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The geographic and demographic scope of shared sanitation: an analysis of national survey data from low- and middle-income countries

Marieke Heijnen[1], Ghislaine Rosa[1], James Fuller[2], Joseph N. S. Eisenberg[2] and Thomas Clasen[1,3]

1 *Faculty of Infectious and Tropical Diseases, London School of Hygiene & Tropical Medicine, London, UK*
2 *Department of Epidemiology, University of Michigan School of Public Health, Ann Arbor, MI, USA*
3 *Department of Environmental Health, Rollins School of Public Health, Emory University, Atlanta, GA, USA*

Abstract

OBJECTIVE A large and growing proportion of the world's population rely on shared sanitation facilities that have historically been excluded from international targets due to concerns about acceptability, hygiene and access. In connection with a proposed change in such policy, we undertook this study to describe the prevalence and scope of households that report relying on shared sanitation and to characterise them in terms of selected socio-economic and demographic covariates.

METHODS We extracted data from the most recent national household surveys of 84 low- and middle-income countries from Demographic and Health Surveys and Multiple Indicator Cluster Surveys. We describe the prevalence of shared sanitation and explore associations between specified covariates and reliance on shared sanitation using log-binomial regression.

RESULTS While household reliance on any type of shared sanitation is relatively rare in Europe (2.5%) and the Eastern Mediterranean (7.7%), it is not uncommon in the Americas (14.2%), Western Pacific (16.4%) and South-East Asia (31.3%), and it is most prevalent in Africa (44.6%) where many shared facilities do not meet the definition of 'improved' even if they were not shared (17.7%). Overall, shared sanitation is more common in urban (28.6%) than in rural settings (25.9%), even after adjusting for wealth. While results vary geographically, people who rely on shared sanitation tend to be poorer, reside in urban areas and live in households with more young children and headed by people with no formal education. Data from 21 countries suggest that most sharing is with neighbours and other acquaintances (82.0%) rather than the public.

CONCLUSIONS The determinants of shared sanitation identified from these data suggest potential confounders that may explain the apparent increased health risk from sharing and should be considered in any policy recommendation. Both geographic and demographic heterogeneity indicate the need for further research to support a change in policies.

keywords sanitation, Demographic and Health Surveys

Introduction

An estimated 2.5 billion people lack access to 'improved sanitation facilities'(Joint Monitoring Programme 2014). In developing regions where people are most vulnerable to infection, only one in every three people has access to improved sanitation (Joint Monitoring Programme 2014). At the current pace, the Millennium Development Goal (MDG) sanitation target – to halve the proportion of people with access to basic sanitation by 2015 – is set to miss the target by half a billion people (Joint Monitoring Programme 2014).

Progress towards the MDG sanitation target is monitored by the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP). The JMP defines 'improved sanitation facilities' to include a flush or pour-flush toilet or latrine connected to a piped sewer system or septic system, a simple pit latrine with a slab, a ventilated improved pit latrine (VIP) or a composting toilet used by only one household (Joint Monitoring Programme 2010). Any other flush or pour-flush latrine, open pit latrine, bucket latrine, hanging latrine or open defecation is 'unimproved' and not scored towards the MDG target (Joint Monitoring Programme 2010).

Significantly, public and other 'shared facilities' – those used by two or more households – have been excluded from the definition of 'improved sanitation' regardless of the service level (Joint Monitoring Programme 2010). The reason stems from concerns that shared facilities are unacceptable, both in terms of cleanliness (shared toilets may not be as hygienic as private ones or they may result in increased contact with human waste) and accessibility (facilities may not be available at night, or easily used by women and children) (Joint Monitoring Programme 2012a). This original policy on shared sanitation was consistent with contemporaneous evidence that shared sanitation was associated with adverse health outcomes including perinatal mortality (Golding *et al.* 1994), helminth infection (Curtale *et al.* 1998) and risk of polio during an outbreak (Kim-Farley *et al.* 1984).

Nevertheless, shared facilities comprise a large and growing proportion of sanitation options available in low-income countries – the JMP reports an increase from 6 to 11% between 2008 and 2012, with approximately 784 million people using public and shared facilities of an otherwise improved type worldwide (Joint Monitoring Programme 2014). The JMP considers shared sanitation to be a step on the sanitation ladder, where users of unimproved sanitation upgrade to a shared facility, and eventually to an improved private facility. Communal or public latrines are considered by some to be the only realistic option for high-density populations in many urban slums (Wegelin-Schuringa & Kodo 1997; Nelson & Murray 2008; Joint Monitoring Programme 2012a,b).

Perhaps as a result, the JMP is considering a revision to its policy that would include shared sanitation as 'improved' – and thus scored towards the MDG and future targets – if the facility otherwise meets the definition of improved sanitation and is shared among no more than five families or 30 persons, whichever is fewer, and if the users know each other (Joint Monitoring Programme 2012c). While this proposed change is based on advice from an expert committee, recent evidence raises questions about the evidentiary basis for the change in policy. A systematic review (Heijnen *et al.* 2014) showed shared sanitation to be associated with adverse health outcomes (as compared to private sanitation facilities), though acknowledging that there were few studies, many with methodological shortcomings. It was not possible to distinguish between improved or unimproved shared facilities in the above-mentioned review. In addition, a recent study analysing shared sanitation and diarrhoea using DHS data showed an increased risk of diarrhoea associated with sharing sanitation facilities (Fuller *et al.* 2014). This increased risk remained when only considering shared facilities of an otherwise 'improved' type.

We undertook this study on behalf of the JMP to examine the geographic and demographic scope of shared sanitation access among low- and middle-income countries. We also sought to identify factors associated with reliance on shared sanitation that help explain why shared sanitation might increase the risks of adverse health outcomes. We extracted and tabulated data from national household surveys, and compared results across countries, regions and basic socio-economic characteristics. We then used log-binomial regression to examine factors that may be associated with reliance on shared sanitation.

Methods

Data sources

We extracted data from the major national survey programmes relied on by the JMP, including the UNICEF-supported Multiple Indicator Cluster Surveys (MICS), and the United States Agency for International Development-supported Demographic and Health Survey (DHS). MICS and DHS are nationally representative household survey programmes with sample sizes ranging from 2500 to 60 000 households. These surveys are conducted in a range of low- and middle-income countries and are typically repeated every 5 years. For countries that had multiple surveys available, we used only the most recent one. Most data gathered in these surveys are collected through a questionnaire administered by paid enumerators. Further details about the sampling design, survey management and quality control are provided in the individual survey reports (DHS 2013; MICS 2013). Data from the household surveys were extracted and data sets were pooled for regional and global analyses.

Shared sanitation

Data on shared sanitation were derived from two core questions included in all surveys: (i) 'Do you share this facility with other households?' and, if the response is affirmative, (ii) 'How many households use this facility?'. Whereas the first question asks for a yes or no response, the second question allows for the exact number of households to be stated, up to 10, after which the '10+' is indicated. The response 'do not know' is also accepted. The latest round of available MICS surveys has an additional question on whether the facility is shared with persons known to the respondent, such as neighbours, or shared with the general public. Information on the type of facility (i.e. pour flush, pit latrine, etc.) used by the household is also collected in most surveys, which allows

classification of the facilities into 'improved' or 'unimproved' per the JMP definitions. As only respondents with access to sanitation facilities are asked whether the facility is shared, in all analyses, respondents without a sanitation facility were excluded. Thus, all comparisons are with households that report using individual household latrines, not with those that report practising open defecation.

Other survey data

To characterise the potential determinants of sharing sanitation, we extracted data on: residence status (urban or rural), wealth tertiles (poorest, middle and least poor), access to water supplies (improved or unimproved), education level of the head of the household (no education, primary or secondary and above), the number of children under 5 years of age in the household, the number of individuals living in the household and for those reporting access to shared sanitation, the number of households with whom they share their latrines.

Wealth tertiles

The original wealth variable included in the household surveys is often constructed using water and sanitation variables. To avoid codetermination, we constructed a new relative index of socio-economic status or wealth that combined household-level information on type of cooking fuel and household flooring, as well as ownership of specific items (which varied per country), using principal component analysis to define the summed weights (Filmer & Pritchett 2001). Each primary component explained a minimum of 25% variance (range 25–58%). To better discriminate wealth within these low-income settings, the resulting indices were used to categorise each household into poor, middle and least poor tertiles (Nundy *et al.* 2011). For analyses at regional and global level, the wealth tertiles were recalculated from the pooled wealth index to ensure a uniform distribution of the households.

Statistical analysis

All analyses were performed using Stata SE/13 (Stata Corp., College Station, TX, USA). Weights were used throughout the analysis to restore the representativeness of the sample, and the complex design was taken into account by using the Stata *svyset* and *svy* commands. The regional and global estimates were calculated as the weighted averages of the country estimates. As the analyses were performed at household level, the number of households in each country was estimated using population figures (United Nations 2014) closest to the corresponding survey year and the average number of people per household, as provided by the survey. This allowed us to weigh each survey based on the number of households available for sampling (estimated) and the number of households included in the survey. Log-binomial regression was used to generate both unadjusted and adjusted prevalence ratios (PR) and 95% confidence intervals (CI) for shared sanitation and for neighbour or general public sharing. The prevalence ratio indicates the prevalence of shared sanitation in one group (i.e. rural households) relative to another group (i.e. urban households). In the case of a continuous variable (e.g. number of people or children in the household), the prevalence ratio indicates the prevalence increase/decrease of sharing sanitation facilities for each additional household member/child under 5 years of age. We chose the list of potential predictive factors *a priori* and analysed them individually to assess their impact on the prevalence of shared sanitation (univariate analysis), after which all significant variables were included in the multivariate model. As wealth was expected to interact with the other variables, a stratified analysis was also conducted.

Results

The analysis included surveys from 84 countries with survey completion years ranging from 2000 to 2013. These countries represent approximately 54% of the total population of low- and middle-income countries. These combined surveys include data on over one million households, comprising over 3 million individuals.

The overall proportion of households that rely on any type of shared sanitation is 27.3% (Table 1). Significantly, about half of the shared latrines globally would be classified as 'improved' and count towards the MDG target but for the fact that they are shared. As noted in Table 1, however, this proportion varies considerably by region and country. Just over half (56.0%) of improved shared facilities are shared with five or fewer households and thus could be included in the new definition of 'improved sanitation' if the JMP proceeds with its policy change; (Table 1). Once again, these proportions are characterised by considerable geographic heterogeneity.

Geographic profile

While shared sanitation is relatively rare in Europe (2.5% total, 2.4% 'improved') and the Eastern Mediterranean (7.7% and 4.6%), it is more common in the Americas (14.2% and 9.4%), Western Pacific (16.4% and 11.5%)

Table 1 Summary statistics of surveyed households by country, among households sharing sanitation facilities. Data from 49 Demographic and Health Surveys and 35 Multiple Indicator Cluster Surveys, 2000–2013

Country (year)	Sample size (*N*)	No toilet facility (%)	Improved toilet facility (%)	Any shared toilet facility (%)	Improved shared toilet facility (%)*	Any Shared with ≤5 households (%)	Improved shared with ≤5 households (%)†
Africa	389 652	26.4	37.1	44.6	17.7	72.2	34.8
Benin (2011–2012)	17 422	54.2	32.6	56.8	18.1	63.2	44.9
Burkina Faso (2010)	14 422	62.3	31.3	51.0	16.0	70.0	57.7
Burundi (2010)	8591	4.0	39.8	18.3	8.0	89.6	37.2
Cameroon (2011)	14 195	7.0	59.3	36.2	23.3	78.1	52.5
Central African Republic (2010)	11 732	31.0	5.0	40.3	2.0	87.7	5.6
Congo, Democratic Republic of the (2010)	11 391	17.0	12.2	52.5	7.6	85.6	14.2
Congo, Republic of the (2012)	11 631	8.7	41.6	69.8	30.2	72.4	33.1
Cote d'Ivoire (2006)	7591	34.1	56.9	55.4	30.8	57.1	48.5
Ethiopia (2011)	16 690	38.3	13.3	38.1	7.9	73.4	19.1
Gabon (2012)	9754	2.3	64.6	49.9	30.6	65.0	38.9
Gambia (2005–2006)	6066	4.2	86.3	46.2	41.1	77.5	70.2
Ghana (2011)	11 925	18.4	65.8	77.8	51.1	66.8	51.6
Guinea (2012)	7108	19.5	44.2	58.4	25.2	75.8	37.6
Guinea-Bissau (2006)	5280	33.5	11.6	48.4	3.3	44.1	3.7
Kenya (2009)	9056	12.1	48.6	50.2	25.9	66.2	34.7
Lesotho (2009)	9385	33.0	35.0	36.6	13.4	63.8	31.7
Liberia (2007)	6808	54.6	27.7	71.4	17.3	31.0	17.7
Madagascar (2009)	17 841	42.6	4.4	63.5	2.1	85.7	4.4
Malawi (2010)	24 815	10.8	13.7	43.2	5.4	92.1	12.9
Mali (2006)	12 968	21.4	59.7	42.8	23.2	79.6	55.8
Mauritania (2007)	1033	47.5	37.2	28.3	9.7	1.6	1.5
Mozambique (2011)	13 191	41.7	23.2	15.8	4.3	92.5	42.2
Namibia (2007)	9195	48.6	46.7	27.4	12.4	61.4	55.9
Niger (2012)	10 743	72.8	18.9	45.1	9.4	80.6	61.1
Nigeria (2011)	29 050	28.9	52.6	44.1	24.2	55.5	45.0
Rwanda (2010)	12 532	1.4	73.9	21.9	16.6	93.9	71.9
Sao Tome and Principe (2009)	3536	61.4	38.1	19.2	7.2	64.4	64.4
Senegal (2011)	7902	17.7	60.2	28.6	19.1	80.2	58.0
Sierra Leone (2010)	11 344	29.6	41.0	73.1	29.7	69.5	39.6
Swaziland (2010)	4830	13.9	79.8	42.8	34.6	51.8	48.0
Tanzania, United Republic of (2010)	9620	14.0	20.6	33.7	7.7	83.3	20.1
Togo (2010)	6031	51.1	29.2	70.1	27.5	50.3	42.1
Uganda (2011)	9030	9.7	50.4	44.1	21.6	71.9	41.2
Zambia (2007)	7160	25.2	35.4	40.7	15.1	86.9	41.8
Zimbabwe (2010–2011)	9756	26.2	64.4	44.2	28.9	81.2	72.0
Americas	185 172	10.3	83.6	14.2	9.4	83.2	66.3
Belize, Plurinational State of (2011)	4423	1.7	96.9	9.8	9.3	76.4	74.4
Bolivia (2008)	19 564	–	–	28.6	–	88.3	–
Colombia (2010)	54 447	4.8	95.1	10.8	10.3	–	–
Cuba (2010–2011)	9183	1.1	94.4	5.4	5.0	86.9	81.0
Dominican Republic (2007)	32 366	4.1	87.3	13.0	4.5	–	–
Guyana (2009)	5623	1.0	93.1	10.6	9.1	88.8	77.5
Haiti (2012)	13 179	25.1	54.6	51.2	28.9	79.0	61.1
Honduras (2012)	21 359	9.4	77.3	14.9	10.6	96.6	75.5
Nicaragua (2001)	11 313	14.5	84.9	8.4	7.2	–	–
Peru (2000)	28 881	22.5	73.6	7.4	5.1	–	–
Suriname (2010)	7398	5.7	91.4	13.0	11.1	81.5	74.5

Table 1 (*Continued*)

Country (year)	Sample size (*N*)	No toilet facility (%)	Improved toilet facility (%)	Any shared toilet facility (%)	Improved shared toilet facility (%)*	Any Shared with ≤5 households (%)	Improved shared with ≤5 households (%)†
South-East Asia	162 485	49.3	42.8	31.3	12.6	76.0	59.7
Bangladesh (2007)	17 140	4.6	52.6	39.6	18.9	86.4	43.0
Bhutan (2010)	7680	4.1	66.1	13.2	10.4	88.1	71.3
India (2006)	108 939	55.4	41.1	29.1	11.7	71.5	64.8
Maldives (2009)	6437	1.5	96.3	2.5	2.1	43.3	36.9
Nepal (2011)	10 826	35.5	56.8	31.7	18.8	92.6	84.7
Timor-Leste (2010)	11 463	37.4	49.3	15.1	8.6	94.3	86.0
Western Pacific	71 279	11.5	79.0	16.4	11.5	84.1	57.0
Cambodia (2011)	15 662	56.7	41.1	18.3	7.5	91.9	86.8
Lao People's Democratic Republic (2011–2012)	18 830	35.3	62.0	4.5	2.6	74.7	67.3
Mongolia (2005)	10 087	13.5	82.6	36.5	29.8	98.6	93.3
Philippines (2008)	12 468	9.5	85.9	22.8	19.0	–	–
Vanuatu (2007)	2622	3.2	63.6	31.9	19.1	86.1	49.0
Viet Nam (2010–2011)	11 610	6.0	78.9	10.9	5.4	81.9	49.9
Eastern Mediterranean	140 800	11.2	82.0	7.7	4.6	90.7	77.3
Afghanistan (2010–2011)	13 103	18.5	30.9	10.9	3.3	69.4	25.8
Djibouti (2006)	4857	4.7	65.5	11.1	5.5	82.5	38.8
Egypt (2008)	18 959	0.4	99.5	3.3	3.3	90.5	89.8
Iraq (2011)	35 688	0.6	97.3	3.6	3.5	94.3	92.2
Jordan (2012)	15 190	0.0	100	0.2	0.2	85.6	85.6
Morocco (2004)	11 509	15.9	83.8	7.7	6.3	–	–
Pakistan (2012–2013)	12 935	21.2	69.7	16.3	10.9	93.2	79.8
Somalia (2006)	5956	56.6	35.3	41.1	14.9	82.0	69.9
Syria (2006)	19 019	1.0	97.3	4.0	3.8	97.7	90.5
Yemen (2006)	3584	24.1	49.5	6.4	2.4	87.7	42.7
Europe	134 635	0.3	97.3	2.5	2.4	72.1	68.3
Albania (2009)	7999	0.0	93.6	2.3	2.0	99.9	89.2
Armenia (2010)	6699	0.1	80.7	1.6	1.1	41.4	17.4
Azerbaijan (2006)	7174	0.3	85.0	8.0	7.5	67.3	62.4
Belarus (2012)	8284	0.0	98.2	3.3	3.1	65.2	60.6
Bosnia and Herzegovina (2011–2012)	5770	0.0	94.8	0.8	0.7	90.8	74.3
Georgia (2005)	12 000	0.0	96.2	2.1	2.0	57.5	54.5
Kazakhstan (2010–2011)	15 800	0.0	99.4	2.6	2.6	64.0	63.0
Kyrgyzstan (2005–2006)	8039	0.0	98.7	4.0	4.0	73.6	73.2
Macedonia, The Former Yugoslav Republic of (2011)	4013	0.7	94.7	1.8	1.6	92.3	83.1
Moldova, Republic of (2005)	11 086	6.1	76.8	6.5	5.9	80.3	69.0
Montenegro (2005–2006)	2357	0.2	99.1	3.5	3.4	81.7	79.6
Serbia (2010)	6386	0.0	98.5	0.8	0.7	95.6	94.3
Tajikistan (2005)	6684	0.5	93.7	3.4	3.2	56.9	55.2
Turkey (2003)	10 829	0.5	98.8	2.4	2.4	–	–
Ukraine (2012)	11 317	0.0	99.0	1.8	1.7	74.1	72.9
Uzbekistan (2006)	10 198	0.0	99.4	2.0	1.9	99.0	97.9
Global averages	1 084 023	40.9	49.0	27.3	12.1	75.9	56.0

*Among households that access a sanitation facility (improved shared).
†Among households accessing an improved shared sanitation facility. '–' indicates data not collected.

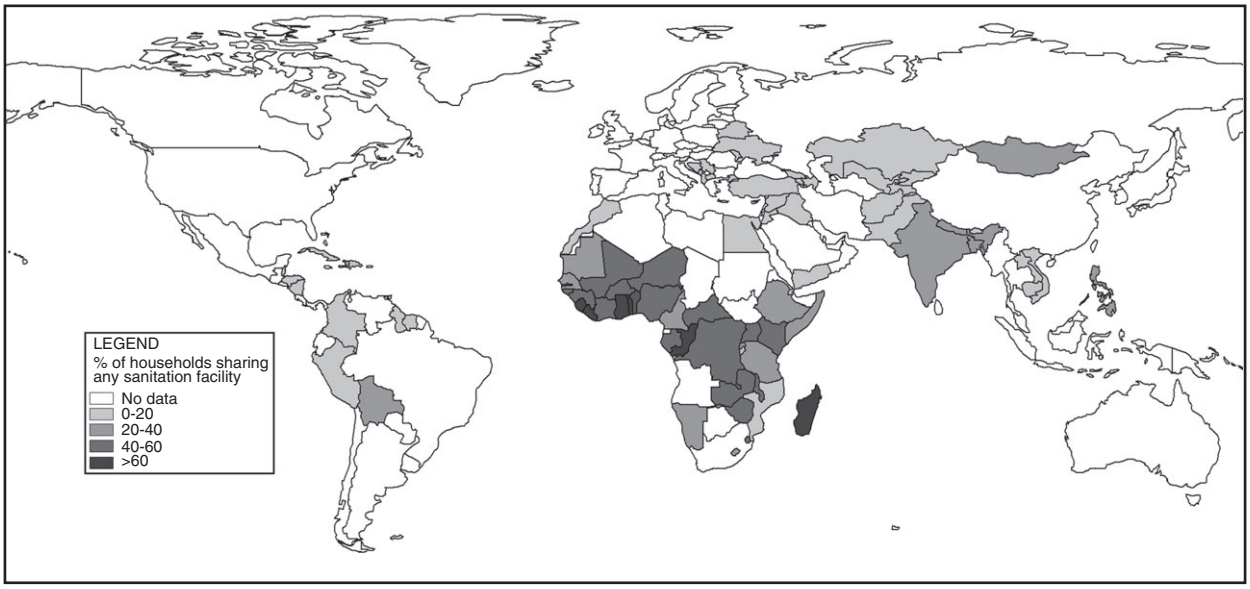

Figure 1 Overview of households sharing any sanitation facilities in the 84 included survey countries.

and South-East Asia (31.3% and 12.6%). Reliance on shared sanitation is most common in Africa, where the overall prevalence is 44.6% but where less than half (17.7%) otherwise qualify as 'improved' sanitation facilities.

Figure 1 shows that some of the highest rates of sharing sanitation facilities are found in Africa, particularly West Africa. Sharing is practised by over half the population of 13 African countries, with especially high rates of sharing in Ghana (77.8%), Sierra Leone (73.1%), Liberia (71.4%), Togo (70.1%), Republic of the Congo (69.8%), Madagascar (63.5%), Guinea (58.4%), Benin (56.8%), Côte d'Ivoire (55.4%), Democratic Republic of the Congo (52.5%), Burkina Faso (51.0%) and Kenya (50.2%); it is just under half in Gabon (49.9%). The only non-African country with over half the population sharing sanitation is Haiti (51.2%) (Table 1).

Overall, the prevalence of shared sanitation is slightly higher in urban (28.6%) than in rural settings (25.9%) ($P < 0.001$) (Table 2). In other words, more households access shared sanitation in urban areas (53.8%) than in rural areas (46.2%) (of a total of 385 383 households in urban areas, and 737 528 households in rural areas). Globally, taking into account potential confounders, households in rural areas are 36% less likely to rely on shared sanitation facilities than urban households (adjusted PR 0.64, 95% CI: 0.60–0.69) (Table 3). This urban predominance is most notable in the African and Asian region, whereas the Americas, Western Pacific and Eastern Mediterranean region show a higher prevalence of sharing sanitation in the rural regions (Table 2), which is confirmed by the crude prevalence ratios in Table 3. The global urban predominance of shared sanitation is consistent across wealth tertiles (Table S1).

Socio-economic and Demographic profile

At a global level, sharing is more common among households in the most poor (lowest) wealth tertile (Table 3). People in the least poor (highest) tertile are 51% less likely to share than those in the most poor tertile (adjusted PR 0.49, 95% CI: 0.45–0.52); those in the middle tertile are 26% less likely to share (adjusted PR 0.74, 95% CI: 0.71–0.78). This pattern is consistent across all regions except Africa; here households in the middle wealth tertile were slightly more likely to share sanitation facilities (adjusted PR 1.05, 95% CI: 1.00–1.10), whereas there was no effect in the least poor tertile. The wealth exposure was expected to interact with other covariates (region, education), and as such a stratified analysis by wealth tertile was conducted (Table S1).

Overall results indicate that increasing numbers of individuals in the household results in lower prevalence of shared sanitation (adjusted PR 0.84, 95% CI: 0.83–0.85) (Table 3). This association is consistent across all regions. On the other hand, increasing numbers of children under the age of five in the household is associated with a higher prevalence of shared sanitation (adjusted PR 1.38,

Table 2 Regional prevalence of any type of shared sanitation, per urban/rural with the associated 95% confidence interval and the results of a two-sample t-test assessing the difference between urban and rural prevalence, accounting for survey design

Region	Urban prevalence (95% CI)	Rural prevalence (95% CI)	*P*-value
Global	28.6 (27.4–29.8)	25.9 (25.2–26.5)	<0.001
Africa	57.1 (55.6–58.6)	37.0 (36.1–37.9)	<0.001
Americas	14.0 (13.5–14.4)	14.6 (13.8–15.3)	0.220
South East Asia	33.8 (31.9–35.6)	28.6 (27.7–29.6)	<0.001
Western Pacific	16.0 (14.7–17.3)	16.6 (15.6–17.6)	0.436
Eastern Mediterranean	4.6 (4.2–5.0)	11.6 (10.7–12.5)	<0.001
Europe	2.5 (2.0–2.9)	2.5 (2.2–2.9)	0.798

95% CI: 1.35–1.41). Again, this effect is consistently shown across all regions.

Overall, if the head of the household has completed primary education, the prevalence of shared sanitation is 13% lower than if the head of the household had no formal education (adjusted PR 0.87, 95% CI: 0.83–0.91) (Table 3). The direction of this effect is consistent across regions except in Africa (adjusted PR 1.16, 95% CI: 1.11–1.22). There was no association between shared sanitation use and education of the head of the household in the Western Pacific, Eastern Mediterranean and European region. Similarly, the prevalence of sharing sanitation is lower if the head of the household has completed secondary education or higher compared with no formal education (Global: adjusted PR 0.48, 95% CI: 0.47–0.51). Similar to the above, in the African region more education is associated with an increased prevalence in sharing, with no effect seen in the Western Pacific and European region.

In general, there is no apparent association between access to an improved water source and access to shared sanitation (adjusted PR: 1.06 95% CI: 0.98–1.13) (Table 3). Similarly, in the Western Pacific region there is no association between improved water access and shared sanitation access, whereas in the African, South-East Asian and Eastern Mediterranean region households accessing improved water sources also report accessing shared sanitation, whereas the opposite is seen in the remaining regions (Table 3).

Countries reporting high prevalence of shared sanitation

Further analysis was conducted considering only the 13 countries in which 50% or more of the households report shared sanitation access (Table S2). The only difference between this subgroup analysis and the main table of results (Table 3) is that households accessing improved water sources are also more likely to access shared sanitation facilities (adjusted PR 1.18, 95% CI: 1.07–1.31). This result is similar to the effect seen for the African region in Table 3.

Sharing sanitation: public or persons known?

Thus far, 21 country surveys provide information on whether the sanitation facility was shared with the general public or with persons known to the respondent. An overview of the included countries and their sharing prevalence can be found in Table 4. Overall, 23.8% of the households from these 21 surveys reported using some type of shared sanitation; just over half of these (52.5%) reporting the use of 'improved' shared facilities. Of those households sharing any sanitation facility, 82.0% reported sharing with neighbours and other known individuals *vs.* the general public. Sharing with the general public was more common among rural householders (adjusted PR 1.30, 95% CI: 1.06–1.61) (data not shown). No effect was found for households in the middle wealth tertile, but households in the least poor tertile were more likely to share with neighbours or known households as opposed to the general public (adjusted PR 0.71, 95% CI: 0.59–0.86). No association was found between heads of household with primary or secondary education *vs.* no formal education (primary: adjusted PR 0.89, 95%CI: 0.76–1.05, secondary: adjusted PR 1.16, 95% CI: 1.00–1.34). More children under the age of five in the household increased the likelihood of sharing with neighbours or other known households (adjusted PR 0.85, 95% CI: 0.80–0.91). There was no association between the number of household members and type of water source accessed and the type of household sharing (known or general public).

To further assess the impact of a potential change in policy by the JMP, the estimated increase in coverage of 'improved' sanitation was calculated (Table 4). This shows that not only does the prevalence of households sharing sanitation facilities vary considerably between countries, but so does the prevalence of sharing with

Table 3 The crude and adjusted prevalence ratios* and 95% confidence limits of any shared sanitation access by households, controlling for the following factors: rural or urban location, access to improved water, the number of people and children under five in the household, wealth tertile of the household and education level of the head of the household. The outcome (shared sanitation) is coded (0) no sharing and (1) sharing; thus, ratios of <1 reflect lower prevalence of sharing and ratios of >1 represent greater prevalence of sharing. Data from 49 Demographic and Health Surveys and 35 Multiple Indicator Cluster Surveys, 2000–2013

		Region	Wealth tertile†		Number of people in HH*	Education level of household head‡		Number of children under 5	Water source used
		Rural (1) *vs.* urban (0)	Middle (1) *vs.* Poorest (0)	Least Poor (2) *vs.* Poorest (0)	Continuous Variable	Primary education (1) *vs.* none (0)	Secondary education and above (2) *vs.* none (0)	Continuous Variable	Improved source (1) *vs.* unimproved source (0)
Global	Crude	0.87 (0.81–0.93)	0.77 (0.73–0.81)	0.45 (0.43–0.49)	0.89 (0.88–0.90)	0.84 (0.80–0.88)	0.47 (0.44–0.49)	1.07 (1.05–1.09)	0.95 (0.88–1.02)
(*N* = 870 786)	Adjusted	0.64 (0.60–0.69)	0.74 (0.71–0.78)	0.49 (0.45–0.52)	0.84 (0.83–0.85)	0.87 (0.83–0.91)	0.48 (0.47–0.51)	1.38 (1.35–1.41)	1.06 (0.98–1.13)
Africa	Crude	0.44 (0.41–0.47)	1.11 (1.06–1.17)	1.62 (1.51–1.73)	0.85 (0.84–0.86)	1.26 (1.20–1.33)	1.82 (1.72–1.94)	0.84 (0.83–0.86)	1.40 (1.31–1.49)
(*N* = 269 338)	Adjusted	0.49 (0.45–0.53)	1.05 (1.00–1.10)	1.03 (0.96–1.10)	0.83 (0.82–0.84)	1.16 (1.11–1.22)	1.29 (1.21–1.37)	1.19 (1.16–1.22)	1.12 (1.06–1.19)
Americas	Crude	1.05 (0.97–1.13)	0.69 (0.65–0.73)	0.34 (0.32–0.37)	0.87 (0.86–0.88)	0.64 (0.59–0.68)	0.51 (0.48–0.55)	1.20 (1.18–1.23)	0.52 (0.47–0.56)
(*N* = 167 732)	Adjusted	0.61 (0.56–0.67)	0.73 (0.69–0.78)	0.39 (0.35–0.42)	0.79 (0.77–0.80)	0.73 (0.68–0.79)	0.67 (0.62–0.73)	1.59 (1.54–1.64)	0.61 (0.55–0.67)
South-East Asia	Crude	0.79 (0.72–0.86)	0.75 (0.70–0.80)	0.37 (0.34–0.40)	0.86 (0.85–0.88)	0.72 (0.69–0.77)	0.43 (0.40–0.47)	1.07 (1.04–1.10)	1.43 (1.23–1.66)
(*N* = 111 318)	Adjusted	0.56 (0.51–0.62)	0.72 (0.68–0.77)	0.36 (0.33–0.40)	0.82 (0.81–0.84)	0.79 (0.74–0.84)	0.54 (0.50–0.59)	1.39 (1.35–1.43)	1.61 (1.39–1.87)
Western Pacific	Crude	1.05 (0.93–1.18)	0.64 (0.58–0.71)	0.23 (0.20–0.26)	0.95 (0.93–0.98)	0.84 (0.74–0.97)	0.76 (0.65–0.88)	1.28 (1.22–1.35)	0.72 (0.60–0.85)
(*N* = 53 646)	Adjusted	0.71 (0.63–0.81)	0.62 (0.56–0.69)	0.20 (0.17–0.23)	0.93 (0.91–0.96)	0.94 (0.81–1.08)	1.11 (0.95–1.29)	1.38 (1.30–1.47)	0.92 (0.77–1.10)
Eastern	Crude	2.69 (2.37–3.06)	0.17 (0.14–0.19)	0.28 (0.25–0.32)	1.01 (1.00–1.02)	0.78 (0.68–0.88)	0.38 (0.33–0.43)	1.21 (1.17–1.26)	0.79 (0.65–0.95)
Mediterranean	Adjusted	1.74 (1.50–2.03)	0.24 (0.20–0.28)	0.42 (0.36–0.48)	0.94 (0.92–0.96)	1.05 (0.91–1.20)	0.64 (0.56–0.74)	1.25 (1.19–1.32)	1.66 (1.31–2.12)
(*N* = 128 406)									
Europe	Crude	1.03 (0.81–1.32)	0.48 (0.39–0.58)	0.31 (0.25–0.38)	0.94 (0.90–1.00)	0.85 (0.63–1.14)	0.71 (0.54–0.95)	1.27 (1.17–1.38)	0.69 (0.52–0.90)
(*N* = 140 364)	Adjusted	0.83 (0.64–1.07)	0.47 (0.38–0.58)	0.32 (0.25–0.40)	0.88 (0.84–0.93)	0.94 (0.70–1.26)	0.77 (0.58–1.01)	1.58 (1.44–1.73)	0.77 (0.60–1.00)

*Prevalence ratio indicates the prevalence of an event in one group (i.e. HH in a rural area) relative to another group (i.e. HH in an urban area). In the case of a continuous variable (i.e. Number of people or <5 child in HH), the prevalence ratio indicates the prevalence increase/decrease of sharing sanitation facilities for each additional household member/child under 5 years of age.

†Cuba excluded from analysis on wealth as these data are not collected.

‡Somalia and Uzbekistan excluded from analysis on education.

Table 4 Sanitation coverage implications if shared sanitation is considered 'improved' sanitation. 21 MICS surveys with data on sanitation facilities shared with other households known by the respondent or the general public

Country	Total number of households	Number of households reporting sharing sanitation	Percentage of households reporting sharing sanitation	Of the households sharing, percentage of those sharing with 'known' households (*vs.* 'general public')	Of the households sharing, percentage of those sharing with five or fewer households	Of the households sharing, percentage of those sharing a facility of an 'improved' type	Of the households sharing, percentage of those sharing a facility with five or fewer households, known to the respondent and of an 'improved' type	Percentage of households using an improved sanitation facility (excluding shared facilities)	Expected coverage of improved sanitation if shared proposed JMP policy is implemented
Belarus	8563	268	3.3	100	65.2	93.9	57.8	91.2	93.1
Central African Republic	11 966	3114	40.3	91.9	87.7	4.9	3.5	3.0	4.4
Afghanistan	13 468	1326	10.9	80.4	81.7	30.3	21.1	27.5	29.8
Belize	4900	433	9.8	93.7	76.4	94.9	68.4	87.6	94.3
Bhutan	7681	829	13.2	94.4	88.1	78.8	64.4	55.7	64.2
Bosnia	6838	49	0.8	99.3	90.8	87.5	75.0	94.0	94.6
Cuba	9525	483	5.4	91.8	86.7	92.6	74.1	89.4	93.4
Democratic Republic of the Congo	11 490	4761	52.5	92.2	85.6	14.5	10.9	4.6	10.3
Ghana	12 150	5616	77.8	43.9	66.8	65.7	18.5	14.7	29.1
Iraq	36 592	1402	3.6	93.2	94.3	97.2	86.1	93.8	96.9
Kazakhstan	16 380	481	2.6	75.4	64.0	100	50	96.9	98.2
Lao PDR	19 960	491	4.5	85.8	74.7	56.5	37.8	59.2	60.9
Macedonia	4703	80	1.8	85.3	92.3	88.9	72.2	92.9	94.2
Nigeria	29 349	7296	44.1	87.0	55.6	54.9	27.7	28.4	40.6
Serbia	6885	42	0.8	78.4	95.7	87.5	75.0	97.5	98.1
Sierra Leone	11 923	5703	73.1	87.3	69.4	40.6	24.2	11.2	28.9
Suriname	9356	1028	13.0	88.2	81.1	85.4	61.5	80.3	88.3
Swaziland	5475	1856	42.8	97.4	51.7	80.8	40.2	45.2	62.4
Togo	6651	1856	70.1	81.5	53.5	39.2	17.5	11.6	23.9
Viet Nam	11 874	1092	10.9	88.7	81.9	49.5	41.3	73.5	78.0
Ukraine	12 459	163	1.8	94.5	74.1	94.4	66.7	97.1	98.3
OVERALL	205 343	38 222	23.8	82.0	68.9	52.5	27.3	54.1	60.6

'known' households, sharing with five or fewer households and sharing of an sanitation facility which is considered 'improved' in terms of service type. Though the proposed policy change does not increase the coverage of 'improved' sanitation dramatically in countries which already have high improved sanitation coverage (i.e. some countries in Europe and the Americas), it at least doubles the level of improved sanitation in three countries (Togo, Sierra Leone, Democratic Republic of the Congo), and almost doubles it in one (Ghana).

Discussion

Sharing latrines with other households represents a large and growing sanitation option that policymakers are proposing to endorse under certain conditions by counting it as 'improved' for purposes of international targets. However, evidence that shared sanitation is may be associated with adverse health outcomes (Fuller *et al.* 2014; Heijnen *et al.* 2014) raises questions about the circumstances under which it can be a safe, effective and sustainable solution. We undertook this study to characterise the geographic and demographic scope of shared sanitation and to identify factors that could help explain the apparent increase in health risks associated with the practice.

Shared sanitation prevalence is highest in the African and the South-East Asian regions. There are 13 countries, many of which in West Africa, where shared sanitation actually represents the predominant approach. While the shared sanitation facilities in most regions meet the JMP's definition of 'improved' sanitation, less than half of those in Africa meet this definition. As unimproved sanitation is associated with a risk of diarrhoea (Clasen *et al.* 2010; Norman *et al.* 2010; Fink *et al.* 2011; Lim *et al.* 2012; Fuller *et al.* 2014), helminth infection (Ziegelbauer *et al.* 2012) and poor growth (Fink *et al.* 2011), it is important for analyses of the risk of shared sanitation to control for the type of sanitation.

Our results also suggest that shared sanitation is substantially more common in urban than in rural settings, a finding consistent with the JMP's own conclusions (Joint Monitoring Programme 2012a). Sharing of facilities is also likely to be higher in urban slums and other high-density informal settlements with poor services.

In a prior analysis of shared sanitation and the risk of diarrhoea, we showed that even after taking into account potential confounders, a residual risk was present, though it varied geographically (Fuller *et al.* 2014). Many of the determinants of sharing used in this study (number of household members, education of the head of household, etc.) were also considered as confounders in the study by Fuller *et al.* (2014) and were found to attenuate the risk of diarrhoea. As such, though there may be aspects of sharing sanitation that increase risk, it is likely that there are other processes at play that are independent of reliance on shared sanitation. While results vary geographically, people who rely on shared sanitation tend to be poorer, reside in urban areas, and live in households with more young children and headed by people with no formal education. Households in urban areas are more likely to share sanitation than those in rural areas. Significantly, these each represent independent risk factors for diseases associated with poor sanitation (Fink *et al.* 2011).

Our results show that larger households are less likely to share sanitation facilities. It is possible that increasing family size is associated with home ownership or more adults contributing earnings to the households, or other factors that the surveys do not measure but may be reasons for not relying on shared sanitation. Interestingly, our results consistently show that increasing numbers of young children in the household is associated with increased sharing. The results remain strong when separated by wealth tertile. Reasons for this are not clear, but an in-depth analysis of wealth or fertility might help explain this result.

Although data from only 21 countries are available so far, sharing of latrines is predominantly with family members or other persons known rather than the public. Under the proposed change in JMP definitions, these would count towards international sanitation targets if they are shared by five or fewer households and are otherwise improved. As more country surveys become available, it will be possible to explore whether households which fit these new criteria actually have access to 'safer' sanitation, or whether other factors, such as wealth, education and access to improved water supplies – may be more relevant to restricting risk. Perhaps surprisingly, sharing with the general public was found to be slightly more common among rural householders. In some rural villages, all households may know each other, which might make the division between 'known households' and the 'general public' less distinct. As more surveys with this information become available, additional data may help to explain this.

This study has several limitations. First, the data were drawn from JMP surveys based on questionnaires subject to measurement and reporting bias (Boerma & Sommerfelt 1993). While the JMP recommends standard questions for eliciting information on shared sanitation, there are potentially important differences between DHS and MICS surveys and among many national surveys and survey methodologies that could impact the validity of pooling the results. Moreover, the questions have not been rigorously validated. Even though a particular facility is

reportedly used by the household members, this facility might not be used the same or consistently by all household members. The reliability of the data on shared sanitation has been questioned previously, mostly due to varying shared sanitation prevalence reports from the same country during the same time period (JMP Taskforce 2010). For this reason, we chose to use only the most recent dataset for each country, as few countries have repeat measures on shared sanitation, and further questions on the number of households that use shared sanitation facilities have only been added to all DHS and MICS surveys since 2005 (JMP Taskforce 2010).

Second, although we endeavoured to control for potential confounders, this is not always possible. Land tenure or size of plots, for example, could impact the ability of householders to construct their own latrines, but these data are not always collected (Isunju *et al.* 2011). Moreover, the potential for controlling for confounders is limited when characteristics are codetermined. This may be the case, for example, for characteristics associated with urban–rural settings. Similarly, the prevalence of shared sanitation is likely to vary considerably within urban areas – either in high-density slum settlements or surrounding peri-urban areas. Unfortunately no such detailed data is available through the household surveys used.

Third, while this study includes 84 countries, these countries only represent 54% of the population of low- and middle-income countries (World Bank 2014). Due to a lack of DHS or MICS data, it excludes some large countries, such as China, South Africa and Brazil. It is reported that almost a fifth of the population (19%) or an estimated 256 million people in China access improved shared sanitation (24% in urban, 14% rural) (Joint Monitoring Programme 2013). Similarly, approximately 8% of the South African population accesses shared sanitation (9% urban, 6% rural) (Joint Monitoring Programme 2013). Although it is important to include these countries' data in the analysis when it becomes available, the substantial geographic heterogeneity that we have already observed suggests that each country's results should be viewed carefully on its own.

Notwithstanding these limitations, our results provide the first specific large-scale global and regional estimates for the prevalence of shared sanitation and exploration of factors associated with the practice. These estimates clearly identify countries where shared sanitation predominates. This allows for targeting interventions to help minimise any adverse consequences of the practice. We also identified factors associated with increased reliance on shared sanitation, some of which are likely to also be associated with increased health risks. Future research using more robust study designs will be necessary to determine whether these are actually part of a causal chain between shared sanitation and health or merely confounders.

Our other main finding is the substantial variability in the geographic and demographic characteristics of those who report relying on shared sanitation. This variability underscores the importance of the contextual factors that may increase dependence on and any risks associated with shared sanitation. At the same time, this heterogeneity may make it difficult to implement a single, uniform and global policy on shared sanitation that is effective in rendering it a safe, effective and sustainable solution that can be promoted universally as part of international targets. Lastly, the proposed policy change considering certain types of shared sanitation as 'improved' may affect funding allocation, government interest and local policies, especially in countries where the coverage of improved sanitation stands to increase considerably as a result. As such, all available evidence must be carefully considered before such a policy is implemented.

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References

Boerma JT & Sommerfelt AE (1993) Demographic and Health Surveys (DHS): contributions and limitations. *World Health Statistics Quarterly* **46**, 222–226.

Clasen TF, Bostoen K, Schmidt WP *et al.* (2010) Interventions to improve disposal of human excreta for preventing diarrhoea. *The Cochrane Database of Systematic Reviews* CD007180. doi: 10.1002/14651858.CD007180.pub2.

Curtale F, Shamy MY, Zaki A, Abdel-Fattah M & Rocchi G (1998) Different patterns of intestinal helminth infection among young workers in urban and rural areas of Alexandria Governorate, Egypt. *Parassitologia* **40**, 251–254.

DHS (2013) *Demographic and Health Surveys*. ICF International, Rockville, MD, USA.

Filmer D & Pritchett LH (2001) Estimating wealth effect without expenditure data or tears: an application to educational enrollments in states of India. *Demography* **38**, 115–132.

Fink G, Gunther I & Hill K (2011) The effect of water and sanitation on child health: evidence from the demographic and health surveys 1986–2007. *International Journal of Epidemiology* **40**, 1196–1204.

Fuller JA, Clasen T, Heijnen M & Eisenberg JN (2014) Shared sanitation and the prevalence of diarrhea in young children: evidence from 51 Countries, 2001–2011. *American Journal of Tropical Medicine and Hygiene* **91**, 173–180.

Golding J, Greenwood R, McCaw-Binns A & Thomas P (1994) Associations between social and environmental factors and perinatal mortality in Jamaica. *Paediatric and Perinatal Epidemiology* **8** (Suppl. 1), 17–39.

Heijnen M, Cumming O, Peletz R *et al.* (2014) Shared sanitation versus individual household latrines: a systematic review of health outcomes. *PLoS One* **9**, e93300.

Isunju JB, Schwartz K, Schouten MA, Johnson WP & van Dijk MP (2011) Socio-economic aspects of improved sanitation in slums: a review Socio-economic aspects of improved sanitation in slums: a review. *Public Health* **125**, 368–376.

JMP Taskforce (2010) *Joint Monitoring Programme Technical Task Force-Meeting on Sanitation and Methods for Estimating Progress*. UNICEF/WHO, New York, NY, USA.

Joint Monitoring Programme (2010) *Progress on Sanitation and Drinking-Water, 2010 Update*. WHO/UNICEF, Geneva.

Joint Monitoring Programme (2012a) *Progress on Drinking Water and Sanitation: 2012 Update*. World Health Organization and UNICEF, Geneva.

Joint Monitoring Programme (2012b) *Proposal for Consolidated Drinking Water, Sanitation and Hygiene Targets, Indicators and Definitions*. WHO/UNICEF, The Hague, the Netherlands.

Joint Monitoring Programme (2012c) *Post-2015 Proposal for Sanitation Targets and Indicators, December 2012*. UNICEF, New York, NY, USA.

Joint Monitoring Programme (2013). *Progress on Sanitation and Drinking-Water*. WHO/UNICEF, Geneva.

Joint Monitoring Programme (2014) *Progress on Drinking Water and Sanitation: 2014 Update*. WHO/UNICEF, Geneva.

Kim-Farley RJ, Rutherford G, Lichfield P *et al.* (1984) Outbreak of paralytic poliomyelitis, Taiwan. *Lancet* **2**, 1322–1324.

Lim SS, Vos T, Flaxman AD *et al.* (2012) A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* **380**, 2224–2260.

MICS (2013) *Multiple Indicator Cluster Survey*. UNICEF, New York, NY, USA.

Nelson KL & Murray A (2008) Sanitation for unserved populations: technologies, implementation challenges, and opportunities. *Annual Review of Environment and Resources* **33**, 119–151.

Norman R, Bradshaw D, Lewin S *et al.* (2010) Estimating the burden of disease attributable to four selected environmental risk factors in South Africa. *Reviews on Environmental Health* **25**, 87–119.

Nundy S, Gilman RH, Xiao L *et al.* (2011) Wealth and its associations with enteric parasitic infections in a low-income community in Peru: use of principal component analysis. *American Journal of Tropical Medicine and Hygiene* **84**, 38–42.

United Nations (2014) World population prospects, the 2012 revision. http://esa.un.org/wpp/Excel-Data/population.htm [accessed 11 July 2014].

Wegelin-Schuringa M & Kodo T (1997) Tenancy and sanitation provision in informal settlements in Nairobi: revisiting the public latrine option. *Environment and Urbanization* **9**, 181–190.

World Bank (2014) *Country and Lending Groups*. World Bank, Washington, DC [cited 22 January 2014].

Ziegelbauer K, Speich B, Mäusezahl D, Bos R, Keiser J & Utzinger J. (2012) Effect of sanitation on soil-transmitted helminth infection: systematic review and meta-analysis. *PLoS Medicine* **9**, e1001162. doi: 10.1371/journal.pmed.1001162.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. The crude and adjusted prevalence ratios and 95% confidence limits of any shared sanitation access by households, by wealth tertile.

Table S2. Data specific for those 13 countries reporting a shared sanitation prevalence of 50% and above.

Corresponding Author **Marieke Heijnen,** Faculty of Infectious and Tropical Diseases, London School of Hygiene & Tropical Medicine, Keppel Street, London WC1E 7HT, UK. Tel.: +44 20 7927 2213; E-mail: Marieke.Heijnen@lshtm.ac.uk