>LATRINES/FECAL DISPOSAL PRACTICES</u>	
Public Toilets	Use this code in reference to a public latrine. This could refer to a communal toilet in a neighborhood or one in a public setting, such as a market. This does not refer to defecating on public streets or at an individual's household, instead use the defecation, and private toilets respectively.
Wood toilet	Use this code in reference to a wood structure latrine.
Flush toilet	Use this code in reference to a flush toilet.
Block Toilet	Use this code in reference to a block toilet.

Private Toilets	Use this code in reference to a public latrine or paying for a public latrine. This could refer to a communal toilet in a neighborhood or one in a public setting, such as a market. This does not refer to defecating on public streets or at an individual's household, instead use the defecation, and private toilets respectively.
Take Away	Use if someone mentions a take-away or in reference to a take away (e.g. polyethene bags or toilet tied in rubber). Do not use if someone mentions a chamber pot or a diaper - use the chamber pot and diaper codes respectively.
Chamber pot	Use in reference to a chamber pot for defecation (e.g. a child relieved themselves in a chamber pot). Do not use in reference to a take away, such as a polyethylene bag or a diaper use the take away and diaper codes respectively
Diapers	Any discussion on children's defecation that involves a disposable or reusable diaper use this code, or the disposal of diapers. Do not use this code in reference to defecation in chamber pots; use the fecal waste container code.
Defecation	Use this code if someone mentions defecating in an open setting (E.g. Toilet on ground, alleyway, public street, on the sand etc.). This does not include defecation in private toilets or public toilets use the codes private toilets and public toilets respectively.
Feces	Use for any mention of feces on ground. (E.g. Feces all over the sand, dog feces, etc.). Also use in reference to the phrase 'kpor'. Do not use for references to feces in latrines, containers such as a polyethylene bag or a chamber pots. Instead use the public or private latrine codes, take away or chamber pot codes respectively.
Accessibility	Use this code in reference to accessibility of latrines. E.g. the latrine is far away.
Comfort of toilet	Use in reference to mention of the comfort of a toilet. For example, the smell of toilet, what it is made of etc.
<u>ACTIVITIES</u>	
Sweeping	References to sweeping with a broom e.g. a woman sweeping up the dirt on the floor or sweeping garbage out of the house. Use in reference to sweeping inside or outside the home.
Breast feeding	Use this code if a mother mentions breast-feeding a child. Do not use this code if a child is drinking breast milk from a bottle – use the code eating.
Hawking	Use this code for discussion of “hawking” or any reference to selling items on public streets. For example, woman and children sell food or water in the street.

Eating	Any mention of eating food (e.g. porridge, fruit etc.). This does not include breastfeeding- use breastfeeding code.
Cleaning	Any reference to someone dusting, doing dishes, or a cleaning a particular environment (e.g. bathroom). Do not use this code for references to sweeping or doing laundry, instead use the sweeping and laundry codes respectively.
Laundry	Use when referring to someone washing, hanging, drying, folding or ironing clothes.
Cooking	Use for any reference to someone preparing food, boiling food, baking food, and/or the word cooking. Do not use this code in reference to buying food, instead use the code errands,
Education	Use this code for any mention of a child's education. Also, use in reference to schooling or education (e.g. this teacher is schooling a child, she received a proper education). Do not use this code in reference to homework use the homework code.
Sleep	Use this code if someone mentions sleeping. This includes napping during the day, and resting.
Bathing Oneself	References to bathing/washing oneself, This could be an adult bathing oneself or a child bathing oneself. This does not refer to bathing a child; please use the bathing child code. (E.g. A mother washes herself, the child bathed with no help.)
Bathing Child	Use this code in reference to someone bathing a child. (E.g. the mother washes the baby). Do not use this code if a child is bathing him/herself, instead use the bathing oneself code.
Playing	Use for any mention of a child playing. Also use for mention of playing different sports and activities (E.g. a child plays table tennis, football, or using electronics for recreational purposes). Do not use in reference to watching TV – instead use the TV watching code.
Watching TV	Use this code when someone is watching TV (E.g. the children watch TV before they go to bed, she watched TV last night).
Pray	Use this code in reference to prayer (E.g. someone is praying, they went to a mosque to pray etc). Do not use this in reference to a mosque or a church use the mosque and church codes respectively.
Homework	Use this code when homework is mentioned or in reference to schoolwork. Do not use this code to discuss schooling or education – use the education code.
Errands/Buying	Use for reference to someone doing errands. This includes the act of buying (e.g. the child bought bread, I send her to complete errands in town etc.)

<u>WATER (STRUCTURES)</u>	
Hand Washing	Use this in reference to someone washing their hands or encouraging children to wash their hands. Do not use this in reference to mitigating the risk of something – washing before/after dinner etc.
Water	Use this code when there is mention of water supply, water conditions, or water storage. – Whether good or bad (E.g. taps are broken, the water supply in this neighborhood is good, water barriers not cleaned etc.)
Fetching Water	Use in reference to “Faayaa”- the act of fetching water (E.g. a woman collects water in town, a child fetches water at the polytank etc).
Gutters	Use this code when someone refers to gutters or drains (open or closed) in a public or private setting. E.g. the gutters are full of refuse.
Manholes	Use this code when someone mentions a manhole. Do not use this code in reference to a gutter – instead use the gutters code (e.g. broken/open manholes)
<u>GARBAGE/FECES DUMPING</u>	
Feces Dumping	Use this code in reference to dumping feces. For example, when someone dumps a take away into the garbage, dumps feces directly into the garbage or if they dump it in an unnecessary place such as a gutter. Do not use this code in reference to garbage dumping instead use the refuse dumping code.
Refuse Dumping	Any references to the disposal of garbage in a container, regardless of where this happens. For example, when someone dumps their garbage in someone else’s refuse bin, puts their garbage directly in the gutter, drops off their garbage in the beach or market in secret areas, or does not dispose of their garbage at all. This does not refer to the collection of garbage; instead use the refuse collection code.
Private Refuse collection	Use for references to private garbage collection. And refuse bins (or lack of bins in accordance to private companies) This includes mention of the collection company (Zoomlion) or just the collection by an individual. This code does not refer to public collection of garbage or the disposal of garbage, instead use the public refuse collection, inappropriate refuse dumping or appropriate refuse dumping codes. .

Public refuse collection	Use for references to public garbage collection and refuse bins (or lack of bins in accordance to public collection). This includes mention of the assemblyman collecting garbage, or the government. . This code does not refer to private collection of garbage or the disposal of garbage, instead use the private refuse collection, inappropriate refuse dumping or appropriate refuse dumping codes.
<u>RISK</u>	
Risk Mitigation	Use this code in reference to preventive measures that an individual does to mitigate the risk of fecal contamination or lower their risk for infection to themselves or to others. (eg. Washing hands before food prep, wash feet after stepping in feces, covering their hair etc.)
Occupational risk	Use this code for any reference to risk of fecal contamination due to a job or occupation. (E.g. a fisherman exposed to feces through net on the beach where people relieved themselves). Do not use this code in association to selling goods, instead use the hawking code.
Perceptions of Risk	Use in reference to perceptions of risk of fecal contamination. E.g. contamination of food, Squatting next to someone in the bathroom can spread disease through exchange of heat, the garbage in the drains cause disease. Do not use this code for the mention of a clean or hygienic environment use the hygienic code.
<u>COST</u>	
Cost	Use this code for mention of cost or financial stress. Also use this code if someone mentions ahustre. (E.g. I cannot buy a refuse bin for garbage collection, I don't have the funds for that, refuse bins are too expensive etc.)
Poverty	Use this code in reference to how someone earns money or references to money/poverty or people in poverty
<u>PEOPLE</u>	
Assembly man	Use for any reference of the assemblyman. (E.g.. The assemblyman is involved in community decisions, he sprays the communities gutters for mosquitoes etc).
Latrine Attendant	Use this code in reference to a latrine attendant.
<u>OTHER</u>	
Hygienic	Use in reference to something being clean or hygienic. (E.g. If we covered our gutters they would be clean, my environment is clean, that is not hygienic). Do not use for the act of cleaning, use the cleaning code.

Insects	Use this code in reference to insects in general or insecticide.(E.g. due to the garbage the insects increased in the neighborhood). Do not use this code in reference to specific insects: mosquitoes, maggots or houseflies - instead use the mosquitoes, maggots and house flies codes respectively.
Environmental factor	Use when contamination, sanitary, or housing destruction problems occur due to an environmental factor (E.g. wind blowing garbage into drains, fires and flooding). Do not use this code when people cause the contamination problem, use contamination.
Access to latrines	Use this code in reference to accessibility of latrines.
Gender differences	References to different activities, skills or actions an individual will perform on the basis of their gender. (E.g. boys playing sports, girls doing laundry after school).
Neighborhood Amenities	Use for any mention of neighborhood amenities. Whether they are referring to the good or bad amenities. E.g. Public latrine, street lights, clean gutters, broken latrine, overflowing gutters, taps will not flow, street lights broken, and transformer.
Neighborhood Conditions	Use this code in reference to neighborhood conditions – good or bad. (E.g. crime, electricity, fire, etc.)
Crime	Use for any mention of crime or theft. (E.g. crime has decreased in our community, there is a lot of crime In that neighborhood, without street lights there is more theft)
Discipline	Use in reference to mention of discipline ones children or comparing discipline levels to other children. (e.g. if you instill discipline in a child, children in Accra are not as disciplined as children in our neighborhood)

Appendix C: IRB Approval Letter

Page 1 of 2



Institutional Review Board

TO: Christine Moe
Principal Investigator
Global Health

DATE: October 4, 2013

RE: **Notification of Amendment Approval**
AM3_IRB00051584
IRB00051584
Assessment of Fecal Exposure Pathways in Low-Income Urban Settings

Thank you for submitting an amendment request. The Emory IRB reviewed and approved this amendment under the expedited review process on 10/2/2013. This amendment includes the following:

Changes to Protocol Document; added surveys of school children
Changes to Study Team members; added Suraja Raj, Jacqueline Hurd, Katherine Roguski, David Berendes, and Deema Elchoufi

Important note: If this study is NIH-supported, you may need to obtain NIH prior approval for the change(s) contained in this amendment before implementation. Please review the NIH policy directives found at the following links and contact your NIH Program Officer, NIH Grants Management Officer, or the Emory Office of Sponsored Programs if you have questions.

Policy on changes in active awards: <http://grants.nih.gov/grants/guide/notice-files/NOT-OD-12-129.html>

Policy on delayed onset awards: <http://grants.nih.gov/grants/guide/notice-files/NOT-OD-12-130.html>

In future correspondence with the IRB about this study, please include the IRB file ID, the name of the Principal Investigator and the study title. Thank you.

Sincerely,

Andrea Goosen, MPH, CIP
Research Protocol Analyst
This letter has been digitally signed