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Measuring Disparities In Sanitation Access: Does The Measure Matter?

By: **Richard Rheingans**, 2, John D. Anderson, 1, Rolf Luyendijk, 3, and Oliver Cumming

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Measuring disparities in sanitation access: does the measure matter?

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Abstract

objective Initiatives to monitor progress in health interventions like sanitation are increasingly focused on disparities in access. We explored three methodological challenges to monitoring changes in sanitation coverage across socio-economic and demographic determinants: (i) confounding by wealth indices including water and sanitation assets, (ii) use of individual urban and rural settings versus national wealth indices and (iii) child-level versus household-level analyses.

methods Sanitation coverage by wealth for children and households across settings was estimated from recent Demographic and Health Surveys in six low-income countries. Household assignment to wealth quintiles was based on principal components analyses of assets. Concordance in household quintile assignment and estimated distribution of improved sanitation was assessed using two wealth indices differing by inclusion or exclusion of water and sanitation assets and independently derived for each setting. Improved sanitation was estimated using under five children and households.

results Wealth indices estimated with water, and sanitation assets are highly correlated with indices excluding them but can overstate disparities in sanitation access. Independently, derived setting wealth indices highly correlate with setting estimates of coverage using a single national index. Sanitation coverage and quintile disparities were consistently lower in household-level estimates.

conclusions Standard asset indices provide a reasonably robust measure of disparities in improved sanitation, although overestimation is possible. Separate setting wealth quintiles reveal important disparities in urban areas, but analysis of setting quintiles using a national index is sufficient. Estimates and disparities in household-level coverage of improved sanitation can underestimate coverage for children under five.

keywords Disparities, equity, sanitation

Introduction

The Joint Monitoring Programme (JMP) for the Millennium Development Goal (MDG) targets for water and sanitation monitors current progress at the national, urban and rural level (WHO, UNICEF 2012a,b; WHO, UNICEF 2013a,b). However, there is increasing attention in the sector as to whether these services are reaching those most in need (UNICEF 2010).

Although progress towards meeting the MDG targets for water and sanitation differs significantly between countries, progress within countries also differs greatly. Large variation exists within and between countries in the extent to which progress is pro-poor, evenly distributed, or pro-rich. As the MDGs reach their end-point, there is wide discussion about how future development goals might better address these disparities (Vandemoortele 2009; Vandemoortele & Delamonica 2010).

In 2012, WHO and UNICEF initiated a technical consultation to formulate post-2015 global targets and indicators for water and sanitation (WHO, UNICEF 2013a,b). This process drew heavily on key human rights principles, such as non-discrimination, and emphasised the need to reduce disparities by focusing specifically on the poor and most disadvantaged (WHO, UNICEF 2012a,b). In 2013, the High-Level Panel Report on the post-2015 Development Agenda presented a set of 'illustrative post-2015 goals and targets' to the UN Secretary General, which included achieving 'universal access to water and sanitation' (United Nations 2013).

With this increased attention to monitoring progress on reducing disparities for sanitation access, there is a

need to evaluate current measures and indicators. Over the past decade, there has been increased use of a wealth index based on household assets to characterise household economic status in surveys (O' Donnell *et al.* 2008a, b). These are routinely generated and used for national household surveys such as Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) (UNICEF 2009–2011; MEASURE DHS, ICF International 2012). The indices are calculated using principal components analysis (PCA) and multiple correspondence analysis (MCA) based on the presence of a range of household goods and characteristics (Filmer & Pritcett 2001; Sahn & Stifel 2003; Rutstein & Johnson 2004; Booysen *et al.* 2008). The index is then used to rank households and group them into quintiles.

Several issues arise in using these indices for assessing disparities and progress in water and sanitation access, some specific to water and sanitation and others that are more general. Firstly, the standard indices include water and sanitation as assets, creating a risk of confounding when analysing the distribution of water and sanitation outcomes by socio-economic status. As poor households are likely to have unimproved sanitation, it follows that households with poor sanitation are more likely to be categorised as poor. When considering changes over time, poor households that improve their sanitation are more likely to be reclassified as less poor and moved into higher quintiles in subsequent surveys. Given that the wealth index includes a number of assets, this particularly affects households at the border between the two lowest quintiles. If there are large improvements in coverage for the poor over time, this effect might be partly or completely missed due to this reclassification of households. As a result, over time, progress in water and sanitation will be difficult to accurately monitor, as the poorest households will appear to make little or no progress, while coverage will improve in wealthier quintiles.

Secondly, asset indices and wealth quintiles are typically calculated using national sample populations. However, assets that reflect wealth in rural areas (e.g. tin roof) may reflect poverty in urban areas, while other resources (e.g. thatch roofs, firewood for cooking) may not be available in urban settings. There is a commonly held notion that asset indices used by DHS and MICS have a rural bias and may not accurately reflect urban/rural or intra-urban disparities. This raises a question of whether separate indices and analyses are needed for urban and rural settings.

Lastly, due to generally higher fertility, poor households tend to have higher numbers of children (Milanovic 1996). Therefore, there are proportionally more children in the lower quintiles than in the higher quintiles. In terms of the health effects, poor sanitation is most likely to affect young children, so disparities in risk may be underestimated through household-level analysis.

This study explores a series of questions on the measurement of disparities in access to sanitation in both rural and urban areas: (i) Does the inclusion of water and sanitation in the asset index affect the estimation of sanitation disparity or progress over time? (ii) Do rural and urban differences necessitate the use of separate asset indices to better reflect urban/rural and intra-urban disparities in access to sanitation? (iii) Does the unit of analysis (child or household) affect the estimated level of disparity?

Methods

Data

For this analysis, we used DHS surveys from six countries: Bangladesh, India, Malawi, Nigeria, Kenya and Tanzania, a subset selected from a larger study of ten countries (Rheingans *et al.* 2012). Selection was based on size of population without sanitation, geographical distribution and expected patterns of disparities. For each country, the most recent DHS survey characteristics were used in the analyses (Table 1).

Surveys differ slightly in the availability of asset data. We used a common set of assets for all countries to ensure compatibility. Reducing the number of assets included in PCA has shown little impact on the asset index or on the final categorisation of households into quintiles (Houweling *et al.* 2003). Yang and colleagues observed a similar effect for drinking-water quality Yang *et al.* (2013). The countries and assets are listed in Table 1. Standard methods were used for estimating an asset index using PCA (O' Donnell *et al.* 2008a,b) in Stata 12 (StataCorp 2011). Each of the surveys included data on household sanitation access and was used to construct the best definition of 'improved sanitation' based on current JMP facility definitions (WHO, UNICEF 2013a,b), but did not exclude shared facilities.

Excluding water and sanitation assets

For each country, we developed two variants of the asset index, one with water and sanitation included as assets and one without water and sanitation. Households were grouped into wealth quintiles using each of the indices. It would have been possible to examine an asset index that only excludes sanitation, however, we chose to exclude both for this analysis so that the same index could be

Table 1 Data used in analysis of sanitation disparities

Country/DHS survey year	No of households/children
Bangladesh 2007	10 375/6134
India 2005–6	108 700/51 381
Kenya 2008–9	9008/6044
Malawi 2010	24 541/19 765
Nigeria 2008	33 378/27 990
Tanzania 2010	9563/7963

Asset index composition	Description
Present in household	Electricity, radio, television, refrigerator, bicycle, motorcycle or scooter, telephone, car, bank or post office account
Descriptive assets	Roof, floor, and wall materials and cooking fuel
Water and sanitation assets	Drinking-water source and type of toilet

Sanitation definition	Description
Any improved sanitation (including shared facilities)	Flush toilet; piped sewer system; septic tank; flush/pour flush to pit latrine; ventilated improved pit latrine (VIP); pit latrine with slab; composting toilet
Unimproved	Flush/pour flush to elsewhere; pit latrine without slab; bucket; hanging toilet or latrine; no facilities or bush or field

used to assess disparities in sanitation and water (which are often analysed together).

We compare variant asset indices for individual households in two ways. First, a Pearson rank correlation (PRC) test was carried out to test whether the indices produced similar ordering of households by wealth. Second, we compared the concordance between the quintile assigned to each household by the different indices. We calculated the Kendall Tau-*b* and associated asymptotic standard error (ASE) to assess the level of concordance between quintile assignments.

To assess the effect of including water and sanitation on the index across urban and rural settings, household improved sanitation coverage was estimated by wealth quintile for both settings in each country. To test whether the choice of index affects the level of disparity, concentration indices of improved sanitation coverage are compared across urban and rural settings in each country. The concentration index is a measure of overall disparity analogous to a GINI index (O' Donnell *et al.* 2008a,b). It is based on a concentration curve showing the cumulative portion of a given outcome (e.g. improved sanitation) on the vertical axis, against the cumulative portion of households ranked by relative wealth along the horizontal. An equally distributed outcome would follow a 45° diagonal line (line of equity), with the poorest 40% of households accounting for 40% of improved sanitation (etc). Outcomes concentrated in the rich lie below the line of equity and those that are concentrated among the poor lie above. The overall level of disparity can be compared using the concentration index, which is twice the area between the line of equity and the particular concentration curve. A concentration index of zero represents no disparity, a positive value is concentrated in the rich and a negative value is concentrated in the poor.

Rural and urban differences

To assess whether separate urban and rural asset indices are needed, we first compare the distribution of rural and urban households across the wealth index using a density plot and then examined whether a separately generated rural asset index would result in a different ranking of rural households (compared with the ranking based on the national index) and similarly for the urban households. We developed separate rural and urban asset indices, excluding water and sanitation, using PCA and including only households in those respective settings. We then calculated the PRC coefficient for the national index and the separate urban/rural indices. We also assessed concordance between the quintile assigned using the national index and the setting-specific index for urban and rural settings in each country using Kendall tau-*b* coefficients.

Children or households

The analyses presented above examine whether households have sanitation and how coverage differs based on the wealth of the household. In considering the health consequences of disparities in sanitation, this may understate coverage and disparity. To address this issue, we compare the concentrations of sanitation among children under five by wealth to sanitation among households ranked by wealth. We analysed water and sanitation coverage using children under five as the unit of analysis, excluding households without children. We then ranked children by wealth of their households and created quintiles of children. This allows us to compare the coverage for the poorest 20% of children to that of richer quintiles, rather than focusing on children in the poorest 20% of households. This was carried out for urban and rural settings in each country. We compared the level of

coverage (household or child) and resulting disparities (based on the concentration index) between units of analysis.

Results

Excluding water and sanitation assets

For all six countries, asset indices calculated with and without water and sanitation access were highly correlated with each other. PRC analyses comparing household ranks by wealth index with and without water and sanitation ranged from $R = 0.96$ ($P < 0.001$, Bangladesh and Malawi) to $R = 0.99$ ($P < 0.001$, Nigeria) (Figure 1). In cases where there was disagreement between the two indices, the result was a household being classified in the adjacent wealth quintile (blue points, Figure 1). For example, if a household was classified in the poorest quintile by the index with sanitation and in the 2nd quintile by the index without water and sanitation, which is a difference of one adjacent quintile. In very few cases, the resulting difference was greater than a shift from one adjacent quintile (yellow and red points, Figure 1). National-level cross-tabulation analyses of these quintile assignments show concordance ranging from 85% (tau $b = 0.93$, ASE = 0.001, $N = 33\ 296$ HH) in Nigeria to 80% concordance in India (tau $b = 0.90$, ASE = 0.001, $N = 108\ 595$ HH) and Malawi (tau $b = 0.88$, ASE = 0.002, $N = 24\ 527$ HH).

For all countries and settings, the coverage in the poorest quintile is higher for the index excluding water and sanitation than the one including it (Figures 2 and 3). This trend is generally present in the 2nd quintile as well except in urban Bangladesh, India and Kenya (Figure 2) and rural Bangladesh and Nigeria (Figure 3). The opposite trend is evident in about half of the 4th and all of the wealthiest quintiles for half of the countries in rural settings, but only present for about half of the countries in urban settings. Overall, fewer households with improved sanitation are classified in those higher wealth quintiles using the index without water and sanitation than the index with water and sanitation in both settings.

The level of inequity in sanitation coverage is similar regardless of which asset index is used. In Figure 4, the concentration index for country and setting is plotted for the asset index with water and sanitation (horizontal axis) and without (vertical). Points on the diagonal line reflect both indices providing the same estimate of inequity. Overall, the two indices provide similar estimates of inequity. However, for almost all countries and settings,

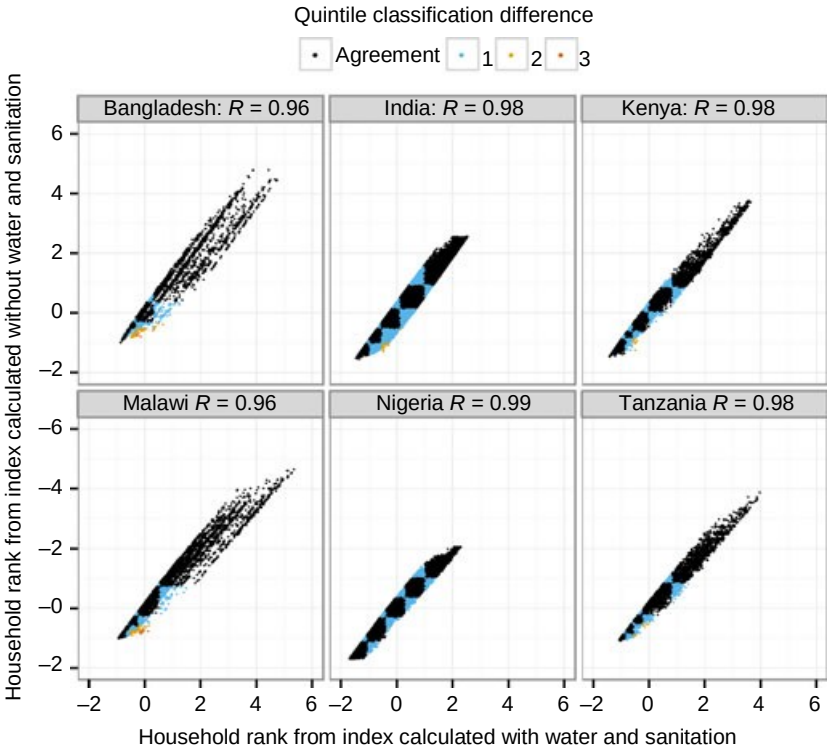

Figure 1 Each household plotted by the rank of the two index values. The colours represent the difference in quintile classification for a single household, if it was classified differently by the two indices. Wealth rank as calculated by the index without water and sanitation is on the *y*-axis and the index with sanitation, and water is on the *x*-axis. Pearson's correlation values (R) were statistically significant ($P < 0.001$) for each country.

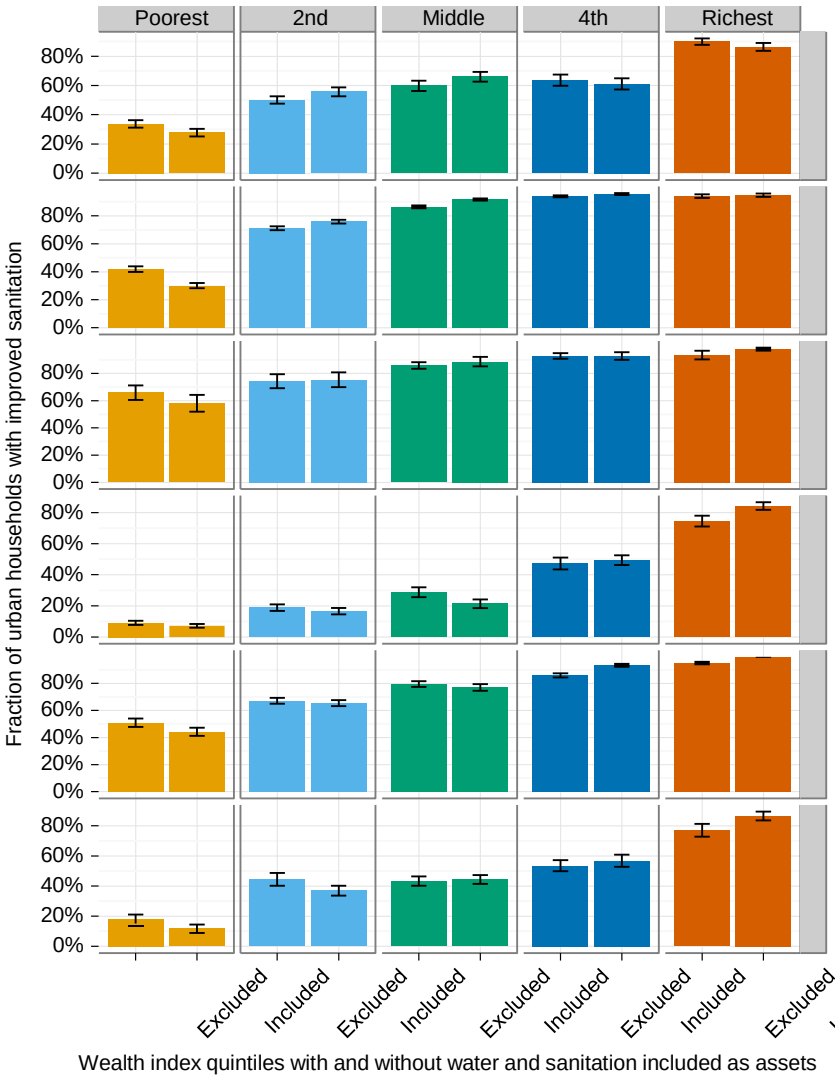

Figure 2 Improved sanitation coverage by wealth quintile using asset indices with and without water and sanitation, for urban settings in six countries.

the estimated level of disparity is greater (higher concentration index) for the asset index with water and sanitation included. This effect is most pronounced in countries where sanitation is particular inequitable (high concentration index) and overall coverage is lower.

Rural and urban differences

We compared the distribution of asset scores for urban and rural settings using the asset index without water and sanitation (Figure 5). For all countries, urban households are skewed to the right, making them more likely to be classified in a higher national wealth quintile – even poor urban households. The partial exception is Bangladesh where the poorest urban households are similar to poor rural households. Overall, this makes national quintiles hard to interpret as they reflect a mix of wealth and urban/rural setting.

We compared disparities in improved water and sanitation coverage using indices calculated separately for urban and rural households and those calculated using the national asset index to rank and classify all households into rural and urban. For all countries, the correlation between the two indices was high for urban and rural households, with PRC coefficients ranging from $R = 0.996$ ($P < 0.0001$, Bangladesh) to $R = 0.980$ ($P < 0.0001$, Nigeria) for the urban comparison and from $R = 0.997$ ($P < 0.0001$, India) to $R = 0.984$ ($P < 0.0001$, Malawi) for the rural comparison. Similarly, there was high concordance between the quintile assignments using

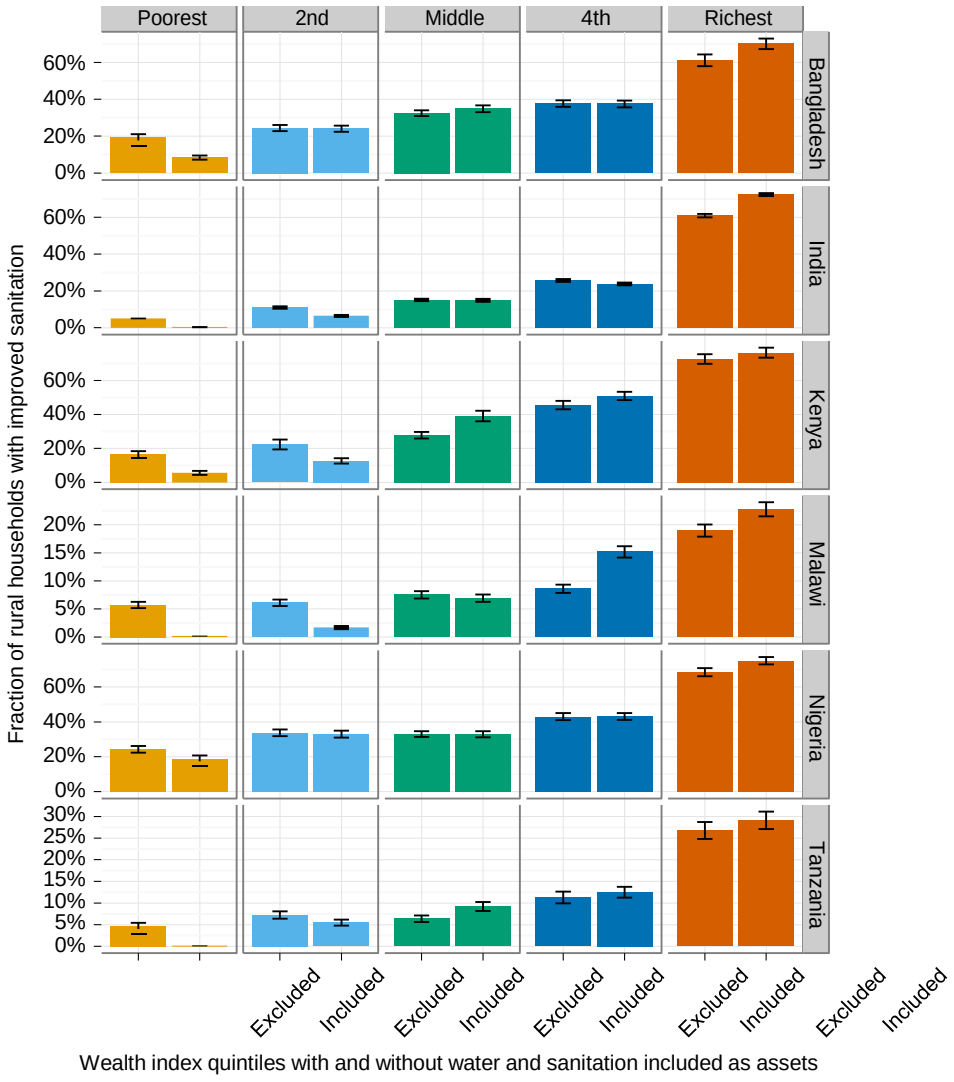

Figure 3 Improved sanitation coverage by wealth quintile using asset indices with and without sanitation, for rural settings in six countries.

the two approaches, with a range from 96% (Bangladesh; tau b = 0.96, ASE = 0.002, N = 3807) to 80% (Malawi; tau b = 0.91, ASE = 0.002, N = 2879) concordance across urban households and 91% (Tanzania; tau b = 0.96, ASE = 0.002, N = 7372) to 77% (Bangladesh; tau b = 0.88, ASE = 0.003, N = 6568) across rural households. Setting asset indices and national asset indices did not differ in estimates of disparities in improved sanitation coverage (Figure 6).

Children or households

We examined whether the choice of unit of analysis (household or child) affected the estimated level of improved sanitation or disparities within it. For most countries and settings, improved sanitation coverage for children under five is lower than that of households. National sanitation coverage estimates calculated at the child-level ranged from 8.9% (Kenya: 39.7 ± 2.2%, N = 6044) to 1.8% (Nigeria: 51.3 ± 1.2% N = 27 990) lower than estimates calculated at the household level (Kenya: 48.6 ± 2.0% N = 9008; Nigeria: 53.0 ± 1.1% N = 33 378). Sanitation coverage estimates in urban settings using child-level estimates ranged from 6.6% (Malawi: 29.1 ± 2.5%, N = 1896) to 1.4% (Nigeria: 74.3 ± 1.8%, N = 7613) lower than estimates calculated at the household level (Malawi: 35.6 ± 2.5% N = 2909; Nigeria: 75.8 ± 1.7% N = 10 724). Sanitation coverage estimates in rural settings using child-level estimates ranged from 6.0% (Kenya: 30.9 ± 2.3%, N = 4612) to

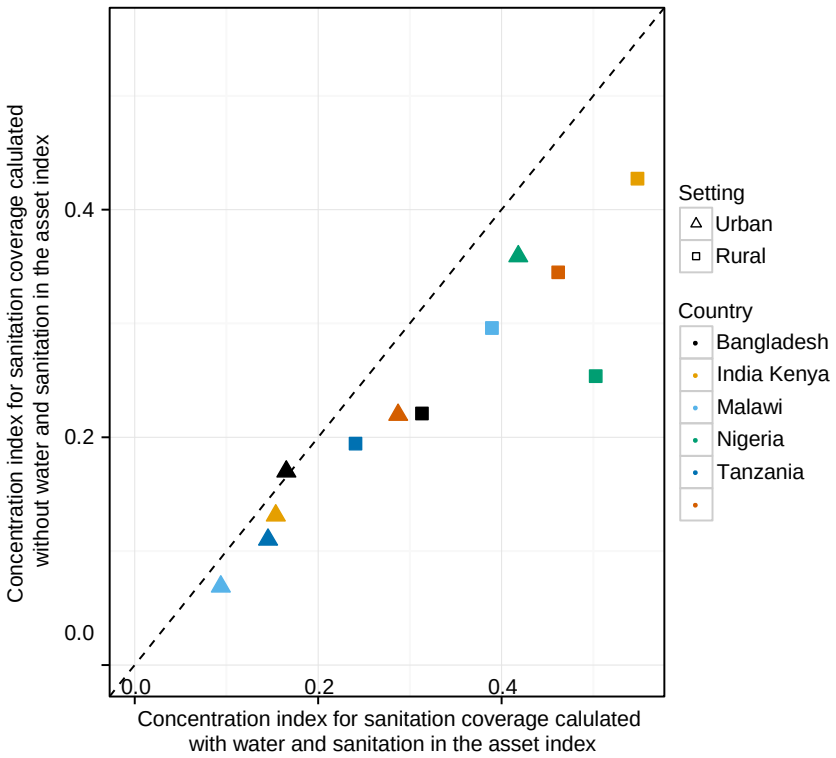

Figure 4 Level of disparities in improved sanitation (concentration index) measured using asset indices with and without water and sanitation (urban and rural settings in six countries).

1.6% (Malawi: 8.8 ± 0.5%, N = 18 071) lower than estimates calculated at the household level (Kenya: 36.9 ± 2.1% N = 6147; Malawi: 9.4 ± 0.5% N = 21 916). The only partial exception to this trend was rural Nigeria, where sanitation coverage estimates were 1.0% higher at the child level (41.5 ± 1.5%, N = 21 034) than the household level (40.5 ± 1.4%, N = 23 346).

While sampling level had relatively small effects on coverage estimates across quintiles, household estimates were consistently higher across settings in all countries (Figure 7). Concentration indices were consistently lower for household-level estimates than child-level estimates of coverage in most settings, indicating consistently lower estimates of disparities using households as sampling units (Table 2). In all six countries, urban disparities were greater for both child-level and household-level coverage estimates than in rural settings.

Discussion

With increasing attention on the need to assess and monitor disparities in water and sanitation, it is important to assess potential measurement strategies and specific measures to ensure their validity and usefulness. Existing data sources such as DHS and MICS provide substantial data for assessing these issues, and we examine three questions regarding how measurement choices affect the characterisation of sanitation disparities.

Excluding water and sanitation assets

Estimates of household economic status using asset indices with and without water and sanitation provide highly concordant and correlated rankings. Households with improved sanitation but few other assets tend to be ranked in higher quintiles when using the asset index that includes water and sanitation. This results in a tendency to increase the estimated coverage for the higher quintile. Conversely, a moderately poor household without sanitation may be categorised in a lower quintile using an asset index that includes water and sanitation (compared with one without). This would have the tendency to reduce estimated coverage among the poorer quintile. Overall, estimates of sanitation coverage and disparities were similar when using both indices with and without water and sanitation as assets. However, estimates with these included tended to provide lower estimates of coverage

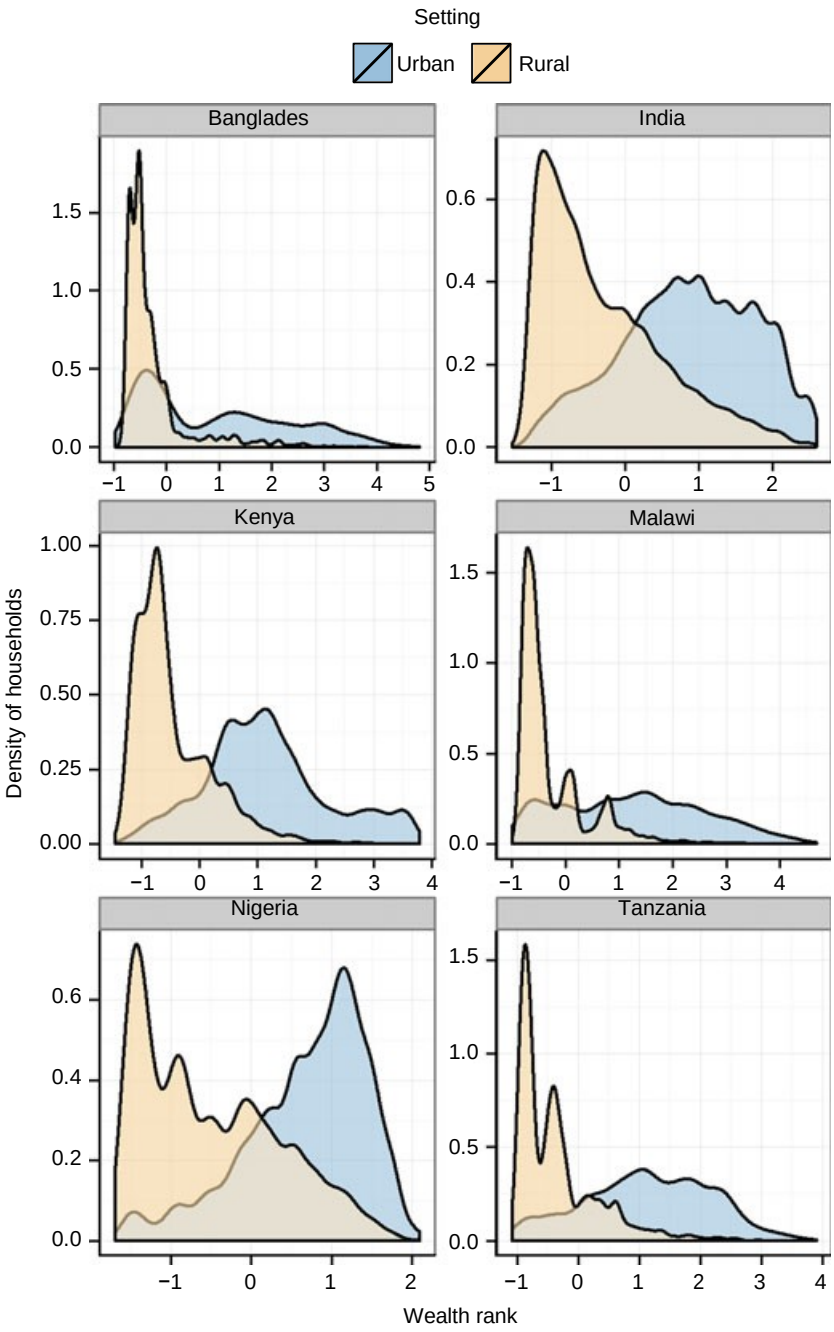

Figure 5 Density plots of asset index for urban and rural households in six countries.

for the poor and higher estimates of disparities. This effect differs between settings and countries.

Purely on theoretical grounds, excluding water and sanitation form the asset index is required as their presence in the index directly influences both the independent and dependent variables (wealth quintile and sanitation coverage). However, the traditional measures provide reasonable approximations of the level of coverage and disparity. The added complexity of generating water- and sanitation-specific wealth indices, with both removed as assets, may serve as a disincentive for this important analysis to be conducted. Using separate indices for examining sanitation also creates complications in comparison with other outcomes of interest (e.g. stunting), as

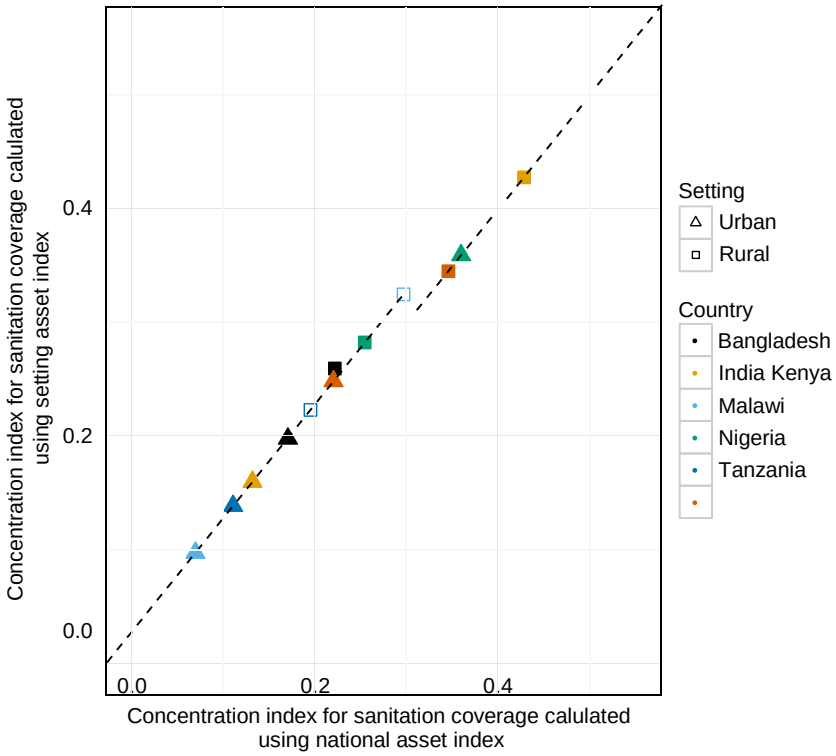

Figure 6 Level of disparities in improved sanitation (concentration index) measured using asset indices calculated at a national level and calculated by each setting separately (urban and rural settings in six countries).

standard analyses of these other outcomes would use somewhat different population divisions. As such, and given that traditional wealth indices with water and sanitation included as assets are sufficiently approximate, they will remain useful proxies for the purposes of disaggregated global monitoring in the context of post-2015 development goals and targets for the water and sanitation sector.

Rural and urban differences

It remains difficult to compare asset scores in urban and rural settings. In all of the countries examined, the poorest 20% of urban households were comparable to the wealthiest 20% of rural households. It is hard to tell whether this is a product of greater urban wealth or just a difference in how household assets reflect economic status. Using national quintile categories obscures differences by wealth within urban areas, in particular, the low improved sanitation access among the urban poor. Thus, separate quintile analyses are recommended for urban and rural settings.

There are two potential options for doing such analyses – either using the household asset scores from the national asset index to divide the urban and rural populations into separate quintiles or estimating separate urban and rural indices to determine wealth quintiles. We estimated both and found that the two indices provide highly correlated rankings of households, resulting in highly concordant quintile assignments. This suggests that a single national asset index can be used to establish urban and rural quintiles.

Children or households

MDGs differ in whether they track progress for household, children or other subpopulations. Improved sanitation is a developmental goal for all, but is of particular importance to children who are disproportionately affected by associated diarrhoea mortality (Boschi-Pinto *et al.* 2009) and other health outcomes (e.g. undernutrition). We compared disparities using child-level and household-level analyses to assess whether household-level analyses alone can adequately capture the burden and disparity for children. We found that estimates for sanitation disparities based on household-level analyses overestimate coverage and underestimate the level of disparity among children under 5. The level of difference varies across countries but is consistent in direction.

Table 2 Estimated distribution of improved sanitation by wealth quintile, calculated at the household and child level

Country/Setting/Level	*N*	Proportion with improved sanitation - % (SE)					Concentration index
		Poorest	Poorer	Middle	Richer	Richest	
Bangladesh							
Urban							
Household	3821	33.6 (2.6)	50.1 (2.5)	59.8 (3.6)	63.6 (3.9)	90.0 (2.1)	0.170
Child	2107	33.7 (4.4)	47.2 (4.5)	50.4 (4.4)	61.5 (4.5)	82.7 (2.7)	0.167
Rural							
Household	6579	19.4 (1.7)	24.4 (1.6)	32.5 (1.6)	37.7 (1.8)	61.1 (3.1)	0.221
Child	4043	19.3 (2.4)	20.8 (2.1)	30.5 (2.2)	35.4 (2.5)	61.9 (4.0)	0.228
India							
Urban							
Household	50 236	41.9 (2.0)	71.2 (1.4)	86.4 (1.0)	94.0 (0.7)	94.1 (1.3)	0.131
Child	19 483	36.4 (2.8)	62.3 (2.2)	80.2 (1.6)	91.6 (1.1)	95.5 (0.8)	0.137
Rural							
Household	58 805	5.0 (0.5)	10.9 (0.7)	15.1 (0.7)	25.7 (0.8)	60.9 (1.0)	0.427
Child	32 072	3.9 (0.5)	8.9 (0.8)	13.1 (1.0)	20.9 (1.0)	51.9 (1.3)	0.434
Kenya							
Urban							
Household	2910	65.9 (5.3)	74.3 (5.2)	85.9 (2.4)	92.9 (2.0)	93.5 (3.2)	0.069
Child	1467	60.6 (6.9)	73.8 (6.8)	80.1 (4.7)	93.0 (2.7)	91.0 (3.1)	0.075
Rural							
Household	6174	16.4 (2.0)	22.3 (2.9)	27.8 (2.0)	45.5 (2.5)	72.7 (2.8)	0.296
Child	4612	14.1 (3.0)	17.8 (2.5)	23.6 (3.0)	32.2 (3.4)	67.0 (3.9)	0.303
Malawi							
Urban							
Household	2909	9.1 (1.3)	18.8 (2.1)	28.8 (3.2)	47.2 (3.8)	74.5 (3.5)	0.359
Child	1896	6.3 (2.6)	15.9 (3.5)	23.4 (3.6)	34.1 (4.1)	66.0 (4.3)	0.314
Rural							
Household	21 916	5.7 (0.6)	6.1 (0.6)	7.5 (0.6)	8.6 (0.7)	19.0 (1.1)	0.254
Child	18 071	5.5 (0.7)	6.5 (0.9)	7.0 (0.8)	8.1 (0.8)	17.0 (1.3)	0.167
Nigeria							
Urban							
Household	10 724	50.9 (3.1)	67.2 (2.2)	79.5 (2.1)	85.9 (1.5)	95.0 (0.9)	0.110
Child	7613	52.3 (3.8)	64.3 (2.9)	74.8 (2.5)	85.7 (1.6)	93.8 (1.3)	0.113
Rural							
Household	23 346	24.3 (1.9)	33.7 (1.9)	33.0 (1.7)	43.0 (2.0)	68.5 (2.3)	0.194
Child	21 034	26.2 (2.4)	38.5 (2.4)	41.1 (2.4)	39.4 (2.1)	62.4 (2.3)	0.228
Tanzania							
Urban							
Household	2209	18.1 (3.0)	44.5 (4.2)	43.2 (3.1)	53.5 (3.6)	77.0 (4.3)	0.220
Child	1511	10.7 (2.9)	43.0 (6.6)	41.5 (4.8)	56.5 (5.6)	76.1 (5.1)	0.257
Rural							
Household	7414	4.7 (0.7)	7.2 (0.8)	6.4 (0.8)	11.3 (1.4)	26.8 (1.9)	0.345
Child	6512	2.8 (0.7)	5.3 (1.1)	4.7 (0.9)	6.3 (1.1)	18.8 (1.8)	0.348

This pattern is due to the greater concentration of children in poor households and lower sanitation coverage in households with children (controlling for wealth). This may be explained by a number of factors, including association between educational levels and number of children, and households with children being younger and less economically established. Regardless of the underlying cause, household-level analyses underestimate the disproportional impact of lack of sanitation on the poorest children.

Conclusion

The results presented here have important implications for analyses and monitoring of disparities in improved sanitation. Current disparity measures using standard

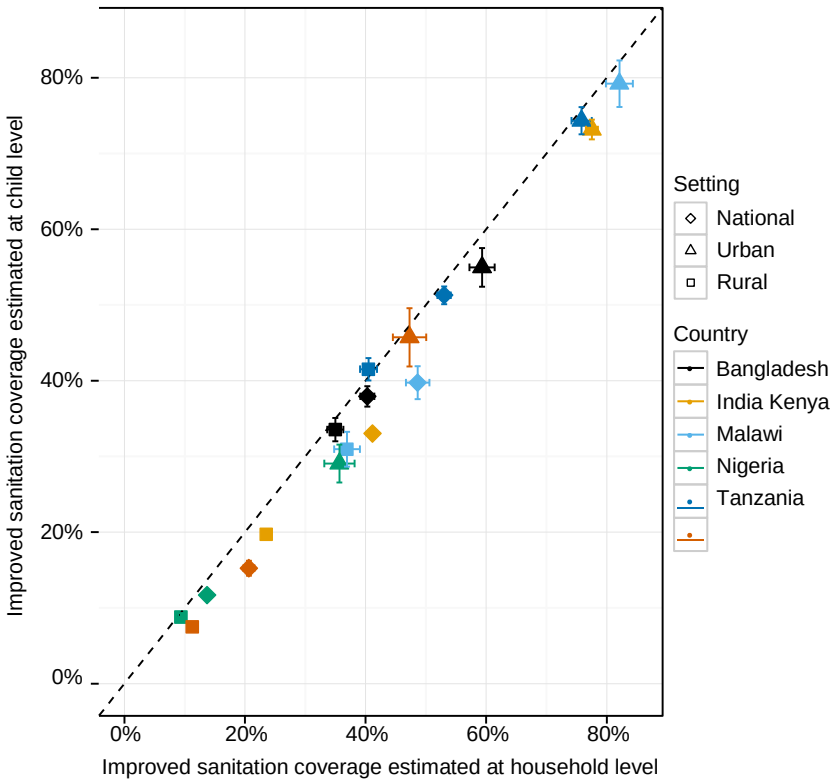

Figure 7 Improved sanitation coverage estimates for national, urban and rural populations using children and households as the sampling unit in six countries.

asset indices that include water and sanitation provide good proxies for the distribution of disparities in improved sanitation. Using standardised wealth measures facilitates comparisons to other equity analyses and likely increases the availability of information on sanitation disparities. However, this suggests that over time supplementary analyses with asset indices that exclude water and sanitation would be helpful if only to test the ongoing validity of this approach.

Measures of household wealth are strongly related to urban and rural setting, making national-level analyses by quintile misleading. In particular, they underestimate and obscure the low coverage for the urban poor. Discrete analysis of urban and rural quintiles should be taken to track progress in both settings.

In six countries, we found that children under five are less likely to have improved sanitation than household coverage alone suggests. This has important implications for how international progress will be measured for the post-2015 goals and targets. Although it has been proposed that a post-2015 goal of universal access be set, priority may be needed in the short term to medium term to ensure and incentivize improving coverage and reducing disparities for children. Recognising that these children are concentrated in particular households is important in both identifying where services are most needed and where the rate of development returns on investments may be greatest.

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