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Context Matters: A Multi-Country Analysis of Individual- and Neighborhood-Level Factors Associated with Women's Sanitation Use in Sub-Saharan Africa

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Abstract

Objectives: To identify cross-national trends in factors associated with women's sanitation use in sub-Saharan Africa.

Methods: Using data from Demographic and Health Surveys conducted in 14 SSA countries between 2008 – 2014, we modeled women's sanitation use in relation to various individual- and neighborhood-level factors.

Results: Substantial variation exists between countries in the strength and direction of factors associated with sanitation use. Particularly significant associations across the region included access to different water sources, years of education, family size, age, living in a female-headed household, being married and wealth. Neighborhood-level poverty, ethnic diversity and urbanization were important factors in a majority of countries.

Conclusions: International development goals for sanitation are frequently framed in terms of availability, implicitly suggesting that if facilities are accessible, they will be used. A more nuanced view that takes into account not only the existence of facilities but also the factors influencing their use is needed to understand the dynamics of women's sanitation use in the region. Policies focused on availability may not yield the desired public health benefits from improved sanitation in sub-Saharan Africa. Context-relevant factors must be addressed concurrently to achieve sanitation development goals.

Keywords: women; Sanitation; sub-Saharan Africa; DHS data; multi-country

Introduction

Approximately 2.4 billion people worldwide lack access to safe toilet facilities today.¹ Lack of access to sanitation remains a persistent problem in the Global South^{2,3}. In sub-Saharan Africa (SSA) recent reports suggest only 30% of the population use safe sanitation.¹ Even within the region, access to sanitation varies by

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country, with reported ranges of 15-93%. The health consequences of lack of access to sanitation around the world are well established.⁴⁻⁶ Poor sanitation has been linked to water-borne diseases such as diarrhea, typhoid, and other parasitic infections.⁷ In developing countries, in particular, almost half of the population has, at one time, suffered from diseases associated with lack of access to sanitation.⁷⁻⁹ Evidence also suggests that poor sanitation is one of the biggest killers of children under five through diseases like diarrhea and cholera.^{9,10}

Access to sanitation is often understood to be a function of availability, not choice or other constraining factors.¹¹ Recently, however, discussions of factors that may influence sanitation use such as preference, willingness to pay, and experiences of health improvements have begun to appear in the literature.¹²⁻¹⁶ Some research has also identified psycho-social factors, e.g. religious and cultural rules as important drivers of sanitation use.^{11-15,17-19}

Scarce research on the factors that influence sanitation use has addressed neighborhood-level characteristics. For example, lack of access roads, broken or non-existent central water supply and/or sewer infrastructure, high population densities, complicated land ownership dynamics, and environmental barriers can make it difficult to build and maintain safe sanitation facilities in certain neighborhoods.²⁰ Other studies suggest that the social environment can also influence individuals' ability and desire to use existing sanitation options.^{11,13} Neighborhood-level factors such as crime rates, security lighting, 24-hour toilet facilities, and community safety may also exert an influence.

Women are disproportionately burdened by the persistent lack of access to safe sanitation.²¹⁻²⁶ Recent studies have suggested a number of factors that may be associated uniquely with women's sanitation use and, consequently, their health and well-being. For example, women's experiences and/or fear of physical and sexual violence associated with having to walk to and use sanitation facilities, particularly in more violent neighborhoods (e.g. informal settlements), have forced many to revert to forms of sanitation that increase their risk of direct contact with untreated waste (e.g. plastic bags or bucket toilets).²⁷⁻²⁹ Other research suggests that women's sanitation use may be affected by their fear of contracting infections from unclean sanitation facilities.^{21,23}

The objective of this study was to examine the association between a number of socio-economic factors at the individual and neighborhood levels and women's reported sanitation use across 14 countries in sub-Saharan Africa. This study (1) focused specifically on the associations between different factors and sanitation use, (2) explored individual- and neighborhood-level factors associated with sanitation use across countries, and (3) aimed to identify possible trends in the region that may have public health policy implications.

Methods

Data and Sample

We used cross-sectional data from the Demographic and Health Surveys (DHS) from 14 countries in sub-Saharan Africa, including Cameroon (CMR), Côte d'Ivoire (CIV), Democratic Republic of Congo (DRC), Gabon (GAB), Ghana (GHA), Kenya (KEN), Malawi (MWI), Mali (MLI), Mozambique (MOZ), Nigeria (NGA), Sierra Leone (SLE), Togo (TGO), Uganda (UGA), and Zambia (ZMB). In general, DHS datasets provide nationally representative data on general health and population indicators. The DHS surveys, at present, provide the most comprehensive source of information that may identify socio-cultural factors associated with women's sanitation use in sub-Saharan Africa. All women, ages 15-49, from selected households are eligible to be interviewed in the DHS; however, one of the gender-specific factors used in this study (e.g. experiences of recent non-partner violence) required that the analytic sample include only women who completed the domestic violence module of the DHS.³⁰ Details about the specific sampling strategies used in the DHS datasets have been documented elsewhere.³¹

Measures

For this analysis, a three-level categorical variable was created to correspond to each type of reported sanitation methods: a private facility (any facility not shared with any other household including flush or pour-flush toilet, pit latrine, composting toilet, or hanging toilet/hanging latrine); a toilet facility shared by additional households; or open defecation [OD] ('no facility/bush/field/bucket'). The study focuses on OD and use of shared facilities versus private because OD and shared facilities, in particular, have been associated with adverse health outcomes.^{32,33}

Individual-level, socio-economic factors included age, marital status, household wealth quintile, respondent's employment status, level of education, residence in a female-headed household, and family size. As previous studies have suggested that attitudes in certain non-Christian religions may influence sanitation practices,^{11,34} a binary Christian/non-Christian variable was also included. A variable for women's primary drinking water source was also used, given earlier research that suggests people's sanitation use may be influenced by the availability of water.^{20,35,36} Some scholars have also suggested that women, in particular, may revert to unimproved sanitation alternatives rather than walk to a shared or public facility if they do not feel safe outside their homes.^{27,28,37} A binary variable, *recent non-partner violence*, was therefore created from women's survey responses about sexual and physical violence in the past 12 months.

The models have a number of neighborhood-level indicators that are commonly used as proxy variables to identify high-crime, high-violence, or structurally disorganized/disadvantaged communities.^{38,39} These included the proportion of female headed-households in the neighborhood, the proportion of households in a neighborhood reporting no employment, the proportion of households in a neighborhood who fall in the lowest wealth quintile, and the proportion of households in a neighborhood that have at least

one woman reporting recent non-partner violence. A neighborhood ethnic diversity index calculated using a diversity entropy method commonly used in multi-level analyses was also included.^{38,40}

Analysis

All data analyses were conducted using Stata/MP v.14. Fourteen separate two-level, multinomial logistic regressions were run using the user-written program `gllamm`.⁴¹ Women's individual responses were nested in communities. Communities were represented by DHS primary sampling units³¹ of about 20-200 people because they are the most consistent measure of community between DHS datasets and have been used to represent community in a number of multi-level studies using DHS data.⁴²⁻⁴⁵

Results

Sample Characteristics

A total of 102,399 women completed the domestic violence module across the 14 countries selected for this study. As item non-response indicated minimal missing data (less than 5%) on all independent, dependent, and control variables in each country, a method of hot-deck imputation was utilized to fill in missing values.⁴⁶ The final analytic sample consisted of 102,399 surveys (level 1) collected in 7,268 communities (level 2) in 14 countries. Descriptive statistic ranges are summarized in Table 1. Frequencies for all countries are presented in Appendix 1.

Women's reported use of sanitation facilities was extremely varied within and across all countries included in this study. Reported practices of OD ranged from 2.5% (Gabon) to 54.2% (Togo). Reported use of private facilities ranged from 12.7% (Ghana) to 63.4% (Cameroon) with ranges for reported use of shared facilities from 9.9% (Mozambique) to 64.3% (Sierra Leone).

Figure 1 provides relative-risk ratios and confidence intervals for the associations between individual- and neighborhood-level factors and sanitation use in each country. Detailed results from the two-level regressions are provided in Appendix 2.

Open Defecation (OD) Versus Private Facility Use

Wealth was the most common individual-level factor associated with OD compared to private toilet use. Relative risk ratios ranged from 0.46 [CI(95%) 0.274-0.77] in Mali to 0.08 [CI(95%) 0.034-0.180] in Cameroon. Access to public or open water compared to private sources emerged as another important factor in 10 of the countries. Relative risk for public vs. private water sources in those countries ranged from 1.30 [CI(95%) 1.007-1.689] in Mozambique to 11.44 [CI(95%) 5.533-23.641] in Ghana. Relative risk for open vs. private sources ranged from 1.54 [CI(95%) 1.171-2.034] in Mozambique to 9.56 [CI(95%) 6.333-14.417] in Togo. In half the countries, residing in a female-headed household was associated with higher risk of OD relative to risk of private sanitation use. Relative risk ratios in those countries ranged from 1.45 [CI(95%) 1.268-1.665] in Nigeria to 2.28 [CI(95%) 1.760-2.944] in Malawi. Religion was also an important factor, but

the direction and size of the relative risk varied, e.g. RRR=0.16 [CI(95%) 0.079-0.332] in Mali and RRR=2.36 [CI(95%) 1.404-3.955] in Cameroon.

Education and family size were important individual-level factors. Increasing family size and increasing years of education were associated with lower relative risk of OD compared to private facility use in 13 of the 14 countries. For example, each additional year of education was associated with lower risk of OD relative to risk of private facility use. Relative risk ratios for years of education in the 13 countries ranged from 0.95 [CI(95%) 0.912-0.985] in Sierra Leone to 0.82 [CI(95%) 0.784-0.855/0.755-0.898] in Kenya/Gabon).

Important neighborhood-level factors associated with risk of using OD relative to private facility use included urban area (8 countries), diversity (4 countries), and poverty (12 countries). The direction and magnitude of the neighborhood-level associations varied by country. For example, urban area ranged from RRR=0.21 [CI(95%) 0.088-0.500] in Gabon to 6.40 [CI(95%) 2.24-18.279] in Uganda; diversity ranged from RRR=0.18 [CI(95%) 0.073-0.427] in Mali to 2.29 [CI(95%) 0.999-5.232] in Togo; and poverty ranged from RRR=0.97 [CI(95%) 0.955-0.979] in Gabon to RRR=1.08 [CI(95%) 1.068-1.098] in Kenya.

Shared Toilets versus Private Toilets

Several demographic and household structure variables emerged as important factors associated with use of shared relative to private facilities. In most of the countries, living in a female-headed household, being married, and using public or open water sources were positively associated with women using shared rather than private toilets. Family size, age, and education, on the other hand were associated with lower risk of using shared facilities relative to private ones in most countries. For example, for each additional year of education, the risk of a woman using shared facilities relative to using private facilities was lower (3% lower risk [CI(95%) 0.947-0.992/0.942-0.992] in Sierra Leone/Mali to 10% lower risk [CI(95%) 0.882-0.92] in Kenya).

At the neighborhood-level, the urban factor was associated with higher risk of using shared relative to private sanitation in 11 countries—ranging from 1.69 [CI(95%) 1.243-2.301] in the DRC to 4.42 [CI(95%) 3.144-6.225] in Gabon. Neighborhood diversity was also associated with higher risk of shared relative to private facility use in a number of countries with the risk ranging from 1.29 [CI(95%) 1.058-1.566] in Malawi to 2.42 [CI(95%) 1.774-3.309] in Mozambique. The direction and size on the relative risk for neighborhood-level poverty and family disorganization varied between countries.

Discussion

Results suggest that predictors such as wealth, family size, education, water source, religion, and living in a female-headed household are the most prominent individual-level factors associated with OD relative to private facility use across the 14 countries. Neighborhood location (urban versus rural), diversity and poverty were the most prominent community-level factors associated with OD relative to private facility use. Demographic variables, such as family size, age, being married, living in a female-headed household, and

years of education were the most prominent individual-level factors associated with shared relative to private facility use. Whether or not a respondent resided in an urban or rural area was the most common neighborhood-level factor associated with use of shared relative to private toilets across the study countries. Neighborhood-level poverty, family disorganization, and diversity were also important factors associated with shared relative to private facility use in a majority of countries.

The results of this study showed that wealth at the individual level was associated with lower risk of OD relative to private toilet use in almost all countries, and neighborhood-level poverty was also associated with higher relative risk of OD in most countries. These findings are consistent with literature reporting that wealth is empirically linked to demand for and adoption of improved sanitation technologies.^{17,20,47} Neighborhood location also emerged as an important factor associated with OD and shared relative to private facility use. The results are consistent with literature that suggests shared facilities are more common in cities³³ and with studies that suggest OD is common³³ in both rural areas⁴⁸ and informal settlements in urban areas³⁷. Results from this study also suggest that women with increasing years of education have lower risk of using OD relative to private toilets. Again, this is consistent with findings from literature that suggest education and knowledge are linked to individuals' ability to adopt new methods of urine/feces disposal.¹⁷ Health-related education and awareness are often considered leading factors influencing user sanitation preferences and decisions.¹² In fact, many community-focused sanitation adoption and implementation programs rely largely on health education and training.³⁶

Other common demographic variables associated with use of OD and shared facilities relative to private facilities in this study included family size, being married, living in a female-headed household, and having access to different water sources. These individual-level factors were not only common across the countries in this sample, but the direction of the association was also consistent. For example, family size was consistently associated with lower risk of using OD or shared relative to private toilets and female headed households, marriage, and access to shared water sources – both improved and unimproved - were generally associated with higher risk of using OD or shared relative to private facilities. According to the Joint Monitoring Programme (JMP),⁴⁹ unimproved sanitation, which includes OD and use of shared toilet facilities, is particularly persistent in disadvantaged households and communities, especially in sub-Saharan Africa.¹ Several of these demographic variables have been associated with household or neighborhood-level social or economic disadvantage in recent literature. Female headship and family size (number of children), for example, are sometimes used as variables in structural disadvantage measures at the household and neighborhood levels.⁵⁰ In these results, however, family size is associated with lower risk of using OD and/or shared facilities relative to private ones, which does not seem to indicate structural disadvantage. One explanation, as suggested by recent evidence from a study using DHS data from Kenya,⁵¹ is that more children (family size) can increase a woman's decision-making power in the home and, relatedly, her ability to demand improved sanitation. Access to water is also a common factor in measuring household or community disadvantage.¹ For example, 93% of the people still using open water sources (e.g. rivers, lakes, or

unprotected surface water) as their primary water source are located in disadvantaged rural communities, particularly in sub-Saharan Africa.¹

Results from this study also yielded less common and/or less consistent associations between several factors and sanitation use. For example, married women in the study had higher risk of using OD or shared relative to private facilities in almost all countries in the study. Literature does not highlight marriage as a common factor associated with sanitation use. Neither is marriage frequently associated with household or community-level disadvantage. Some literature suggests that it is a cultural taboo for a child-in-law to use the same toilet facility as the parents-in-law in some African communities,⁵² which might provide an explanation for why some married women might use OD or a shared instead of a private facility in a family setting. Yet, this cultural belief is unlikely to fully explain the association. Being a non-Christian also emerged as an important factor associated with women's use of OD or shared relative to private facilities in this study; however, the direction and magnitude of the risk varied between countries. These results suggest, as several previous studies have^{20,34}, that religion may be an important factor in women's sanitation use; however, the binary Christian/non-Christian measure available for this analysis does not provide enough detail about different religions.

Another unexpected finding was that, in several of the countries, being employed was associated with higher risk of OD or shared facility use relative to private facility use. Employment is usually associated with structural advantage and, consequently, one might expect the relative risk of women using OD or a shared facility to be lower for women who are employed. Perhaps women are unable to access sanitation facilities while at work. These findings highlight the need for more precise information on the nature and location of employment and access to and use of facilities while at work.

Many of the neighborhood-level variables in this study varied in direction and magnitude across different countries. This may be largely due to the variability of different methods of urine/feces disposal at the neighborhood level. There may be a uniformity of available sanitation methods in one neighborhood—e.g. an urban neighborhood in which every member of the neighborhood has access to a private, household sanitation facility that feeds into a government sewerage system or a rural neighborhood in which all households have access to pit latrines. In a number of other settings, however, the availability of different sanitation methods may vary considerably.³ For example, residents in a single sampling unit in an informal settlement in a city in Kenya may utilize a variety of different sanitation methods, such as public toilets; private, household facilities; sites for OD; bags or buckets in the home; and/or plot toilets (toilets shared by a cluster of houses or a building). The results from this study suggest that neighborhood-level characteristics may influence sanitation use, but they may also highlight the need to look at the unique context of each neighborhood.

In addition to the more commonly recognized factors associated with sanitation use in the literature (e.g. wealth, access to water, and demographics), this study also yielded associations between neighborhood-level violence and sanitation use in several countries. While the relative risk was small compared to

some of the other factors, these results should not be neglected. Violence was associated with lower risk of OD or shared relative to private facility use in some countries (Nigeria, Uganda). This is contradictory to some studies that suggest that women who defecate in the open or use shared/public facilities are at higher risk of experiencing physical or sexual violence as a result of having to go outside the house at night.^{16,23,25,27} On the other hand, these findings may be consistent with literature that suggests women may adopt alternative sanitation strategies to avoid OD or shared/public toilets if they fear they are at risk of experiencing violence.^{14,15,25,27,28,37} Also, neighborhood-level violence is often associated with social disorganization.^{38,39} Results suggesting a positive relative risk association between neighborhood-level violence and OD or use of shared facilities may be similar to findings that OD or shared sanitation are associated with poorer and/or more socially disorganized neighborhoods. On the other hand, results that suggest a negative relative risk association may reflect literature that suggests women who fear physical or sexual violence in their neighborhoods are likely to develop sanitation strategies that keep them from having to go outside their houses.

While this was the first attempt to quantitatively explore individual and neighborhood-level factors associated with sanitation, it had limitations. First, this study used cross-sectional data; thus, causal claims about the factors influencing sanitation use cannot be made. Second, this study used data from nationally-representative surveys that were not focused on sanitation use. Consequently, there were limited factors available across all datasets that were theoretically appropriate for inclusion, and these variables are sometimes problematic in sanitation analyses.^{3,53} Other factors that are often associated with sanitation use in literature, such as cleanliness of toilets, distance to toilets, level of privacy, characteristics of toilet construction (e.g. doors and locks) were not included in DHS surveys. Neighborhood-level variables were constructed based on primary sampling units (PSU) in the surveys. While this is a common practice with multi-level analyses, it is limited in its ability to truly represent neighborhood-level characteristics.⁵⁴ Lastly, due to confidentiality issues, sampling weights at the neighborhood (PSU) level are not provided with DHS data, limiting the ability to do weighted, nationally representative, multi-level analyses.^{55,56}

Conclusion

This was the first multi-country study to look at the factors associated with sanitation use. Findings from this study suggest that there are numerous individual-level (wealth, access to different water sources, age and education) and household structure (family size and female headship) variables that should be considered important factors associated with sanitation use. Sanitation use is not only a technical issue, but also a social one. While there are a number of small studies that have looked at factors that influence sanitation preferences, behaviors, use, and adoption, there is little information about common factors across a variety of contexts. Findings from this study suggest that household and neighborhood disadvantage, in particular, may be key factors in sanitation use. This is important as it highlights the connection between the social environment and a critical public health issue. Sanitation coverage continues to be a persistent problem,

particularly in SSA. While this may be the result of a number of regional, national, political, or economic issues, social organization may be a key factor in sanitation use. Although our study is an important first step in pushing the development and research agenda to focus on a broader perspective of sanitation use, it also highlights a need for better and more research into this dilemma.

References

1. WHO, UNICEF. *Progress on Drinking Water and Sanitation: 2015 Update*. Geneva 2015.
2. Greenberg MR. Sanitation and public health: A heritage to remember and continue. American Public Health Association; 2012.
3. Fuller JA, Westphal JA, Kenney B, Eisenberg JN. The joint effects of water and sanitation on diarrhoeal disease: a multicountry analysis of the Demographic and Health Surveys. *Tropical Medicine & International Health*. 2015;20(3):284-292.
4. House SW. Planning for Drinking Water and Sanitation in Peri-Urban Areas—A proposed framework for strategic choices for sustainable living. Report; 2007.
5. Prüss A, Kay D, Fewtrell L, Bartram J. Estimating the burden of disease from water, sanitation, and hygiene at a global level. *Environmental health perspectives*. 2002;110(5):537-542.
6. Clasen T, Pruss-Ustun A, Mathers CD, Cumming O, Cairncross S, Colford JM. Estimating the impact of unsafe water, sanitation and hygiene on the global burden of disease: evolving and alternative methods. *Tropical Medicine & International Health*. 2014;19(8):884-893.
7. Interagency Task Force on Gender and Water. *Gender, Water and Sanitation: A Policy Brief*. New York: United Nations Department of Economic and Social Affairs (UN/DESA);2006.
8. Bartram J, Lewis K, Lenton R, Wright A. Focusing on improved water and sanitation for health. *The Lancet*. 2005;365(9461):810-812.
9. Bartram J, Cairncross S. Hygiene, sanitation, and water: forgotten foundations of health. *PLoS Med*. 2010;7(11):e1000367.
10. COHRE, WaterAid. *Sanitation: A human rights imperative*. Geneva: SDC and UN-HABITAT;2008.
11. Mazeau AP. *No Toilet at Home: Implementation, Usage and Acceptability of Shared Toilets in Urban Ghana*, Loughborough University; 2013.
12. Isunju J, Schwartz K, Schouten M, Johnson W, van Dijk MP. Socio-economic aspects of improved sanitation in slums: A review. *Public health*. 2011;125(6):368-376.
13. Tumwebaze IK, Orach CG, Niwagaba C, Luthi C, Mosler H-J. Sanitation facilities in Kampala slums, Uganda: users' satisfaction and determinant factors. *International journal of environmental health research*. 2013;23(3):191-204.
14. Sahoo KC, Hulland KR, Caruso BA, et al. Sanitation-related psychosocial stress: A grounded theory study of women across the life-course in Odisha, India. *Social Science & Medicine*. 2015;139:80-89.
15. Khanna T, Das M. Why gender matters in the solution towards safe sanitation? Reflections from rural

India. *Global public health*. 2016;11(10):1185-1201.

16. Winter SC, Barchi F. Access to sanitation and violence against women: evidence from Demographic Health Survey (DHS) data in Kenya. *International journal of environmental health research*. 2015:1-15.
17. Jenkins MW, Scott B. Behavioral indicators of household decision-making and demand for sanitation and potential gains from social marketing in Ghana. *Social science & medicine*. 2007;64(12):2427-2442.
18. O'Reilly K. Combining sanitation and women's participation in water supply: an example from Rajasthan. *Development in Practice*. 2010;20(1):45-56.
19. Dreibelbis R, Jenkins M, Chase RP, et al. Development of a multidimensional scale to assess attitudinal determinants of sanitation uptake and use. *Environmental science & technology*. 2015;49(22):13613-13621.
20. Okurut K, Kulabako RN, Chenoweth J, Charles K. Assessing demand for improved sustainable sanitation in low-income informal settlements of urban areas: a critical review. *International journal of environmental health research*. 2015;25(1):81-95.
21. Tilley E, Bieri S, Kohler P. Review Paper Sanitation in developing countries: a review through a gender lens. 2013.
22. O'Reilly K. From toilet insecurity to toilet security: creating safe sanitation for women and girls. *Wiley Interdisciplinary Reviews: Water*. 2016;3(1):19-24.
23. Sommer M, Ferron S, Cavill S, House S. Violence, gender and WASH: spurring action on a complex, under-documented and sensitive topic. *Environment and Urbanization*. 2014:0956247814564528.
24. Khosla R. Women and sanitation: Urban reality experiences of government programmes, NGOs and CBOs. *Social Change*. 2000;30(1-2):192-207.
25. Bosch C, Hommann K, Rubio G, Sadoff C, Travers L. *Water, sanitation and poverty chapter, poverty reduction strategy papers' source book*. Washington, DC2001.
26. Greed C. Taking women's bodily functions into account in urban planning and sustainability. 21st International Sustainability Development Research Society (ISDRS) Conference: The Tipping Point: Vulnerability and Adaptive Capacity; 2015; Geelong, Australia.
27. Massey K. *Insecurity and shame: Exploration of the impact of the lack of sanitation on women in the slums of Kampala, Uganda*. London, UK2011.
28. Amnesty International. *Insecurity and indignity: Women's experiences in the slums of Nairobi, Kenya*. London: Amnesty International Publications; 2010.
29. Corburn J, Hildebrand C. Slum Sanitation and the Social Determinants of Women's Health in Nairobi, Kenya. *Journal of Environmental and Public Health*. 2015;2015.
30. MEASURE DHS. Demographic and Health Surveys. In: DHS M, ed. Calverton: ICF International; 2015.
31. ICF International. *Demographic and Health Survey Sampling and Household Listing Manual*. Calverton, Maryland: MEASURE DHS;2012.
32. Heijnen M, Cumming O, Peletz R, et al. Shared sanitation versus individual household latrines: a sys-

tematic review of health outcomes. *PLoS One*. 2014;9(4):e93300.

33. Heijnen M, Rosa G, Fuller J, Eisenberg JN, Clasen T. The geographic and demographic scope of shared sanitation: an analysis of national survey data from low-and middle-income countries. *Tropical medicine & international health*. 2014;19(11):1334-1345.
34. Warner WS. Cultural Influences that affect the acceptance of compost toilets: Psychology, religion and gender. *International Composting Toilet News [online] September*. 1998(2).
35. Carolini GY. Framing water, sanitation, and hygiene needs among female-headed households in periurban Maputo, Mozambique. *American journal of public health*. 2012;102(2):256-261.
36. Dreibelbis R, Freeman MC, Greene LE, Saboori S, Rheingans R. The impact of school water, sanitation, and hygiene interventions on the health of younger siblings of pupils: a cluster-randomized trial in Kenya. *American journal of public health*. 2014;104(1):e91-e97.
37. Corburn J, Karanja I. Informal settlements and a relational view of health in Nairobi, Kenya: sanitation, gender and dignity. *Health promotion international*. 2014:dau100.
38. Parks MJ. Urban Poverty Traps: Neighbourhoods and Violent Victimization and Offending in Nairobi, Kenya. *Urban Studies*. 2014;51(9):1812-1832.
39. Sampson RJ, Raudenbush SW, Earls F. Neighborhoods and violent crime: A multilevel study of collective efficacy. *Science*. 1997;277(5328):918-924.
40. Reardon SF, Firebaugh G. Measures of multigroup segregation. *Sociological methodology*. 2002;32(1):33-67.
41. Rabe-Hesketh S, Skrondal A, Pickles A. Maximum likelihood estimation of limited and discrete dependent variable models with nested random effects. *Journal of Econometrics*. 2005;128(2):301-323.
42. Uthman OA. *Does it really matter where you live? A multilevel analysis of social disorganization and risky sexual behaviours in sub-Saharan Africa*. Calverton: ICF Macro;2010.
43. Gazimbi M, Magadi M. A multilevel analysis of the determinants of HIV testing in Zimbabwe: Evidence from the demographic and health surveys. *HIV/AIDS Res Treat Open J*. 2017;4(1):14-31.
44. Delprato M, Dunne Mi, Zeitlyn B. Preschool attendance: a multilevel analysis of individual and community factors in 21 low and middle-income countries. *International Journal of Quantitative Research in Education*. 2016;3(1-2):1-23.
45. Ononokpono DN, Odimegwu CO. Determinants of maternal health care utilization in Nigeria: a multi-level approach. *The Pan African medical journal*. 2014;17(Suppl 1).
46. Schonlau M. Stata-ado package "hotdeckvar" for single hotdeck imputation. 2012.
47. O'Reilly K, Louis E. The toilet tripod: Understanding successful sanitation in rural India. *Health & place*. 2014;29:43-51.
48. Biran A, Schmidt WP, Zeleke L, et al. Hygiene and sanitation practices amongst residents of three long-term refugee camps in Thailand, Ethiopia and Kenya. *Tropical medicine & international health*. 2012;17(9):1133-1141.

49. WHO & UNICEF. WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation. <https://www.wssinfo.org/>. Accessed June 1, 2017.
50. Ulmer JT, Harris CT, Steffensmeier D. Racial and ethnic disparities in structural disadvantage and crime: White, Black, and Hispanic comparisons. *Social science quarterly*. 2012;93(3):799-819.
51. Hirai M, Graham JP, Sandberg J. Understanding women's decision making power and its link to improved household sanitation: the case of Kenya. *Journal of Water Sanitation and Hygiene for Development*. 2016;6(1):151-160.
52. Thys S, Mwape KE, Lefèvre P, et al. Why latrines are not used: communities' perceptions and practices regarding latrines in a Taenia solium endemic rural area in eastern Zambia. *PLoS Negl Trop Dis*. 2015;9(3):e0003570.
53. Rheingans R, Anderson JD, Luyendijk R, Cumming O. Measuring disparities in sanitation access: does the measure matter? *Tropical Medicine & International Health*. 2014;19(1):2-13.
54. Kravdal Ø. A simulation-based assessment of the bias produced when using averages from small DHS clusters as contextual variables in multilevel models. *Demographic Research*. 2006;15:1-20.
55. Stapleton L. Evaluation of conditional weight approximations for two-level models. *Communications in Statistics-Simulation and Computation*. 2012;41(2):182-204.
56. Koziol NA, Bovaird JA, Suarez S. A comparison of population-averaged and cluster-specific approaches in the context of unequal probabilities of selection. *Multivariate Behavioral Research*. 2017:1-25.

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Appendix 1. Frequencies for descriptive statistics ($n = 102,399$)

Country	C	CI	DR	GA	GH	KE	M	ML	M	NG	SL	TG	UG	ZM
	M	V	C	B	A	N	WI	I	OZ	A	E	O	A	B
	R													
n	50	63	68	55	24	63	62	34	68	276	51	67	20	117
	43	51	11	57	42	18	29	59	35	34	85	01	56	78
<u>Sanitation Variables</u>														
No facility (OD)	29	21	11	14	63	11	71	29	22	839	10	36	25	166
	9	43	31	4	8	35	4	7	10	2	76	30	4	2
Private facility	31	15	28	30	31	26	32	18	39	116	77	99	96	641
	96	64	73	64	1	59	01	12	51	88	3	3	7	7
Shared facility	15	26	28	23	14	25	23	13	67	755	33	20	83	369
	48	44	07	49	93	24	14	50	4	4	36	78	5	9
<u>Individual-level factors</u>														
Non-Christian	32	37	29	81	60	12	76	33	20	132	40	28	29	153
	1	47	9	5	8	56	9	25	01	83	65	84	2	
Married	35	46	51	35	16	42	45	30	48	210	40	48	14	797
	79	40	20	63	00	68	77	50	80	04	29	91	47	3
Employed	33	44	49	25	19	34	35	15	27	176	37	49	14	640
	23	53	21	11	24	88	91	94	28	96	62	23	45	4
Age (years)	28.	29.	28.	30.	29.	29.	28.	28.	29.	29.	30.	29.	28.	29
	6	3	7	1	7	1	6	7	1	2	2	9	5	29
	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.
	13)	11)	11)	13)	19)	11)	11)	15)	11)	06)	13)	11)	2)	08)
Years of education	6.1	2.7	5.3	6.4	6.1	7.3	5.1	1.8	3.9	6.3	2.9	4.2	5.6	6.6
	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.
	06)	05)	05)	04)	09)	06)	05)	06)	05)	03)	06)	05)	09)	03)
Family size	6.2	6.3	6.0	5.8	4.7	5.0	5.3	6.2	5.1	5.5	6.4	5.7	5.6	5.8
	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.	(0.
	05)	05)	03)	05)	05)	03)	03)	05)	03)	02)	04)	04)	06)	02)
Female-headed household	12	12	14	19	89	22	16	36	24	515	14	17	63	297
	47	42	10	65	5	66	61	8	51	9	93	12	2	3
Public water source	26	30	19	18	15	23	45	19	15	147	28	38	31	535
	87	31	64	52	76	46	29	43	65	65	83	03	6	3
Open water source	14	12	39	81	31	20	12	10	26	927	19	21	49	413
	15	51	08	5	2	70	42	60	90	2	85	93	9	8
Private water source	94	20	93	28	55	19	45	45	25	359	31	70	12	228
	1	69	9	90	4	02	8	6	80	7	7	5	41	7
Wealth above the median	22	26	26	15	11	31	27	17	37	139	25	27	98	494
	85	31	96	25	02	35	94	94	09	15	23	90	9	5
Recent non-partner violence	51	26	44	29	17	36	24	26	25	122	42	18	17	491
	2	4	5	1	6	7	4	7	7	7	5	2	1	
<u>Neighborhood-level factors</u>														
Urban	24	26	21	36	10	19	78	10	25	110	18	25	56	525
	51	60	54	20	52	05	2	50	46	15	71	23	0	7
Percent female-headed households	24.	17.	22.	30.	34.	37.	25.	9.3	36.	17.	28.	23.	30.	25.
	6	7	3	8	5	3	7	(0.	3	8	9	7	4	6
	(0.	(0.	(0.	(0.	(0.	(0.	(0.	16)	(0.	(0.	(0.	(0.	(0.	(0.
	21)	17)	13)	17)	41)	19)	15)		2)	09)	23)	16)	29)	12)

Percent households with unemployment	17.2	14.5	15.3	27.7	13.2	35.6	28.6	31.9	42.8	19.3	14.7	14.8	17.8	13.5
	(0.18)	(0.13)	(0.18)	(0.18)	(0.23)	(0.28)	(0.18)	(0.27)	(0.27)	(0.07)	(0.17)	(0.13)	(0.3)	(0.11)
Percent households in lowest wealth quintile	16.2	21.6	25.8	38.4	22.1	21.7	21.1	18.7	15.3	17.1	20.8	21.3	22.0	21.7
	(0.4)	(0.33)	(0.29)	(0.48)	(0.67)	(0.36)	(0.21)	(0.36)	(0.26)	(0.17)	(0.33)	(0.35)	(0.63)	(0.22)
Diversity	0.5	1.2	0.2	0.8	0.5	0.5	0.6	0.7	0.6	0.6	0.6	0.4	0.7	1.0
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)
Percent households with recent non-partner violence	4.6	3.4	3	4.2	4.3	5.8	1.2	3.6	2.3	3.9	3.8	2.4	2.5	3.8
	(0.07)	(0.06)	(0.05)	(0.06)	(0.14)	(0.09)	(0.03)	(0.1)	(0.05)	(0.03)	(0.07)	(0.04)	(0.08)	(0.05)

Appendix 2. Results from all two-level multinomial logistic regressions of factors associated with OD versus private facility use and shared versus private facility use

	Cameroon			Cote d'Ivoire		
	RRR	p-value	CI [95%]	RRR	p-value	CI [95%]
SHARED						
<i>Individual-level factors</i>						
Non-Christian	1.06	0.731	0.762-1.473	1.61	0.000	1.354-1.920
Married	1.34	0.001	1.119-1.608	1.55	0.000	1.268-1.905
Employed	1.19	0.052	0.998-1.418	1.09	0.325	0.918-1.293
Age	0.97	0.000	0.966-0.984	0.98	0.000	0.973-0.992
Years of education	0.94	0.000	0.921-0.966	0.94	0.000	0.919-0.957
Family size	0.81	0.000	0.793-0.836	0.89	0.000	0.868-0.908
Female-headed household	1.28	0.008	1.066-1.542	1.25	0.046	1.004-1.554
Public water source	1.87	0.000	1.546-2.261	3.02	0.000	2.445-3.725
Open water source	2.01	0.000	1.562-2.591	3.55	0.000	2.621-4.813
Wealth above the median	1.05	0.646	0.853-1.292	0.51	0.000	0.416-0.621
Recent non-partner violence	1.03	0.834	0.804-1.311	1.07	0.714	0.745-1.537
<i>Neighborhood-level factors</i>						
Urban	1.05	0.757	0.775-1.421	1.86	0.009	1.165-2.975
Female-headed households	1.01	0.001	1.006-1.021	1.01	0.013	1.003-1.024
Household unemployment	0.98	0.000	0.970-0.988	1.01	0.074	0.999-1.029
Households in lowest wealth quintile	0.97	0.000	0.962-0.974	1.01	0.155	0.998-1.015
Diversity	1.59	0.001	1.209-2.081	1.40	0.003	1.122-1.742
Recent non-partner violence	1.00	0.967	0.980-1.021	1.02	0.348	0.983-1.048
OPEN DEFECATION						
<i>Individual-level factors</i>						
Non-Christian	2.36	0.001	1.404-3.955	1.24	0.066	0.986-1.558
Married	1.12	0.624	0.712-1.760	1.64	0.001	1.240-2.171
Employed	0.99	0.977	0.670-1.475	1.19	0.144	0.942-1.503
Age	1.00	0.820	0.980-1.016	0.98	0.010	0.972-0.996
Years of education	0.92	0.030	0.861-0.993	0.89	0.000	0.856-0.917
Family size	0.94	0.006	0.893-0.982	0.95	0.000	0.921-0.974
Female-headed household	1.58	0.085	0.939-2.672	1.23	0.172	0.913-1.669
Public water source	0.66	0.248	0.329-1.333	5.86	0.000	4.196-8.195
Open water source	1.13	0.735	0.561-2.266	9.33	0.000	6.20-14.028
Wealth above the median	0.08	0.000	0.034-0.180	0.12	0.000	0.093-0.165

Recent non-partner violence	1.61	0.106	0.904-2.854	1.58	0.104	0.911-2.735
<i>Neighborhood-level factors</i>						
Urban	2.59	0.041	1.040-6.471	0.79	0.456	0.434-1.455
Female-headed households	0.95	0.000	0.926-0.974	1.03	0.000	1.014-1.040
Household unemployment	0.99	0.267	0.970-1.008	1.02	0.107	0.996-1.039
Households in lowest wealth quintile	1.03	0.000	1.018-1.038	1.05	0.000	1.040-1.059
Diversity	0.95	0.904	0.434-2.091	0.57	0.000	0.424-0.753
Recent non-partner violence	1.03	0.337	0.970-1.093	1.06	0.060	0.998-1.118
Neighborhood variance (null model)	7.54	1.462 ¹		12.04	1.064 ¹	
ICC (null model)	69.63			78.54		
Neighborhood variance (full model)	2.69	0.494 ¹		2.86	0.282 ¹	
ICC (full model)	45.02			46.49		

¹Standard errors corresponding to neighborhood-variance (level 2 variance)

	<u>DRC</u>			<u>Gabon</u>		
	RRR	p-value	CI [95%]	RRR	p-value	CI [95%]
<u>SHARED</u>						
<i>Individual-level factors</i>						
Non-Christian	1.24	0.193	0.896-1.720	0.93	0.439	0.764-1.124
Married	1.44	0.000	1.226-1.702	1.50	0.000	1.283-1.750
Employed	1.12	0.158	0.957-1.306	1.08	0.295	0.934-1.252
Age	0.98	0.000	0.976-0.991	0.98	0.000	0.975-0.990
Years of education	0.99	0.218	0.969-1.007	0.99	0.339	0.964-1.013
Family size	0.91	0.000	0.889-0.932	0.88	0.000	0.862-0.899
Female-headed household	1.48	0.000	1.242-1.757	1.10	0.227	0.943-1.280
Public water source	0.87	0.325	0.664-1.145	1.62	0.000	1.382-1.903
Open water source	0.85	0.254	0.637-1.126	1.49	0.002	1.157-1.929
Wealth above the median	1.12	0.164	0.954-1.321	0.16	0.000	0.135-0.196
Recent non-partner violence	1.07	0.622	0.828-1.372	1.10	0.535	0.817-1.476
<i>Neighborhood-level factors</i>						
Urban	1.69	0.001	1.243-2.301	4.42	0.000	3.144-6.225
Female-headed households	0.99	0.119	0.983-1.002	1.01	0.025	1.001-1.020
Household unemployment	1.00	0.997	0.992-1.008	1.01	0.041	1.000-1.017
Households in lowest wealth quintile	1.01	0.016	1.001-1.012	1.00	0.674	0.995-1.003
Diversity	1.32	0.132	0.920-1.893	2.41	0.000	1.876-3.099
Recent non-partner violence	1.02	0.243	0.988-1.047	1.02	0.149	0.993-1.046
<u>OPEN DEFECATION</u>						
<i>Individual-level factors</i>						
Non-Christian	1.17	0.503	0.738-1.859	0.68	0.257	0.351-1.323
Married	1.11	0.423	0.863-1.420	1.48	0.129	0.893-2.439
Employed	1.02	0.892	0.793-1.305	1.26	0.332	0.790-2.008
Age	0.99	0.181	0.982-1.003	0.98	0.145	0.959-1.006
Years of education	0.94	0.000	0.913-0.968	0.82	0.000	0.755-0.898
Family size	0.88	0.000	0.842-0.909	0.91	0.009	0.854-0.978
Female-headed household	1.81	0.000	1.418-2.299	1.73	0.032	1.049-2.845
Public water source	1.19	0.481	0.729-1.954	1.97	0.006	1.210-3.200
Open water source	1.25	0.382	0.761-2.044	1.87	0.089	0.909-3.855
Wealth above the median	0.38	0.000	0.295-0.494	0.09	0.000	0.039-0.197
Recent non-partner violence	1.09	0.661	0.743-1.598	0.77	0.586	0.307-1.946
<i>Neighborhood-level factors</i>						
Urban	0.50	0.016	0.288-0.877	0.21	0.000	0.088-0.500
Female-headed households	1.02	0.008	1.005-1.037	1.01	0.528	0.982-1.037
Household unemployment	0.99	0.029	0.972-0.998	1.02	0.034	1.002-1.044
Households in lowest wealth quintile	1.01	0.017	1.002-1.019	0.97	0.000	0.955-0.979

Diversity	0.91	0.767	0.483-1.709	0.69	0.247	0.364-1.297
Recent non-partner violence	0.97	0.286	0.925-1.023	1.11	0.006	1.030-1.196
Neighborhood variance (null)	3.72	0.336 ¹		5.71	1.205 ¹	
ICC (null)	53.05			63.44		
Neighborhood variance (full model)	3.82	0.399 ¹		4.91	0.905 ¹	
ICC (full model)	53.73			59.86		

¹Standard errors corresponding to neighborhood-variance (level 2 variance)

	<u>Ghana</u>			<u>Kenya</u>		
	RRR	p-value	CI [95%]	RRR	p-value	CI [95%]
<u>SHARED</u>						
<i>Individual-level factors</i>						
Non-Christian	1.29	0.289	0.804-2.076	0.54	0.000	0.404-0.730
Married	2.18	0.000	1.465-3.237	1.74	0.000	1.461-2.064
Employed	1.46	0.067	0.973-2.189	1.19	0.028	1.02-1.398
Age	0.98	0.062	0.962-1.001	0.96	0.000	0.955-0.972
Years of education	0.94	0.002	0.897-0.976	0.90	0.000	0.882-0.920
Family size	0.86	0.000	0.799-0.922	0.81	0.000	0.786-0.842
Female-headed household	1.70	0.009	1.146-2.536	1.23	0.016	1.040-1.458
Public water source	7.22	0.000	4.660-11.179	1.78	0.000	1.439-2.208
Open water source	5.91	0.000	2.926-11.938	1.46	0.002	1.152-1.852
Wealth above the median	0.74	0.173	0.486-1.138	1.23	0.023	1.029-1.473
Recent non-partner violence	1.09	0.786	0.582-2.045	1.05	0.737	0.775-1.435
<i>Neighborhood-level factors</i>						
Urban	2.38	0.005	1.292-4.376	4.25	0.000	2.758-6.538
Female-headed households	1.02	0.000	1.012-1.038	1.00	0.398	0.995-1.013
Household unemployment	1.01	0.329	0.990-1.032	1.01	0.040	1.000-1.017
Households in lowest wealth quintile	0.98	0.000	0.967-0.988	1.01	0.017	1.002-1.017
Diversity	1.63	0.121	0.878-3.036	0.87	0.432	0.608-1.237
Recent non-partner violence	0.99	0.459	0.953-1.022	1.02	0.024	1.003-1.047
<u>OPEN DEFECCATION</u>						
<i>Individual-level factors</i>						
Non-Christian	1.97	0.025	1.087-3.564	1.03	0.899	0.623-1.714
Married	1.49	0.165	0.850-2.596	1.28	0.103	0.951-1.734
Employed	0.85	0.574	0.478-1.506	1.12	0.441	0.845-1.472
Age	0.98	0.109	0.953-1.005	0.98	0.004	0.963-0.993
Years of education	0.86	0.000	0.810-0.913	0.82	0.000	0.784-0.855
Family size	0.97	0.552	0.891-1.064	0.84	0.000	0.799-0.888
Female-headed household	1.68	0.067	0.965-2.910	1.23	0.157	0.925-1.625
Public water source	11.44	0.000	5.533-23.641	1.89	0.006	1.197-2.98
Open water source	7.59	0.000	2.809-20.488	2.07	0.002	1.315-3.267
Wealth above the median	0.19	0.000	0.102-0.348	0.10	0.000	0.066-0.157
Recent non-partner violence	0.60	0.261	0.244-1.465	1.42	0.146	0.885-2.287
<i>Neighborhood-level factors</i>						
Urban	1.49	0.427	0.559-3.949	3.42	0.004	1.498-7.827
Female-headed households	1.00	0.775	0.982-1.024	1.00	0.820	0.981-1.016
Household unemployment	0.99	0.733	0.962-1.028	1.00	0.518	0.984-1.008
Households in lowest wealth quintile	1.04	0.000	1.029-1.058	1.08	0.000	1.068-1.098
Diversity	0.70	0.488	0.253-1.928	0.72	0.343	0.358-1.430
Recent non-partner violence	1.01	0.619	0.960-1.071	1.04	0.039	1.002-1.077
Neighborhood variance (null)	30.09	5.580 ¹		19.16	1.796 ¹	
ICC (null)	90.14			85.35		
Neighborhood variance (full model)	5.68	1.070 ¹		5.77	0.817 ¹	
ICC (full model)	63.34			63.70		

¹Standard errors corresponding to neighborhood-variance (level 2 variance)

	<u>Malawi</u>			<u>Mali</u>		
	RRR	p-value	CI [95%]	RRR	p-value	CI [95%]
SHARED						
<i>Individual-level factors</i>						
Non-Christian	0.58	0.000	0.471-0.725	0.66	0.068	0.420-1.032
Married	1.50	0.000	1.271-1.762	1.78	0.000	1.342-2.369
Employed	1.12	0.090	0.983-1.265	1.35	0.001	1.130-1.622
Age	0.97	0.000	0.965-0.980	0.98	0.000	0.968-0.989
Years of education	0.95	0.000	0.932-0.969	0.97	0.009	0.942-0.992
Family size	0.90	0.000	0.873-0.925	0.92	0.000	0.894-0.949
Female-headed household	1.65	0.000	1.394-1.950	1.25	0.128	0.939-1.654
Public water source	3.06	0.000	2.426-3.866	1.26	0.110	0.949-1.672
Open water source	2.68	0.000	2.040-3.511	1.30	0.149	0.911-1.851
Wealth above the median	0.76	0.000	0.669-0.868	1.24	0.066	0.986-1.549
Recent non-partner violence	0.96	0.791	0.695-1.319	0.91	0.594	0.652-1.278
<i>Neighborhood-level factors</i>						
Urban	1.85	0.000	1.421-2.402	2.21	0.000	1.486-3.301
Female-headed households	0.99	0.089	0.988-1.001	1.00	0.752	0.983-1.013
Household unemployment	0.99	0.001	0.986-0.996	0.99	0.002	0.978-0.995
Households in lowest wealth quintile	0.99	0.001	0.986-0.997	1.00	0.610	0.990-1.006
Diversity	1.29	0.012	1.058-1.566	0.73	0.067	0.523-1.022
Recent non-partner violence	1.03	0.095	0.995-1.065	1.03	0.016	1.005-1.053
OPEN DEFECACTION						
<i>Individual-level factors</i>						
Non-Christian	0.82	0.229	0.584-1.137	0.16	0.000	0.079-0.332
Married	1.41	0.011	1.082-1.826	1.23	0.582	0.592-2.543
Employed	1.23	0.041	1.008-1.511	1.14	0.530	0.757-1.719
Age	0.97	0.000	0.963-0.986	1.00	0.889	0.977-1.021
Years of education	0.87	0.000	0.837-0.896	0.91	0.054	0.819-1.002
Family size	0.92	0.000	0.876-0.962	0.93	0.032	0.867-0.994
Female-headed household	2.28	0.000	1.760-2.944	0.99	0.988	0.512-1.933
Public water source	2.55	0.000	1.576-4.139	1.24	0.698	0.412-3.757
Open water source	3.04	0.000	1.815-5.083	1.70	0.359	0.546-5.306
Wealth above the median	0.24	0.000	0.192-0.313	0.46	0.003	0.274-0.770
Recent non-partner violence	0.92	0.772	0.541-1.578	0.88	0.733	0.431-1.808
<i>Neighborhood-level factors</i>						
Urban	0.90	0.724	0.509-1.598	0.92	0.920	0.187-4.541
Female-headed households	0.99	0.094	0.979-1.002	1.00	0.935	0.961-1.044
Household unemployment	0.99	0.176	0.985-1.003	0.97	0.004	0.952-0.990
Households in lowest wealth quintile	1.01	0.170	0.997-1.015	1.04	0.000	1.023-1.054
Diversity	1.24	0.222	0.878-1.749	0.18	0.000	0.073-0.427
Recent non-partner violence	0.99	0.675	0.928-1.050	1.03	0.341	0.970-1.092
Neighborhood variance (null)	1.48	0.197 ¹		10.38	1.488 ¹	
ICC (null)	31.08			75.93		
Neighborhood variance (full model)	1.58	0.212 ¹		5.65	0.972 ¹	
ICC (full model)	32.44			63.20		

¹Standard errors corresponding to neighborhood-variance (level 2 variance)

	<u>Mozambique</u>			<u>Nigeria</u>		
	RRR	p-value	CI [95%]	RRR	p-value	CI [95%]
SHARED						
<i>Individual-level factors</i>						
Non-Christian	0.84	0.150	0.668-1.064	0.83	0.006	0.734-0.948
Married	1.10	0.394	0.878-1.390	1.37	0.000	1.239-1.523
Employed	1.10	0.401	0.883-1.365	1.17	0.001	1.069-1.271
Age	0.97	0.000	0.962-0.984	0.98	0.000	0.980-0.989
Years of education	0.91	0.000	0.886-0.942	0.94	0.000	0.934-0.954
Family size	0.77	0.000	0.733-0.803	0.87	0.000	0.857-0.882
Female-headed household	1.35	0.011	1.069-1.693	1.33	0.000	1.199-1.485
Public water source	0.75	0.023	0.579-0.960	1.15	0.009	1.037-1.285
Open water source	0.60	0.002	0.430-0.830	1.41	0.000	1.223-1.627
Wealth above the median	0.87	0.298	0.669-1.131	0.98	0.663	0.871-1.092
Recent non-partner violence	1.33	0.230	0.837-2.105	1.00	0.988	0.834-1.195
<i>Neighborhood-level factors</i>						
Urban	1.10	0.609	0.767-1.573	1.93	0.000	1.655-2.256
Female-headed households	0.98	0.000	0.968-0.985	1.03	0.000	1.027-1.039
Household unemployment	1.01	0.071	0.999-1.013	0.99	0.000	0.984-0.995
Households in lowest wealth quintile	1.00	0.559	0.986-1.008	0.98	0.000	0.980-0.987
Diversity	2.42	0.000	1.774-3.309	1.06	0.318	0.944-1.193
Recent non-partner violence	0.97	0.149	0.933-1.011	0.97	0.000	0.956-0.982
OPEN DEFECACTION						
<i>Individual-level factors</i>						
Non-Christian	0.93	0.488	0.754-1.144	0.57	0.000	0.480-0.670
Married	0.92	0.418	0.739-1.134	1.12	0.109	0.976-1.276
Employed	1.39	0.001	1.147-1.683	1.20	0.001	1.076-1.340
Age	0.99	0.013	0.978-0.997	0.99	0.000	0.982-0.993
Years of education	0.91	0.000	0.879-0.940	0.90	0.000	0.892-0.917
Family size	0.90	0.000	0.868-0.933	0.93	0.000	0.911-0.943
Female-headed household	1.56	0.000	1.274-1.922	1.45	0.000	1.268-1.665
Public water source	1.30	0.044	1.007-1.689	1.84	0.000	1.561-2.180
Open water source	1.54	0.002	1.171-2.034	3.05	0.000	2.489-3.737
Wealth above the median	0.24	0.000	0.189-0.294	0.31	0.000	0.268-0.353
Recent non-partner violence	0.91	0.686	0.563-1.460	0.94	0.579	0.748-1.176
<i>Neighborhood-level factors</i>						
Urban	0.30	0.000	0.194-0.472	1.97	0.000	1.540-2.515
Female-headed households	1.00	0.804	0.989-1.009	1.06	0.000	1.055-1.072
Household unemployment	1.01	0.003	1.004-1.018	0.99	0.007	0.984-0.997
Households in lowest wealth quintile	1.06	0.000	1.055-1.075	1.03	0.000	1.023-1.031
Diversity	1.56	0.031	1.042-2.325	0.27	0.000	0.218-0.336
Recent non-partner violence	1.05	0.053	0.999-1.098	1.00	0.858	0.982-1.022
Neighborhood variance (null)	8.02	0.770 ¹		10.60	0.514 ¹	
ICC (null)	70.91			76.32		
Neighborhood variance (full model)	3.28	0.333 ¹		10.14	0.467 ¹	
ICC (full model)	49.90			75.50		

¹Standard errors corresponding to neighborhood-variance (level 2 variance)

	<u>Sierra Leone</u>			<u>Togo</u>		
	RRR	p-value	CI [95%]	RRR	p-value	CI [95%]
SHARED						
<i>Individual-level factors</i>						
Non-Christian	2.30	0.000	1.853-2.862	1.30	0.018	1.046-1.626
Married	1.41	0.005	1.108-1.793	1.98	0.000	1.572-2.491
Employed	1.25	0.033	1.019-1.542	0.98	0.859	0.790-1.217
Age	1.00	0.518	0.986-1.007	0.97	0.000	0.955-0.978
Years of education	0.97	0.007	0.947-0.992	0.92	0.000	0.898-0.941
Family size	0.91	0.000	0.881-0.935	0.79	0.000	0.762-0.815
Female-headed household	0.87	0.201	0.701-1.078	1.32	0.016	1.052-1.649
Public water source	3.80	0.000	2.794-5.165	4.07	0.000	3.250-5.084
Open water source	3.81	0.000	2.639-5.487	3.05	0.000	2.227-4.183
Wealth above the median	0.62	0.000	0.493-0.791	1.62	0.001	1.206-2.177
Recent non-partner violence	1.26	0.200	0.884-1.799	1.30	0.364	0.737-2.299
<i>Neighborhood-level factors</i>						
Urban	2.13	0.000	1.415-3.198	0.99	0.954	0.674-1.452
Female-headed households	1.02	0.001	1.007-1.026	1.01	0.018	1.002-1.024
Household unemployment	0.99	0.368	0.982-1.007	0.99	0.199	0.98-1.004
Households in lowest wealth quintile	1.02	0.000	1.008-1.025	0.99	0.043	0.985-1.00
Diversity	0.77	0.113	0.564-1.062	1.04	0.847	0.69-1.570
Recent non-partner violence	1.03	0.059	0.999-1.063	1.08	0.000	1.043-1.125
OPEN DEFECACTION						
<i>Individual-level factors</i>						
Non-Christian	2.13	0.000	1.544-2.927	1.68	0.000	1.317-2.146
Married	1.07	0.705	0.759-1.504	2.13	0.000	1.631-2.787
Employed	1.18	0.296	0.868-1.593	1.37	0.013	1.071-1.761
Age	0.99	0.246	0.977-1.006	0.96	0.000	0.948-0.973
Years of education	0.95	0.007	0.912-0.985	0.89	0.000	0.866-0.920
Family size	0.88	0.000	0.840-0.917	0.89	0.000	0.864-0.921
Female-headed household	0.79	0.133	0.581-1.074	1.69	0.000	1.294-2.197
Public water source	1.35	0.255	0.805-2.265	6.82	0.000	4.737-9.806
Open water source	2.36	0.004	1.308-4.246	9.56	0.000	6.333-14.417
Wealth above the median	0.21	0.000	0.152-0.301	0.16	0.000	0.113-0.238
Recent non-partner violence	1.19	0.483	0.731-1.938	1.07	0.828	0.568-2.029
<i>Neighborhood-level factors</i>						
Urban	1.18	0.724	0.462-3.036	0.57	0.066	0.308-1.038
Female-headed households	1.01	0.221	0.994-1.027	1.03	0.002	1.009-1.044
Household unemployment	1.00	0.894	0.978-1.020	1.04	0.000	1.020-1.060
Households in lowest wealth quintile	1.06	0.000	1.047-1.072	1.05	0.000	1.036-1.057
Diversity	0.77	0.396	0.421-1.408	2.29	0.050	0.999-5.232
Recent non-partner violence	1.09	0.002	1.031-1.150	1.16	0.000	1.080-1.239
Neighborhood variance (null)	5.13	0.506 ¹		7.48	0.715 ¹	
ICC (null)	60.95			69.44		
Neighborhood variance (full model)	4.38	0.533 ¹		3.81	0.457 ¹	
ICC (full model)	57.12			53.65		

¹Standard errors corresponding to neighborhood-variance (level 2 variance)

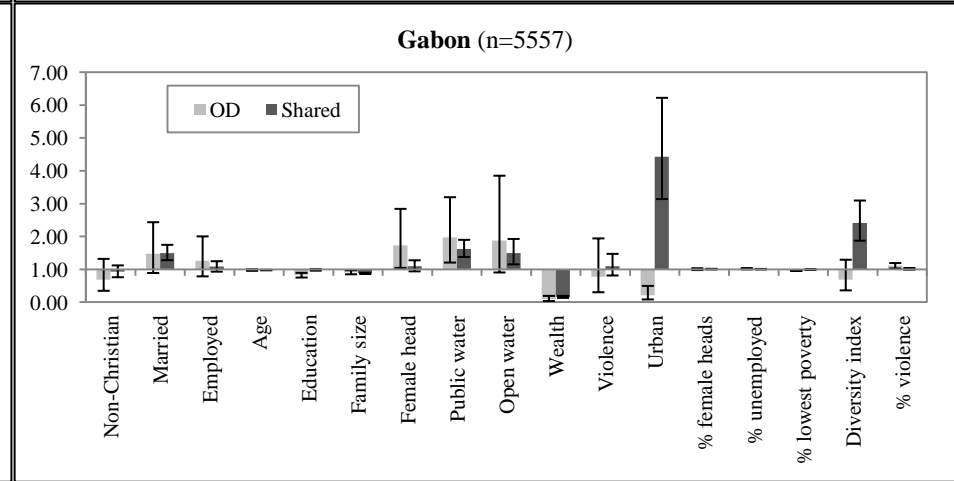
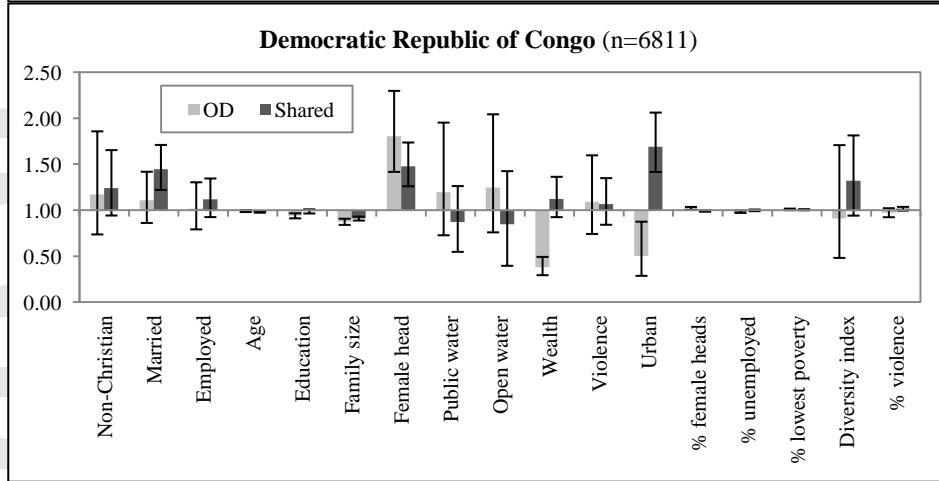
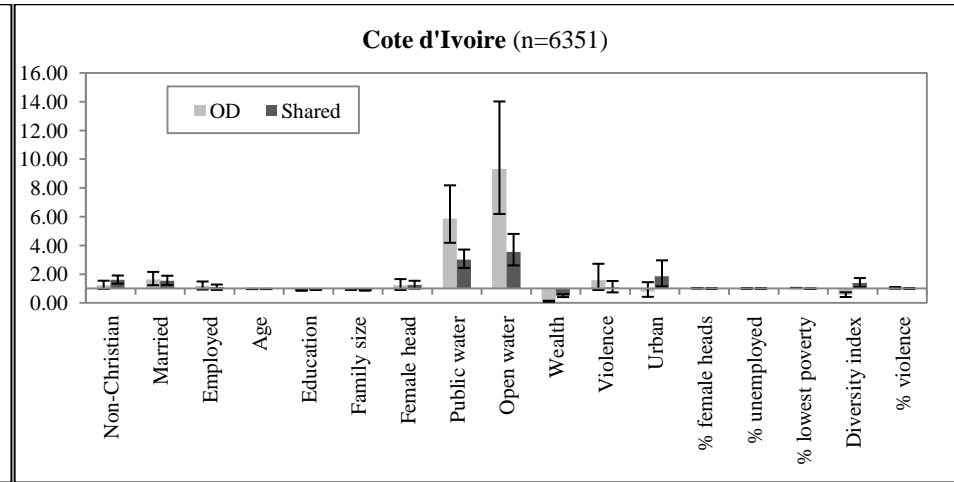
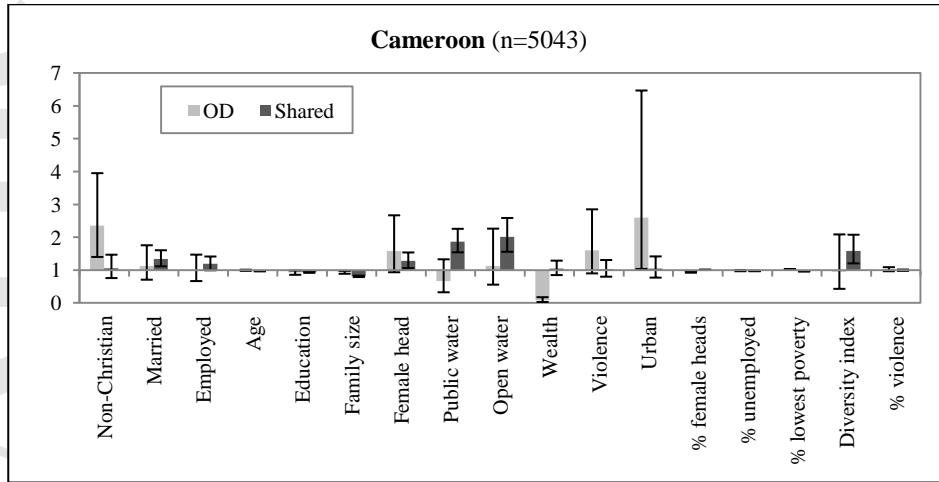
	<u>Uganda</u>			<u>Zambia</u>		
	RRR	p-value	CI [95%]	RRR	p-value	CI [95%]
SHARED						
<i>Individual-level factors</i>						
Non-Christian	1.78	0.001	1.265-2.502	0.81	0.405	0.499-1.325
Married	1.58	0.002	1.183-2.099	1.80	0.000	1.575-2.066
Employed	0.97	0.838	0.741-1.275	0.99	0.928	0.891-1.111
Age	0.97	0.000	0.961-0.989	0.98	0.000	0.976-0.988
Years of education	0.99	0.520	0.957-1.023	0.94	0.000	0.923-0.954
Family size	0.79	0.000	0.756-0.830	0.84	0.000	0.822-0.859
Female-headed household	1.36	0.045	1.006-1.827	1.94	0.000	1.676-2.240
Public water source	1.83	0.001	1.267-2.634	1.59	0.000	1.364-1.862
Open water source	0.83	0.209	0.614-1.113	1.43	0.000	1.187-1.723
Wealth above the median	0.87	0.321	0.665-1.143	0.71	0.000	0.614-0.815
Recent non-partner violence	1.18	0.488	0.744-1.856	1.10	0.447	0.861-1.405
<i>Neighborhood-level factors</i>						
Urban	4.18	0.000	2.825-6.191	2.23	0.000	1.695-2.926
Female-headed households	1.01	0.114	0.998-1.020	0.99	0.114	0.985-1.002
Household unemployment	1.01	0.185	0.997-1.018	1.01	0.063	1.000-1.017
Households in lowest wealth quintile	1.02	0.000	1.014-1.028	0.99	0.000	0.984-0.994
Diversity	0.91	0.618	0.638-1.306	1.38	0.000	1.154-1.646
Recent non-partner violence	0.95	0.024	0.915-0.994	1.00	0.800	0.979-1.017
OPEN DEFECACTION						
<i>Individual-level factors</i>						
Non-Christian	1.67	0.179	0.792-3.503	2.08	0.031	1.067-4.049
Married	1.39	0.241	0.801-2.416	1.39	0.002	1.129-1.708
Employed	1.18	0.535	0.700-1.987	1.06	0.469	0.901-1.255
Age	0.98	0.074	0.950-1.002	0.98	0.000	0.972-0.990
Years of education	0.85	0.000	0.789-0.921	0.88	0.000	0.857-0.904
Family size	0.81	0.000	0.745-0.887	0.90	0.000	0.876-0.934
Female-headed household	1.43	0.196	0.832-2.450	1.61	0.000	1.300-1.992
Public water source	1.09	0.868	0.385-3.103	2.75	0.000	1.872-4.043
Open water source	1.17	0.567	0.687-1.988	3.35	0.000	2.266-4.965
Wealth above the median	0.11	0.000	0.050-0.232	0.18	0.000	0.140-0.239
Recent non-partner violence	0.62	0.304	0.252-1.538	0.97	0.871	0.651-1.439
<i>Neighborhood-level factors</i>						
Urban	6.40	0.001	2.240-18.279	0.39	0.000	0.233-0.659
Female-headed households	1.00	0.922	0.979-1.024	1.00	0.601	0.989-1.020
Household unemployment	1.02	0.132	0.995-1.035	1.01	0.314	0.993-1.022
Households in lowest wealth quintile	1.07	0.000	1.053-1.078	1.01	0.072	0.999-1.015
Diversity	0.68	0.326	0.313-1.471	0.95	0.771	0.698-1.306
Recent non-partner violence	0.99	0.785	0.916-1.069	0.98	0.226	0.941-1.014
Neighborhood variance (null)	8.58	1.405 ¹		4.06	0.305 ¹	
ICC (null)	72.28			55.23		
Neighborhood variance (full model)	1.79	0.543 ¹		3.97	0.413 ¹	
ICC (full model)	35.19			54.70		

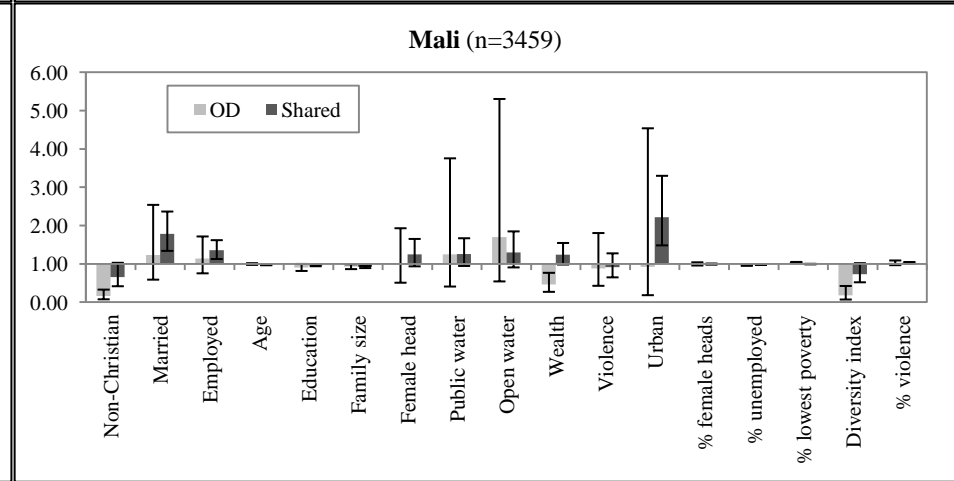
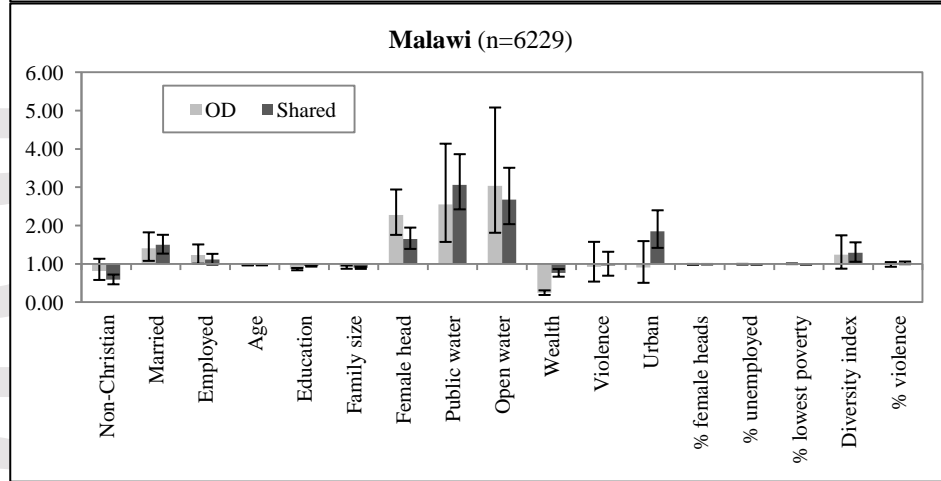
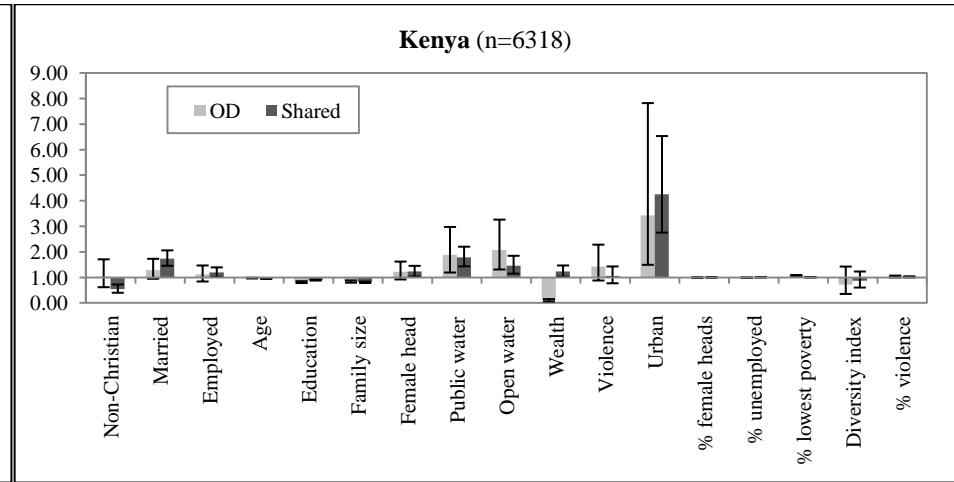
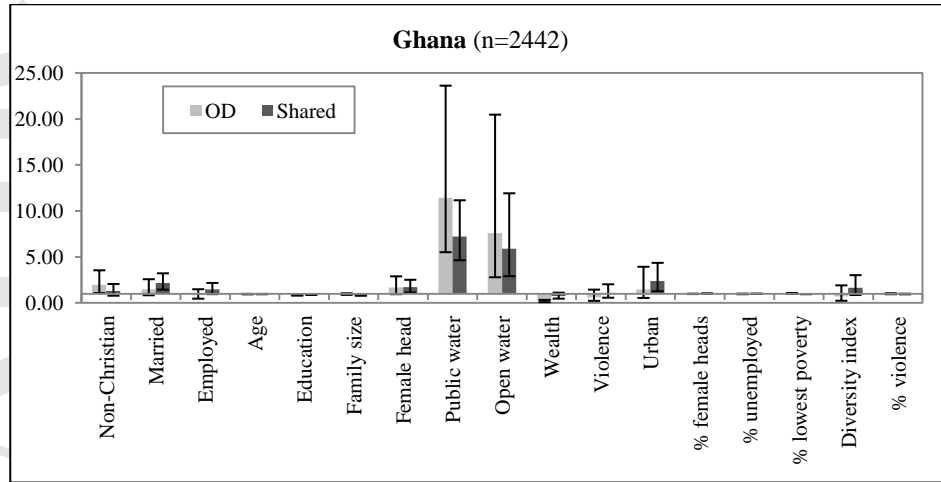
¹Standard errors corresponding to neighborhood-variance (level 2 variance)

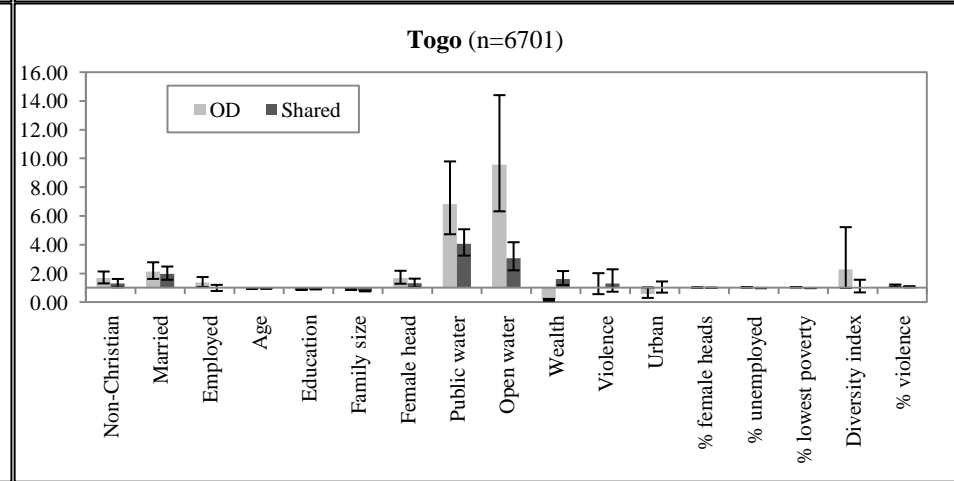
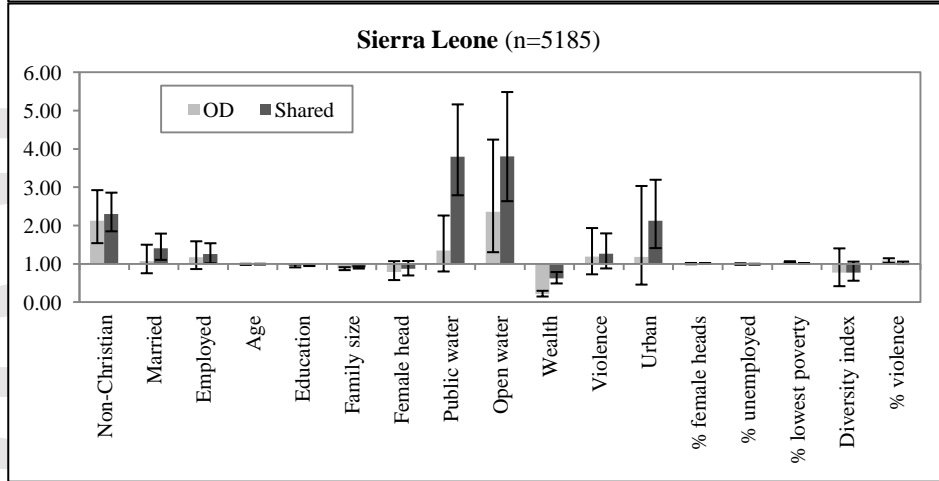
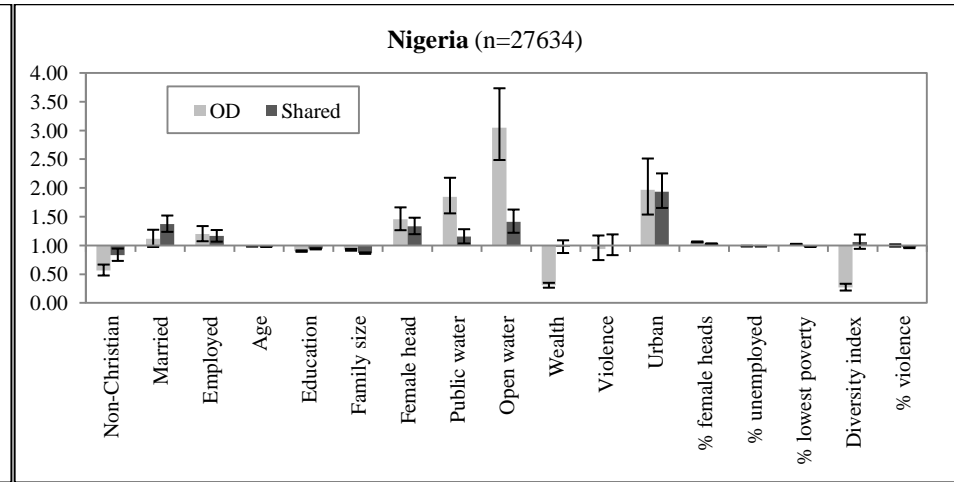
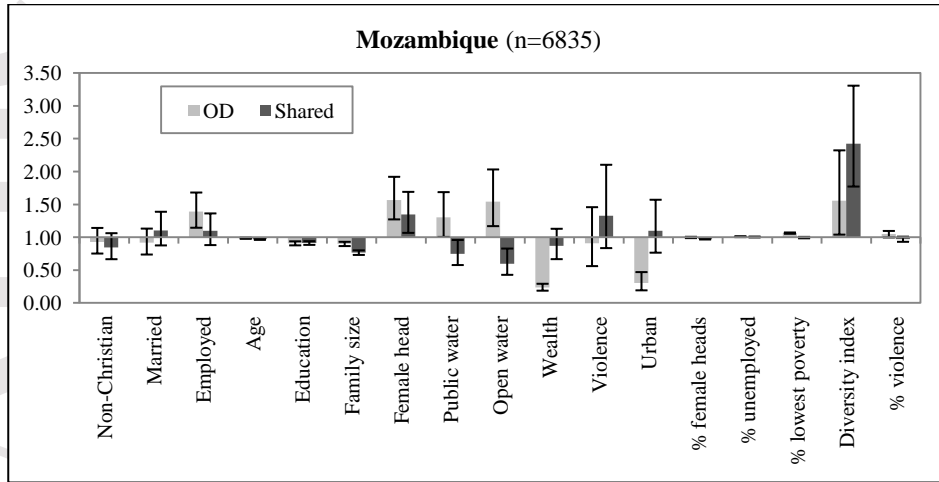
Table 1. Variation in sample characteristics of 14 countries in SSA (n = 102,399)

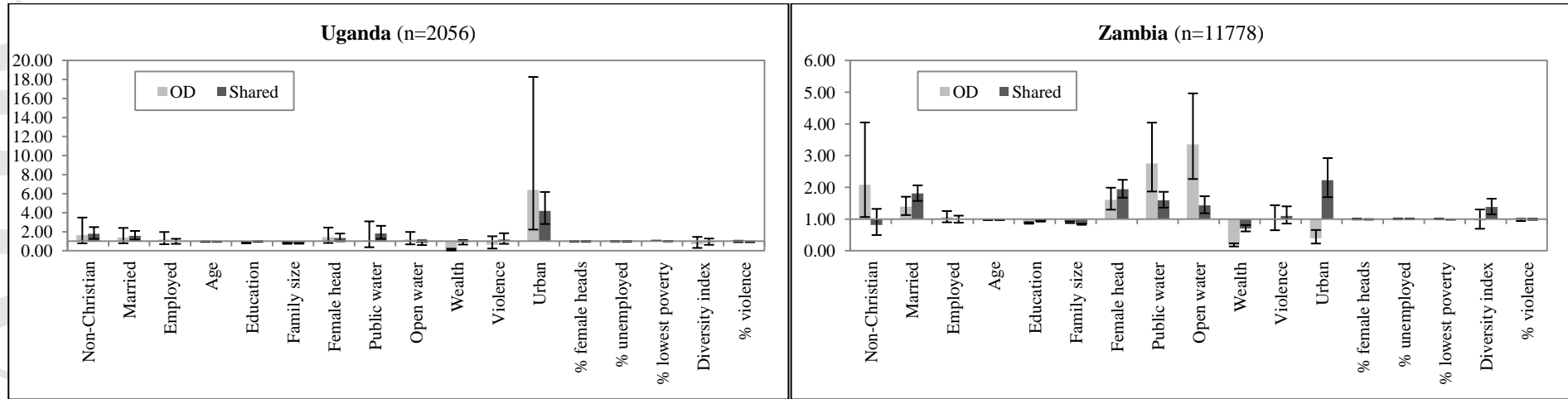
Variable	Range (Percentages except where noted)*
<u>Type of sanitation use</u>	
Open Defecation	2.5 (Gabon) – 54.2 (Togo)
Private Facility	12.7 (Ghana) – 63.4 (Cameroon)
Shared facility	9.9 (Mozambique) – 64.3 (Sierra Leone)
<u>Individual factors</u>	
Non-Christian	1.3 (Zambia) to 96.1 (Mali)
Married	64.1 (Gabon) to 88.2 (Mali)
Employed	39.9 (Mozambique) – 78.8 (Ghana)
Age	28.9 years (Uganda) – 30.2 years (Sierra Leone)
Yrs. of Education	1.8 years (Mali) - 7.3 years (Kenya)
Family Size	4.7 children (Ghana) – 6.4 children (Sierra Leone)
Female-headed Household	10.6 (Mali) – 36.7 (Ghana)
<u>Source of Drinking Water</u>	
Public Water Source	15.4 (Uganda) – 72.7 (Malawi)
Open Water Source	12.8 (Gabon) – 57.4 (DRC)
Private Water Source	6.1 (Sierra Leone) – 60.4 (Uganda)
Wealth above the median	27.4 (Gabon) – 54.3 (Mozambique)
Recent non-partner violence	2.7 (Togo) – 10.2 (Cameroon)
<u>Neighborhood-level factors</u>	
Urban	12.6 (Malawi) – 65.1 (Gabon)
Female-headed Households	9.3 (Malawi) – 37.3 (Kenya)
Household Unemployment	13.2 (Ghana) – 42.8 (Mozambique)
Households in Lowest Wealth Quintile	15.3 (Mozambique) – 38.4 (Gabon)
Diversity	0.2 (DRC) – 1.2 (Côte d'Ivoire)
Women Reporting Recent Non-Partner Violence	1.2 (Malawi) – 5.8 (Kenya)

*Frequencies for all countries are presented in Appendix 1









Figures 1. Relative risk ratios and confidence intervals (95%) for factors associated with OD and shared compared to private facilities for all countries