Article

From Administrative to Political Evaluation: Estimating Water, Sanitation, and Hygiene Indicators for Parliamentary Constituencies in India

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Abstract

With the launch of the *Swachh Bharat Mission* (SBM), India accelerated access to improved sanitation in a 'mass movement' emphasising people's participation and political leadership. However, SBM continues to be implemented at the administrative unit of districts, disassociated from the political and electoral units of Parliamentary Constituencies (PC). We provide estimates of India's 543 PCs by their performance on three important Water Sanitation and Hygiene (WASH) indicators: *unsafe disposal of child stool, unimproved drinking water supply*, and *unimproved sanitary facilities*. We used multilevel modelling to generate precision-weighted estimates of each indicator at PC-level, based on recently developed methodologies linking cluster GPS data from the National Family Health Survey (NFHS), 2016 to potential PCs. We found very high heterogeneity across PCs ranging from 0.95 per cent–95.85 per cent for unsafe stool disposal, 0.35 per cent–64.17 per cent for unimproved drinking water source,

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and 0.19 per cent–90.69 per cent for unimproved sanitation facility. Unsafe child stool disposal and unimproved sanitary facility were strongly correlated (r = 0.85, Pearson and r = 0.83, Spearman). Monitoring of SBM data at the PC level will allow parliamentarians to effectively improve WASH conditions in their constituencies, while accounting for critical between-PC variability that may be obfuscated in an approach focussed on state or district means.

Keywords

Swachh Bharat Mission, water, sanitation, parliamentary constituencies, national family health survey, India

Introduction

India has had a national sanitation policy since 1986 under different names, and executed by different elected governments. The Central Rural Sanitation Program (CRSP) of 1986, followed by the Total Sanitation Campaign (TSC) of 1999, and the Nirmal Bharat Abhiyan (NBA) of 2012, that preceded the current Swachh Bharat Mission (SBM) launched on 2 October 2014, have all had two priorities—improving the coverage of household toilets and the supply of potable water (Martel, 2017). These policies have also had another common thread. They have all been implemented and monitored at the district level (Martel, 2017).

In pre-independent India, interest around sanitation evolved with unrest over periodic outbreaks of diseases like Cholera and Plague that afflicted British troops (Bhaumik & Kumar, 2014; Mushtaq, 2009). In 1863, the Royal Commission recommended the establishment of a Commission of Public Health in each presidency, and sanitary boards were formed in each province in 1864, which were later replaced by Sanitary Inspector Generals, and then Sanitary Commissioners (Bhaumik & Kumar, 2014; Plague Commission; Government of India, 1908). Thus, even though sanitation was recognised as an important public health issue, the bulk of the expenditure on sanitation was devoted towards military sanitation. The 'natives' were often admonished for personal and religious habits that promoted poor sanitation (Fry, 1925). Furthermore, since overhauling rural sanitation infrastructure was seen as a challenging task, initiatives like setting up dry toilets in rural areas and manual scavenging of night soil were promoted in efforts to improve sanitation (Chaplin, 1999).

In independent India, sanitation found mention in the First Five-Year Plan of the Government of India in 1954, as the 'National Water Supply and Sanitation Program' (Jangra, Majhra, & Singh, 2016). The CRSP, launched in 1986, was the first formal policy focussed around sanitation. It concentrated on the provision of toilets through substantial financial subsidies of up to 80 per cent of construction costs for poor households, for at least 25 per cent of the rural population in up to 10 years (Jangra et al., 2016). However, after the majority of these latrines remained unused, it was felt the CRSP's focus on latrine construction was far too supply focussed for the time (Alexander et al., 2016).

To correct this, in 1999, India adopted the TSC, hailed as a community-led, holistic programme with a focus on generating demand for improved sanitation (Alexander et al., 2016). It adopted a twin focus on awareness strategies as well as continued, but reduced monetary incentivisation for construction of household toilets (Hueso & Bell, 2013; Peal, Evans, & van der Voorden, 2010). TSC also introduced in sanitation policy, for the first time, a goal that has persisted through all other policies filed in India since then—namely, making communities open defecation free (ODF). TSC set the first target for this in 2012, and then extended it to 2017 (Alexander et al., 2016). Another financial incentive scheme, the Nirmal Gram Puraskar (NGP), under which financial awards were given to Gram Panchayats of ‘clean’ or ODF villages, was introduced in 2003 to augment the TSC by generating competition among villages to reach ODF status (Alexander et al., 2016). Meanwhile, information, education and communication (IEC) activities also continued to enjoy focussed attention (Hueso & Bell, 2013). IEC activities under TSC adopted the Community Led Total Sanitation (CLTS) approach that triggered disgust against faeces and promoted shaming of open defecators in rural communities (Kar & Chambers, 2008).

Despite these changes, TSC’s initial claims of sweeping improvements in rural sanitation coverage from 22 per cent in 2001 to 68 per cent in 2011 and declaring over 2000 rural communities ODF, were countered by India’s census in 2011, which revised this estimate to a moderate 31 per cent rural sanitation coverage (Government of India, 2012). Poor implementation and follow-up at the grassroots, delayed disbursal of subsidies, and a focus on demand generation at the cost of meeting the supply needs were some of the reasons cited for this lacklustre performance (Hueso & Bell, 2013). For the NGP programme, for example, the lack of long-term evaluation of ODF status meant the NGP became ‘a prize for achievement of total sanitation rather than sustainability of outcomes achieved’ (The World Bank, 2016).

In 2012, the NBA was launched to incorporate these lessons from TSC. A new goal was set, to end open defecation in India by 2022 (Alexander et al., 2016). NBA also stressed on grassroots organisation, drawing inspiration once again from CLTS in Bangladesh (Government of India, 2014). Village Water and Sanitation Committees were formed to manage the sanitation programme in villages and promote transparency, community participation, and community ownership (Alexander et al., 2016; Kar & Chambers, 2008). For the first time, the programme also expanded financial subsidies to above poverty line households (Bhaumik & Kumar, 2014).

In 2014, with the election of a new government with a sweeping majority, NBA was replaced by the SBM in 2014. This latest sanitation policy set a new target yet again to end open defecation in India, this time, by October 2019 (Alexander et al., 2016). On many counts, SBM continued to focus on areas similar to its predecessors, including household toilet construction though the provision of subsidies and community and household focussed networks along with an impetus on behaviour change. However, it also introduced some definitive changes (Alexander et al., 2016). For the first time, evaluation of sanitation policy in India incorporated toilet *usage*, along with toilet *construction.* That construction of toilets did not always translate into their usage had been clear for a while. Yet sanitation policies in India had always used toilet construction as a proxy for toilet use (Gupta et al., 2019; National Annual Rural Sanitation Survey of 2017–2018). Furthermore, like the erstwhile NGP initiative, SBM continued to focus on the identification and certification of ODF villages since 2015, but introduced periodical inspections of ODF free villages that were missing earlier (Gupta et al., 2019). Thus, the SBM, while maintaining many of the historical trends, managed to bring renewed vigour in sanitation policy in India. Recently, the United Nations (UN) secretary general and the World Health Organization (WHO) lauded the SBM's focus to improve sanitation in India (Khetrapal-Singh, 2018; *The Business Standard*, 2019).

The link between sanitation and health was arguably first established in 1842 in British civil servant Edwin Chadwick's seminal 'Report on an inquiry into the sanitary condition of the laboring population of Great Britain' (Lewis, 1952; Mara, Lane, Scott, & Trouba, 2010). This led to Britain's Public Health Act of 1848, possibly the first documented legislation making provision of clean water and improved sanitation a state responsibility, directed at improving public health (Lewis, 1952). Since then, a multitude of studies have established associations between preventable population health outcomes and safe drinking water and improved sanitation (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Over 85 per cent of diarrhoeal disease—the second leading cause of death in children younger than five years—is attributed to unsafe drinking water, inadequate sanitation, and poor hygiene. Diarrhoea morbidity can be reduced by around 21 per cent through improved water supply and by around 37 per cent through improved sanitation (Lopez et al., 2006). Furthermore, studies have shown that the greatest burden of these adverse health outcomes are borne by the most vulnerable sections of society—the impoverished, and the infants, both largely from low- and middle-income countries (Lewis, 1952; Lopez et al., 2006; Mara et al., 2010).

Recent systematic reviews have shown that improved sanitation and water provisions can reduce the rates of morbidity and the severity of various faeco-oral diseases, particularly in children (Freeman et al., 2017; Lopez et al., 2006). For instance, based on estimates pooled from 11 studies, improved sanitation was associated with 12 per cent lower odds of diarrhoea overall, and 20 per cent lower odds of diarrhoea in rural areas (Freeman et al., 2017). Moreover, a 30 per cent to 60 per cent reduction in diarrhoea prevalence was linked to provision of sewerage facilities (Freeman et al., 2017). A meta-analysis of observational studies of infants' faeces disposal practices found that unsafe disposal increased the risk of diarrhoea by 23 per cent (Dangour et al., 2013). Improved sanitation has also been linked to lower odds of helminthic infections like *A. lumbricoides*, *T. trichiura*, hookworm and *S. stercoralis* (Freeman et al., 2017), which can result in adverse nutritional and growth outcomes in children and anaemia in pregnant women (Dangour et al., 2013). Studies have also suggested 'herd protection' for diarrhoea for individuals residing in areas with high sanitation coverage (Alderman, Hentschel, & Sabates, 2003; Andres, Briceño, Chase, & Echenique, 2017; Dangour et al., 2013).

India's share in the global burden of many of these diseases is significant. Diarrhoea is the third leading cause of childhood mortality in India and is responsible for 13 per cent of all deaths each year in children under five years of age (Lakshminarayanan & Jayalakshmy, 2015; Lopez et al., 2006). India also contributes to one-third of the global burden of childhood stunting with 46 million stunted children and another 25.5 million wasted children (Lakshminarayanan & Jayalakshmy, 2015; Lopez et al., 2006). Over 50 per cent school-aged children in six states of India suffer from soil transmitted Helminth infections (Abraham, Kaliappan, Walson, & Ajjampur, 2018). Overhauling sanitation policy has been recognised as a path to achieve substantial improvements in many of these outcomes, under India's new National Nutrition Mission (NITI Aayog, 2017). Sanitation has also been recognised as a necessary focus for India to achieve the Sustainable Development Goals (Khetrapal-Singh, 2018).

A key data-related challenge that remains to be addressed to effectively and efficiently improve sanitary conditions in India stems from the fundamental discordance between its 640 administrative districts and 543 parliamentary constituencies (PCs). These administrative and electoral geographies do not share the same boundaries, and they are not nested within each other (Swaminathan, Kim, Xu, Blossom, Joe, & Venkataramanan, 2019). Thus, 72 years after India's independence, this continues to cause an inherent disconnect between the level at which policies are planned, executed and monitored (i.e., districts) and the level at which political and electoral processes are held in India (i.e., PCs) (French, 2012). Importantly, data on key indicators from socioeconomic, demographic, health, education and other sectors tend to be collected at the level of districts, and completely delinked from PCs. This makes studying the performance of policies from the level of PCs a challenge.

Every five years, India elects legislators into its lower house of Parliament, the Lok Sabha, many of whom seek repeat terms (Mehta, 2012). Under the parliamentary system of democracy, Members of Parliament (MPs) are seen as the directly elected representatives of people. However, their electorate cannot hold them accountable for the performance of key policies in their jurisdiction. 'District collectors', the administrative heads of districts appointed from the Indian Administrative Services (IAS) cadre, who are officially in charge of the district's performance on policy metrics are transferred frequently, and are not directly politically accountable to the citizens of the districts they serve. For voters to hold governments accountable, it should be possible to assign clear responsibility for government performance (Mehta, 2012). In the IAS, however, administrative decisions inevitably have 'collective legitimacy', making accountability for policy decisions 'notoriously difficult' (Mehta, 2012). However, under the parliamentary system of democracy, MPs are seen as directly responsible to their constituents (Mehta, 2012). MPs are also seen as powerful voices for the constituencies they serve. A study evaluating the disbursal of public goods to disadvantaged social groups in India, analysed data by PCs, and found that MPs were more 'influential' than bureaucrats heading districts (Banerjee & Somanathan, 2007). The authors also noted that while PC boundaries had witnessed limited changes since the 1970s, the number of administrative districts had increased substantially, thus making the former a more consistent unit for historical longitudinal analysis of long standing policies (Banerjee & Somanathan, 2007; Yadav, 2002).

To enable better assessment of performance of the SBM, this article provides estimates of water, sanitation and hygiene (WASH) indicators in India by the country's key electoral and political unit of PCs. Using the recently proposed methodologies linking the National Family Health Survey (NFHS) 2016 data to PCs (Kim et al., 2019; Swaminathan et al., 2019), we estimate the prevalence of poor WASH conditions in each PC and assess heterogeneity in PC variation across states. We hypothesise high PC-level variation in WASH indicators, given the interest some MPs have taken in SBM, and the differential performance of different district administrations within the same PC. Our work identifies priority areas as well as best practice areas, and has direct implications to achieve the national and global targets in improving WASH conditions.

Material and Methods

Data Source

The fourth round of NFHS conducted in 2015–2016 was based on a total sample size of 628,900 households across India. This survey, that covered all 640 districts in India as per the 2011 census, was designed to provide estimates of key indicators related to population health and nutrition at the national, state and district levels (International Institute for Population Sciences, 2007). The rural sample was selected through a two-stage sampling design with villages sampled as the Primary Sampling Units (PSUs) selected with probability proportional to size, and 22 households in each PSU randomly selected as the secondary unit. In urban areas, Census Enumeration Blocks (CEBs) were selected at the first stage, also followed by a random selection of 22 households in each CEB. Urban population accounted for 30–70 per cent of the total district population (International Institute for Population Sciences, 2007).

Study Population

The NFHS-4 sampled 628,900 households of which 616,346 were occupied. In all, 601,509 of these households were successfully interviewed (response rate of 98%). In the interviewed households, 723,875 eligible women of age 15–49 years were identified, of which interviews were completed with 699,686 women, with a response rate of 97 per cent (International Institute for Population Sciences, 2007). Complete data was available for 489,302 women for drinking water source and 489,302 women for sanitary facility. Of 259,627 children less than five years old, sampled in NFHS-4, 245,756 had complete data for stool disposal (International Institute for Population Sciences, 2007).

Outcomes

Our analysis focussed on three indicators of WASH. *Unsafe child stool disposal* has received limited attention in sanitation policy in India with the country's historic focus on household toilet infrastructure (Biran et al., 2012). The WHO defines (child) safe stool disposal as 'when the child uses a toilet/latrine; and/or the faeces is put/rinsed in the toilet/latrine or buried' (Biran et al., 2012). Based on mothers' report in the NFHS-4, if the child's faeces were left in the open/not disposed of, put/rinsed into a drain/ditch, or thrown in the garbage, the disposal was coded as 'unsafe'. The second WASH indicator we assessed was *unimproved water source*. The WHO/UNICEF JMP defines improved sources as those that 'by nature of their construction or through active intervention, are protected from outside contamination, particularly faecal matter' (Biran et al., 2012). We coded drinking water source as 'unimproved' if the household used unprotected well or spring, carts with small tank, tanker trucks, surface water (river, dam, lake, pond, stream, canal and irrigation channels) and bottled water. Lastly, *unimproved sanitary facility* is the indicator that has arguably received the most attention in India's WASH programmes since 1986 (Martel, 2017). An 'unimproved' facility was defined as one that flushed to somewhere other than a piped sewer system, septic tank, or pit latrine, pit latrine without slab/open pit and dry toilet following the WHO/UNICEF JMP definitions (Biran et al., 2012).

Analysis

We generated estimates for WASH indicators at the PC level using recently developed methods to link district or individual level data to PCs in India (Kim et al., 2019; Swaminathan et al., 2019). Specifically, Swaminathan et al. (2019) developed two methodologies to generate PC-level estimations from the NFHS data. In one of these, termed their 'direct method', GPS data for each NFHS-4 cluster location as per its latitude and longitude (accurate to ±15 metres), randomly displaced by a maximum of 2 kilometres for urban clusters and 5 kilometres for rural clusters, were used (Kim et al., 2019; Swaminathan et al., 2019). Swaminathan et al. (2019) generated a GIS map of these cluster points and combined it with the 2014 PC boundary shapefiles from the Community Created Maps of India *(http://projects.datameet.org/maps/)* to link each cluster to a potential PC. Kim et al. (2019) advanced this method using precision weighting based on multilevel regression modelling to estimate and rank India's 543 PCs by key malnutrition indicators also using the NFHS-4 data. They recommended precision-weighted estimation and direct linkage using NFHS-4 cluster GPS data for its simplicity and robustness (Kim et al., 2019). As proposed by Kim et al. (2019), we modelled individual women/children i (level-1) nested within cluster/PSU j (level-2), district k (level-3), and state l (level-4) to first calculate cluster-specific probabilities of the WASH indicators. The precision-weighted cluster data were then directly linked to potential PCs to generate estimates and rankings of 534

PCs for unsafe child disposal and 543 PCs for unimproved drinking water source and unimproved sanitary facility.

After calculating the precision-weighted estimates for each indicator, we conducted the following descriptive analyses. First, we calculated summary statistics (mean, median, interquartile range (IQR)) to describe the distribution of WASH indicators across all PCs in the country. We specifically focussed on the intra-state, between-PC performance. Second, Pearson correlation and Spearman rank correlation were computed to assess whether PCs tend to have poor conditions on multiple indicators. Third, maps were generated based on quintiles of prevalence of each WASH indicator from the PC level estimates to visualise the nationwide heterogeneity. Lastly, we also identified 'positive deviant' PCs for each of the three indicators, defined as PCs with low prevalence of the respective WASH indicators across states (below 25th percentile) nested within states with a high burden of the same indicators (above 75th percentile). Similarly, 'negative deviant' PCs were defined as poor performing PCs nationally with a high burden of each WASH indicator (above 75th percentile), nested in high performing states (below 25th percentile).

Multilevel modelling was performed in the MLwiN 3.0 software program via Monte Carlo Markov Chain (MCMC) methods. Statistical analysis of the PC data was performed on R version 3.2. We used ArcGIS to generate maps from the analysis.

Results

There was very high variation across PCs for all the three WASH indicators (Table 1). Unsafe child stool disposal had a national mean of 63.93 per cent, and ranged between a minimum of 0.95 per cent to a maximum of 95.85 per cent. With a mean of 11.40 per cent, unimproved drinking water source ranged from 0.35 per cent to 64.17 per cent. Unimproved sanitation facility had a national mean of 45.93 per cent and ranged from 0.19 per cent to 90.69 per cent, respectively (Table 1). The distribution of PC-level unsafe child stool disposal was left skewed, implying there were some PCs with considerably lower prevalence of unsafe child stool disposal than most other PCs (Figure 1). The distribution of unimproved drinking facility was right skewed, indicating the presence of a group of PCs with substantially higher proportions of unimproved drinking water sources than other PCs. The distribution of unimproved sanitary facility was approximately symmetrical, thus implying that the number of PCs with unimproved sanitary facilities was fairly uniformly distributed around the median value of the indicator. Across PCs, there was a strong correlation between unsafe child stool disposal and unimproved sanitary facility (Pearson $r = 0.85$, Spearman $r = 0.83$) (Table 2). The correlations between other pairs of indicators was very low (Pearson $r = 0.12$ for unsafe child stool disposal vs unimproved drinking water source; Pearson $r = 0.05$ for unimproved drinking water source vs unimproved sanitary facility). The PC-level WASH estimates are provided in Supplementary Table 1.

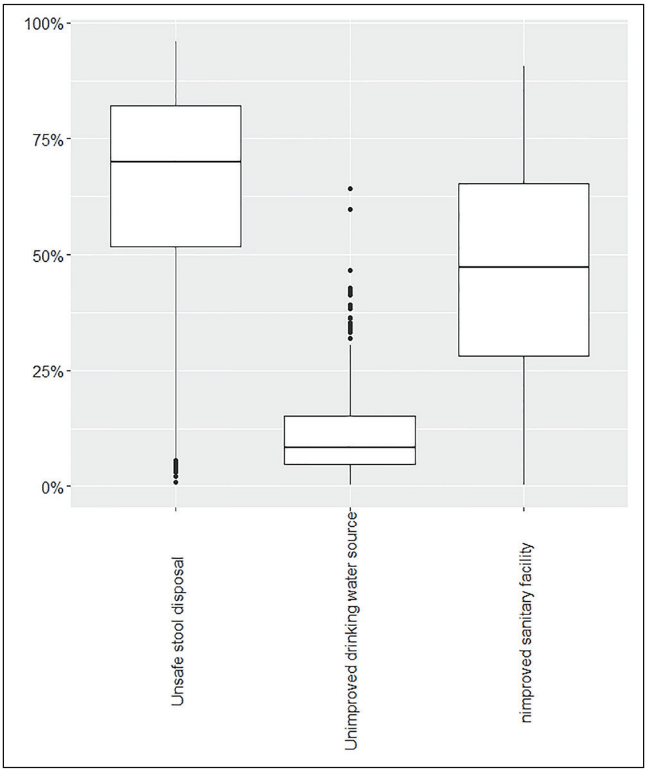


Figure 1. Distribution of Water, Sanitation, and Hygiene (WASH) Indicators Across Parliamentary Constituencies (PCs) Visualised in Box Plots

Source: The authors.

Table 1. Summary of Water, Sanitation, and Hygiene (WASH) Conditions for Parliamentary Constituencies (PCs) in India

Indicator	Min PC	Max PC	Mean PC	Median PC	IQR* PC
Unsafe stool disposal	0.95%	95.85%	63.93%	69.96%	51.64%, 82.17%
Unimproved drinking water source	0.35%	64.17%	11.40%	8.30%	4.77%, 15.08%
Unimproved sanitation	0.19%	90.69%	45.93%	47.29%	28.19%, 65.34%

Source: The authors.

Notes: *IQR (interquartile range) is a measure of statistical dispersion, calculated as the difference between the 75th and 25th percentile values of the respective indicators. It captures the variability in the distribution of the indicator.

Table 2. Correlation Between Water, Sanitation, and Hygiene (WASH) Indicators Across Parliamentary Constituencies (PCs) and Their *p*-Values

	Unsafe Child Stool Disposal	Unimproved Drinking Water Source	Unimproved Sanitary Facility
Pearson coefficient (*p*-values)			
Unsafe child stool disposal	1.00		
Unimproved drinking water source	0.12 (0.0039)	1.00	
Unimproved sanitary facility	0.85 (<0.00001)	0.05 (0.29)	1.00
Spearman coefficient (*p*-values)			
Unsafe child stool disposal	1.00		
Unimproved drinking water source	0.04 (0.39)	1.00	
Unimproved sanitary facility	0.83 (<0.00001)	0.04 (0.39)	1.00

Source: The authors.

Unsafe Stool Disposal

The distribution of prevalence of unsafe stool disposal across PCs within each state are provided in Figure 2, and scatterplots showing state median and within-state IQR values across PCs are presented in Figure 3. PCs in eastern, north-eastern and central India had the highest burden of unsafe stool disposal, particularly in the states of Bihar, Odisha, Jharkhand and Madhya Pradesh (Figure 4). Three PCs in Odisha state, Bargah, 95.85 per cent, Jajapur 95.65 per cent and Kandhamal 95.28 per cent, had the highest burden of unsafe child stool disposal (Supplementary Table 1). PCs in north-eastern, northern and southern India, in Sikkim, Kerala, Chandigarh, Punjab, Delhi and Haryana showed the lowest burden of unsafe stool disposal. Sikkim (0.95%) in north-eastern India and Alappuzha (2.29%) and Ernakulam (3.03%) constituencies in Kerala in the south were the PCs with the lowest burden of unsafe child stool disposal. States with high median values of unsafe child stool disposal generally had higher between-PC variation, indicated by their IQR values (Figure 3). The IQR in the prevalence of unsafe stool disposal was the highest in Maharashtra (IQR = 20.91%), Rajasthan (IQR = 19.99%), and Uttar Pradesh (IQR = 18.17%) (Supplementary Table 2). All these three states are home to several PCs in the top two and bottom two quintiles of prevalence of unsafe child stool disposal (Supplementary Table 1). Four of the five states with the highest IQR values for unsafe stool disposal among their respective PCs, also had high median values for the indicator (50% and higher) (Figure 2). Gujarat was the only state with a median value for unsafe child stool disposal in the bottom 50 per cent that was among the five states with the highest IQRs for the indicator. Six PCs were identified as positive deviants for unsafe child stool disposal, including four constituencies in Uttar Pradesh and two in Telangana. Sultanpur (43.03%), Jaunpur (35.33%), Machhlishahr (47.54%) and Kannauj (51.40%) constituencies in the state of Uttar Pradesh are some examples of these exemplar PCs (Table 3). No negative deviant PCs were identified for unsafe child stool disposal as per this definition.

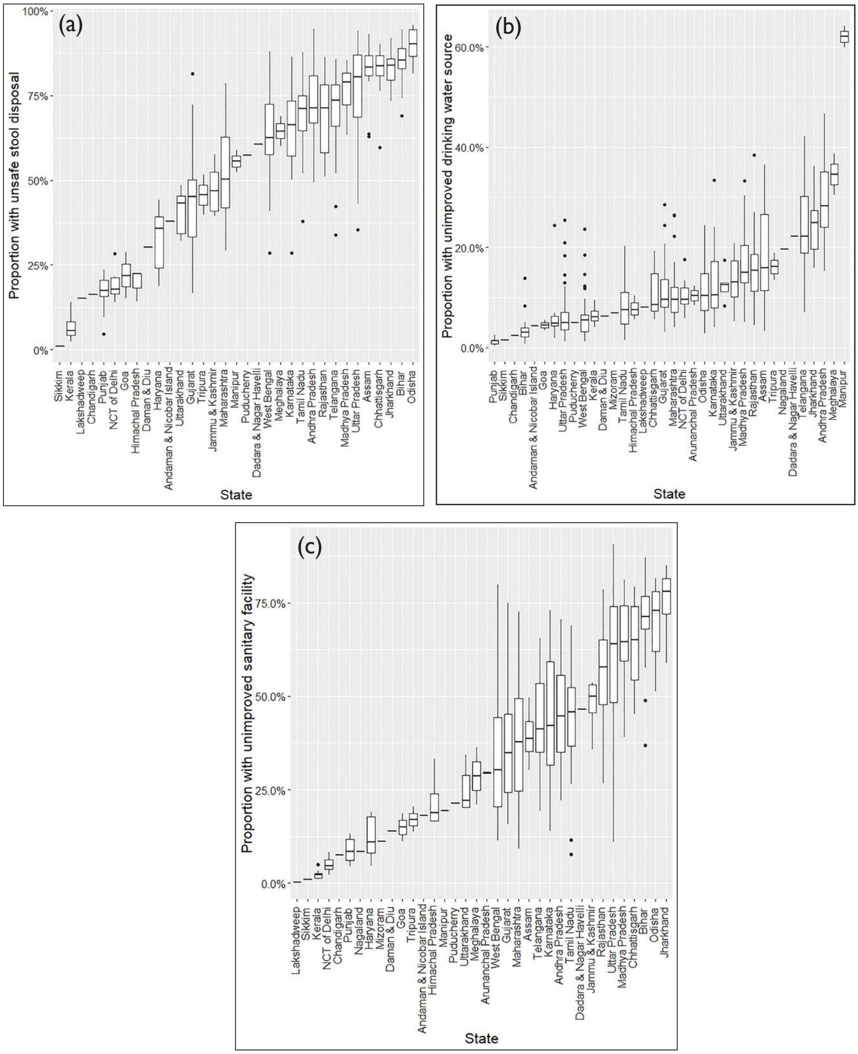


Figure 2. Boxplots Showing the Distribution (Median, Interquartile Range, 95% Range, and Outliers) of (a) Unsafe Child Stool Disposal, (b) Unimproved Drinking Water Source and (c) Unimproved Sanitary Facility Across Parliamentary Constituencies (PCs) Within Each State

Source: The authors.

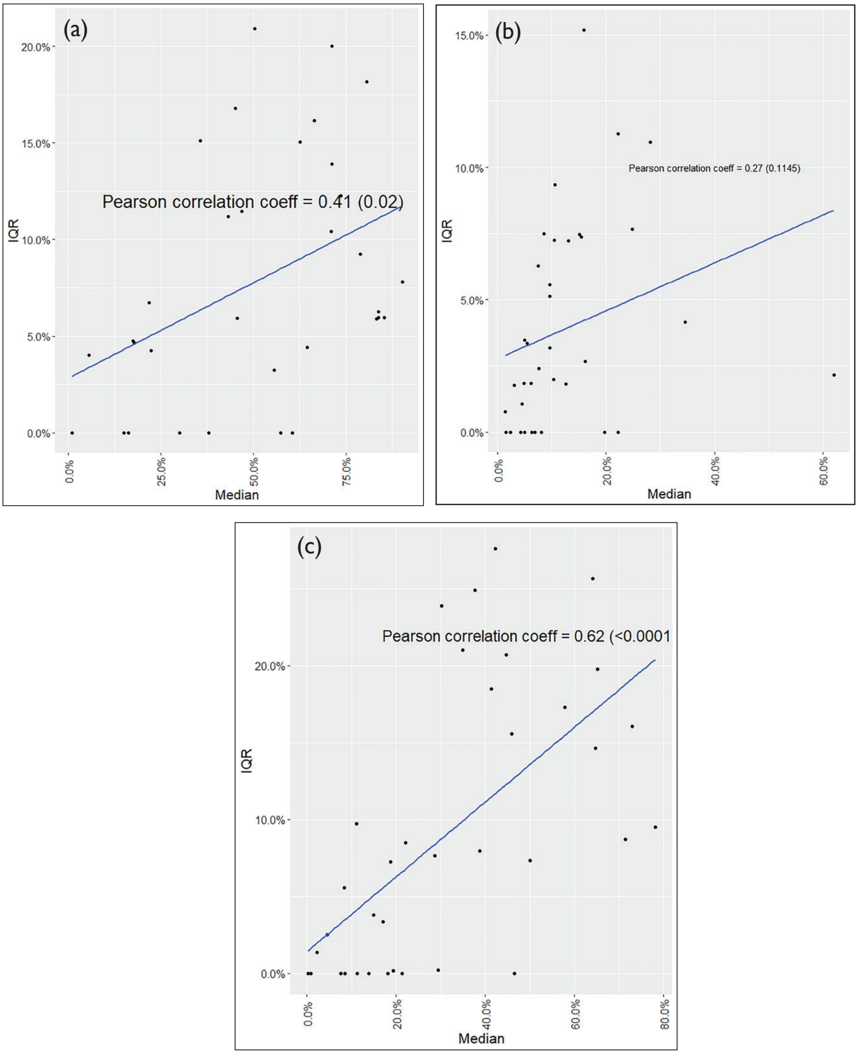


Figure 3. Scatterplots Showing State Median and Within-State Interquartile Range Across Parliamentary Constituencies (PCs) (in %) for (a) Unsafe Child Stool Disposal, (b) Unimproved Drinking Water Source and (c) Unimproved Sanitary Facility

Source: The authors.

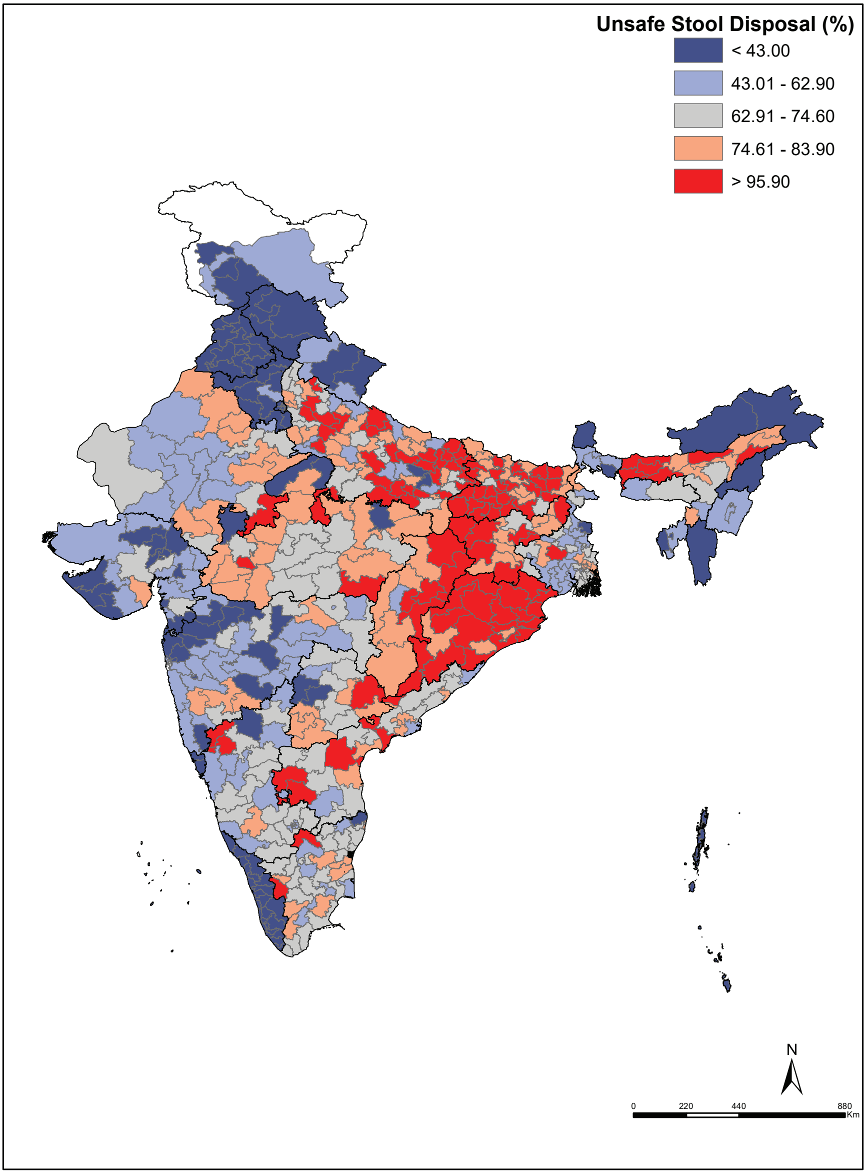
Table 3. List of Positive Deviant Parliamentary Constituencies (PCs), defined as PCs in the National Top 25 Percentiles Nested Within States with Median in the National Bottom 75 Percentiles, in Respect to (a) Unsafe Child Stool Disposal, (b) Unimproved Drinking Water Source, and (c) Unimproved Sanitation Facilities

State Name	PC Name	% in PC	State Median Percentile Nationally	PC Percentile Nationally
(a) unsafe child stool disposal				
Telangana	Zahirabad	42.32	76%	18%
Telangana	Medak	33.93	76%	13%
Uttar Pradesh	Sultanpur	43.03	82%	19%
Uttar Pradesh	Jaunpur	35.33	82%	14%
Uttar Pradesh	Machhlishahr	47.54	82%	22%
Uttar Pradesh	Kannauj	51.50	82%	25%
(b) unimproved drinking water source				
Assam	Jorhat	3.32	85%	14%
(c) unimproved sanitation facilities				
Rajasthan	Jodhpur	26.65	81%	24%
Uttar Pradesh	Pilibhit	25.66	84%	22%
Uttar Pradesh	Domriaganj	22.52	84%	20%
Uttar Pradesh	Fatehpur Sikri	27.01	84%	24%
Uttar Pradesh	Jaunpur	11.04	84%	9%
Uttar Pradesh	Machhlishahr	26.57	84%	24%
Uttar Pradesh	Agra	21.23	84%	19%

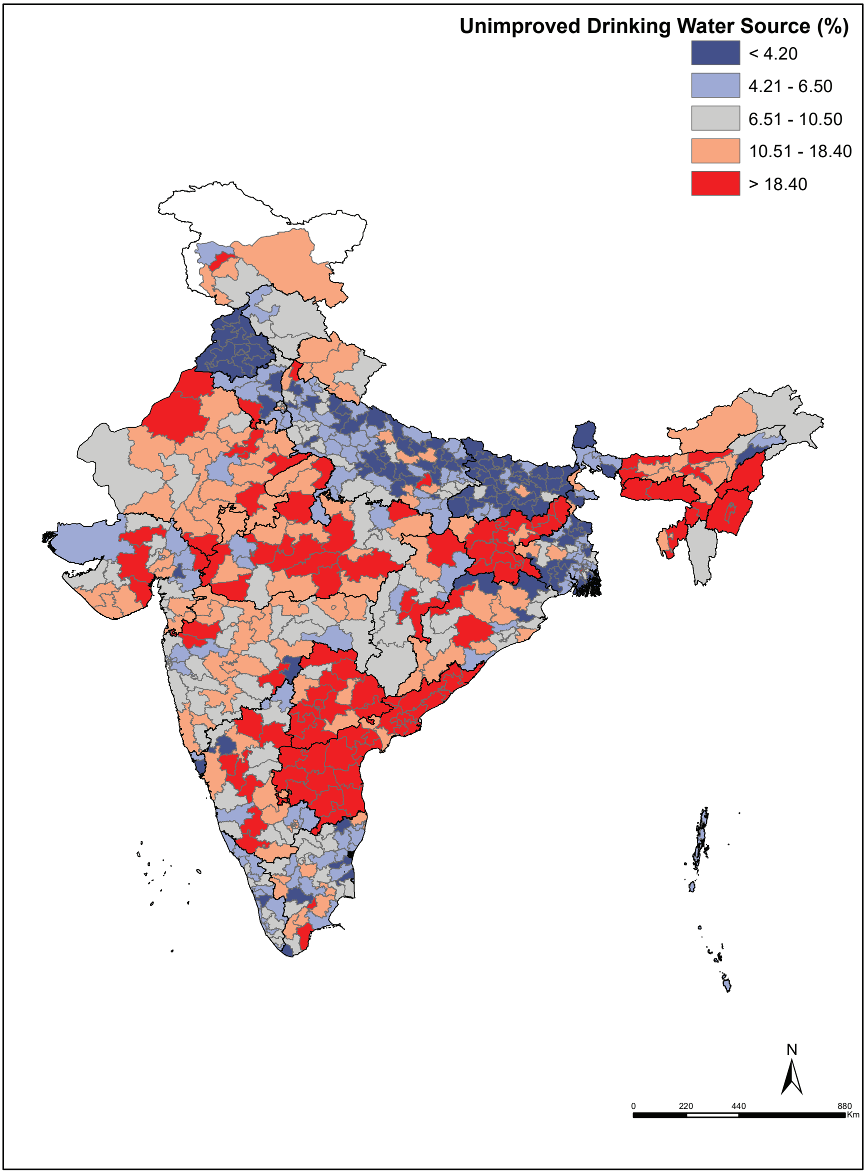
Source: The authors.

Unimproved Drinking Water Source

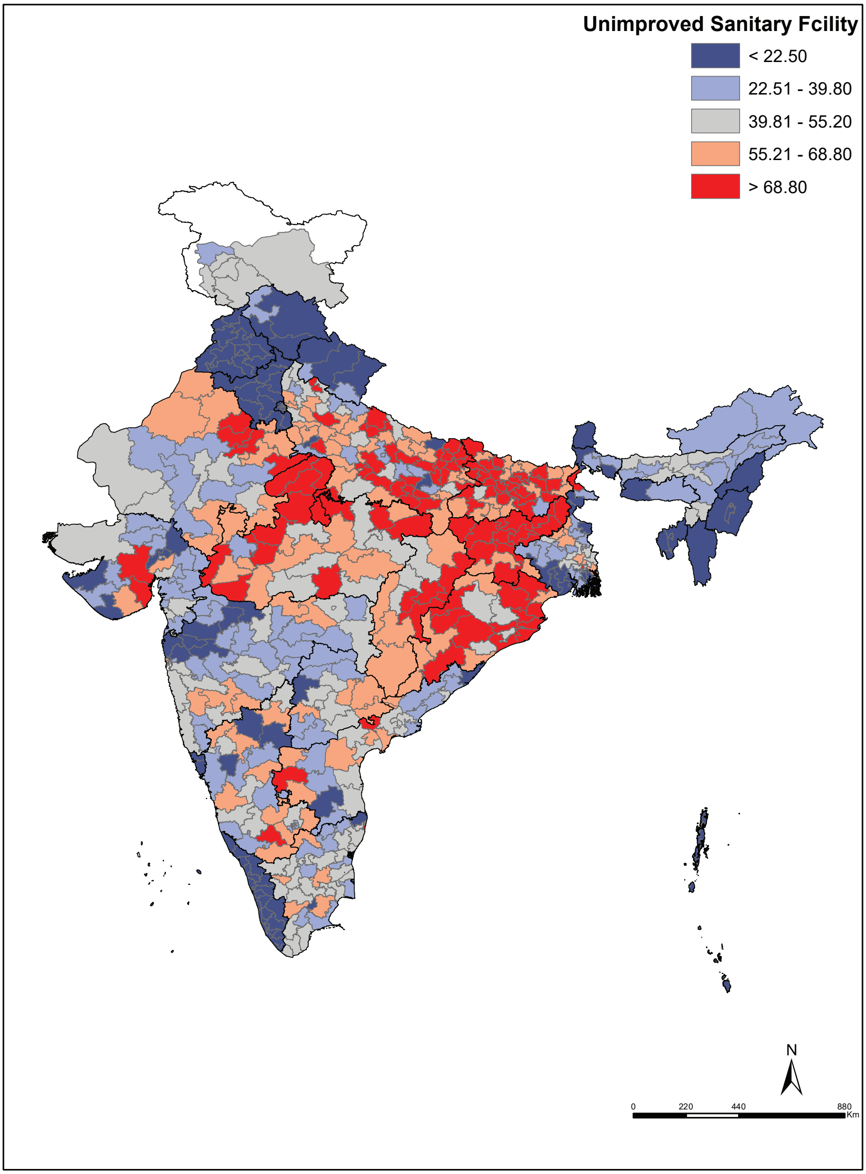
PCs in north-eastern and southern India had the highest burden of unimproved drinking water source, particularly in the states of Manipur, Meghalaya, Andhra Pradesh and Telangana (Figure 4). The PCs with the highest prevalence of unimproved drinking water sources were Inner Manipur (64.17%) and Outer Manipur (59. 86%) in Manipur in north-eastern India; and Kadapa (46.62%) and Kakinada (42.73%) in Andhra Pradesh in the southern part of the country (Supplementary Table 1). PCs in the northern and eastern parts of India had the lowest prevalence of this indicator. Fatehgarh Sahib (0.75%), Ludhiana (0.58%) and Jalandhar (0.35%), all from Punjab state in northern India, comprised the three PCs with the lowest prevalence of this indicator (Supplementary Table 1).



(a) Unsafe Child Stool Disposal



(b) Unimproved Drinking Water Source



(c) Unimproved Sanitation Facilities

Figure 4. Geographic Distribution of (a) Unsafe Child Stool Disposal, (b) Unimproved Drinking Water Source, and (c) Unimproved Sanitation Facilities in Quintiles of Parliamentary Constituencies (PCs) at the National Level

Source: The authors.

States had relatively lower median values for unimproved drinking water, with Manipur being the only state with a national median value for this indicator above 50 per cent in the country. Meghalaya, the state with the second highest median value in the country, trailed at 35 per cent (Figure 2). The states of Andhra Pradesh (10.96%), Telangana (11.27%) and Assam (15.19%) reported the highest between-PC, within-state variation for unimproved drinking water source, with the highest IQR values (Supplementary Table 2). As seen in the scatterplot in Figure 3, some states with lower median values of unimproved drinking water source had comparatively higher IQR values. Manipur appeared to be an extreme outlier with a median prevalence of unimproved drinking water sources of 62.02 per cent. After excluding Manipur from the analysis, there was a strong positive correlation between state IQR and state median values (Supplementary Figure 1). The only positive deviant PC for this indicator was located in Assam (Jorhat PC at 3.32% prevalence of unimproved drinking water source) (Table 3). Four PCs including three in Uttar Pradesh (Saharanpur (25.38%), Kairana (66.25%), Jaunpur (20.91%)) and one in Haryana (Bhiwani-Mahendragarh (24.41%)) were identified as negative deviants for unimproved drinking water source (Table 4).

Unimproved Sanitation Facility

PCs in northern India had the highest burden of unimproved sanitary facilities (Figure 4). Budaun (90.69%) and Ambedkarnagar (89.80%) in Uttar Pradesh in northern India, and Bhagalpur (87.14%) in Bihar in eastern India were the PCs with the highest prevalence of unimproved sanitation facility (Supplementary Table 1). PCs in parts of southern and eastern India had the lowest burden for this indicator (Figure 4). Lakshadweep (0.19%), Sikkim (0.91%) and Idukki (0.96%) and Alappuzha (0.97%) constituencies in Kerala were the PCs with the lowest prevalence of unimproved sanitary facilities (Supplementary Table 1). Maharashtra

Table 4. List of Negative Deviant Parliamentary Constituencies (PCs), Defined as PCs in the National Bottom 25 Percentiles Nested Within States with Median in the National Top 75 Percentiles, in Respect to Unimproved Drinking Water Source

State Name	PC Name	% Unimproved Drinking Water Source in PC	State Median Percentile Nationally	PC Percentile Nationally
Haryana	Bhiwani - Mahendragarh	24.41	17%	90%
Uttar Pradesh	Saharanpur	25.38	20%	91%
Uttar Pradesh	Kairana	18.39	20%	80%
Uttar Pradesh	Jaunpur	20.91	20%	86%

Source: The authors.

Notes: No negative deviants were found for unsafe child stool disposal and unimproved sanitation facilities.

(24.90%), Uttar Pradesh (25.66%) and Karnataka (27.61%) had the highest IQR for unimproved sanitation facility, indicating the highest within-state, between-PC variation (Supplementary Table 2). States with higher national median values for the indicator seemed to have higher IQR values. Of the states with the five highest values of IQR, only one, Uttar Pradesh, had a national median of above 50 per cent (Figure 2). Interestingly, Maharashtra, which seems to perform far better on WASH indicators than Uttar Pradesh, had far more PCs with high burden of unimproved sanitary facilities than Uttar Pradesh (Supplementary Table 1). Seven constituencies, including six in Uttar Pradesh and one in Rajasthan, were identified as positive deviant PCs for this indicator. Of these, Jaunpur and Machhlishahr PCs in Uttar Pradesh (11.04% and 26.57%, respectively) were positive deviants for both unimproved sanitary facility and unsafe child stool disposal (Table 3). Interestingly, Jaunpur, a particularly strong positive outlier for unimproved sanitation facility, was a negative deviant for unimproved drinking water source. Jodhpur PC in Rajasthan (26.65%) was the only positive deviant PC for this indicator from Rajasthan state. No negative PCs were identified for unimproved sanitation facility.

Discussion

This study presents three salient findings. First, we found high correlation between unsafe child stool disposal and unimproved sanitary facility across PCs, indicating that interventions and policies should target hygienic practices and access to toilets jointly. Second, there was a high within-state between-PC variation for all three WASH indicators. This within-state variation tends to be higher in states with higher median values for unsafe child stool disposal and unimproved sanitation facility. This trend was not as clear for unimproved drinking water source, till we eliminated from our analysis, the state of Manipur. As a rare smaller state with a high median value for unimproved drinking water source, Manipur appeared to be an extreme outlier. Lastly, we identified the presence of several positive deviant PCs for all the three WASH indicators, and a few negative deviant PCs for unimproved drinking water source only. Our findings have important implications on informing more efficient resource allocation, increasing political accountability and shifting the unit of data collection to improve WASH parameters. Ultimately our findings can pave the way for achieving national targets outlined in SBM by motivating communities to adopt sustainable sanitation practices and facilities and encouraging cost appropriate technologies for ecologically safe and sustainable sanitation (PMO, India, 2014; Swachh Bharat Mission, Government of India, 2019).

The high correlation across PCs, between two WASH indicators, unsafe child stool disposal and unimproved sanitary facility, implies they can be targeted jointly as a comprehensive unit at the PC level. Converting unimproved hygiene facilities to sanitary household toilets has been a focus of the SBM (PMO, India, 2014). The NFHS-4 also highlighted that children's stools are more likely to be disposed of safely in households with an improved toilet facility than in households with an unimproved or no facility (International Institute for Population Sciences, 2007). Importantly, we also found very low correlation between both unsafe child stool disposal and unimproved drinking water source; and unimproved drinking water source and unimproved sanitary facility, respectively. This possibly speaks to how, historically, improving water coverage on the one hand and overhauling sanitation coverage and stool disposal on the other, have been treated as separate policies instead of a composite one in India (Chaplin, 2011; Martel, 2017). This near dichotomy in sanitation policy is perhaps best exemplified in how Jaunpur PC in Uttar Pradesh is a strong positive deviant PC for both unsafe child stool disposal and unimproved sanitary facility, but a very definitive negative deviant PC for unimproved drinking water source. Clearly, while the PC can be treated as a role model for the former indicators, it has much to improve in the area of unimproved drinking water. Provision of sanitary facilities has been targeted through a range of policies, including the areas of sanitation, rural development and housing, as well as the ministry of human resource development's policies for constructing toilets in schools and *anganwadis* (Martel, 2017). Similarly, improving water coverage has been under different ministries like water resources and river development, among others (Chaplin, 2011; Martel, 2017). Only in May 2019, a new unified Ministry of *Jal Shakti* (Water Power) was created to bring together the erstwhile ministries of water resources, river development and Ganga Rejuvenation, and the Ministry of Drinking Water and Sanitation (India Today, 2019). Thus, parts of India that have improved in water coverage may not have achieved similar strides in sanitation, and vice versa.

There are several factors that may potentially explain the substantial between-PC variation in WASH performance. The effect of home states could be a definitive contributor since states with a higher number of PCs generally had a high between-PC variation in the prevalence of the WASH indicators. We found this trend to stand even in the comparison of IQRs in states with comparative number of PCs (<10, 10–20, 20–30, 30–50, 50+) (Supplementary Table 3). However, there were definite exceptions to the trends between state size and IQR. For example, West Bengal is a relatively small state with high IQR for both unsafe child safe stool disposal and unimproved sanitary facility. Assam is another small state with a high IQR for unimproved drinking water source. States like Karnataka, West Bengal, Rajasthan, Odisha and Maharashtra are interesting in how they are home to PCs in both the top two and bottom two quintiles across the three WASH indicators. Thus, while state size and number of PCs in a state are possible drivers of the observed between-PC variation trends, past studies have highlighted several other possible contributors to the between-PC heterogeneity. Some of these factors include poverty, education, the relative distribution of urban and rural areas, religious and caste-based attitudes towards sanitation and gender roles (Coffey, Spears, & Vyas, 2017; Gupta et al., 2019).

Differential interest taken by legislators in the implementation of WASH programmes in their constituencies could be another contributor to the between-PC variation in WASH performance. Members of Parliament Local Area Development Scheme (MPLADS) is a funding scheme started in 1993, where MPs recommend to administrative officials, annual developmental work of up to ₹5 crore for districts in their respective PCs. Similar to a recent study that hypothesised differential MPLAD spending to be a possible drive of the between-PC variation in performance of nutrition indicators, between-PC variation in WASH parameters could also be partially explained by these spending trends (Swaminathan et al., 2019). For instance, MPs serving PCs in Punjab and West Bengal had the highest sanitation related spending in the 16th Lok Sabha under this scheme (Ahmad, 2019) Other factors like proximity to elections have also been shown to inform the spending recommendations policy areas prioritised by MPs (Blair, 2017). Moreover, some studies have shown that legislators who serve the same constituency for multiple terms perform better on social sector policies including sanitation (Coffey et al., 2017). However, other studies have shown that constituencies served by the same legislators for multiple terms, or by legislators who belong to the same family, perform poorly (Mehta, 2012). The performance of different district administrations within different PCs also likely informs the between-PC heterogeneity. More field research is needed to understand the determinants of between-PC inequality in WASH performance.

The pattern in the association between state median and within-state between-PC variation for different WASH indicators warrants more investigation. We found that states with higher median values generally had higher within-state between-PC variation for unsafe child stool disposal and unimproved sanitary facilities, but the same was not observed for unimproved drinking water sources. However, after excluding the outlier state of Manipur, a strong positive correlation was observed such that states with higher overall burden of unimproved drinking water sources also generally had a higher within-state between-PC variation in WASH outcomes. These trends underline the potential fallacies of using state averages to monitor WASH performance(s). (Subramanian, Kim, & Christakis, 2018). Since our finding highlights that between-PC heterogeneity is especially high for the two indicators critical to the country's current focus to target open defecation in India, namely, unsafe child stool disposal and unimproved sanitary facility, there is a need to study factors driving the variations in WASH performance within states.

This deviation from the mean or median performance of states is illustrated in the positive and negative deviant PCs we identified. As constituencies that perform well despite being nested in poor performing states, the exemplar positive deviant PCs may offer lessons for underperforming constituencies. Future studies should study best practices in these PCs that may be replicated in other parts of the country. That no negative deviant PCs could be identified for unsafe child stool disposal and unimproved sanitary facility highlights how few PCs tend to lag in WASH performances, if their home state does well enough. Negative deviant PCs for unimproved drinking water source highlight the problems that may arise from any oversight of the between-PC variation in WASH performance, in light of high median performance of states. If resources and policy attention for these states are informed by the latter, the inequality between better and poor performing PCs may exacerbate, thus further increasing the between-PC variation for WASH conditions. National water and sanitation policies in India have stressed on states being key partners (Gupta et al., 2019). India's national government funds about 60 per cent of sanitation programmes, with the balance amount contributed by states (Chaplin, 2011; WHO, 2012). Given the wide within-state, between-PC variation in the performance of WASH indicators, if states allocate funds and design implementation around state median (or mean) indicators, PCs within the state that are underperforming may not get the allocations and attention they need.

Since 1986, all national sanitation policies in India have been monitored at the district level. Other recent government initiated sanitation surveys like the National Rural Sanitation Survey (NARSS) have also been based on districts (PMO, India, 2014; Swachh Bharat Mission, Government of India, 2019). Other flagship projects like the National Institute of Transforming India (NITI) Ayog's 'Aspirational Districts' Program in India, focus on improving the implementation of social sector policies in underperforming districts (NITI Aayog, 2018). National surveys like the census and the NFHS also continue to collect data at the district level. However, districts have no tangible political accountability. Indian Administrative Officers who serve as 'district collectors', the administrative heads of districts, are routinely transferred every few years. In comparison, elected members of parliament serve their constituency for five years, or longer, if re-elected (Banerjee & Somanathan, 2007; Mehta, 2012). Moreover, in the federal structure of governance in India, when districts underperform, the central, state and civic level governments each hasten to shift the blame to other levels (Banerjee & Somanathan, 2007). The policies that affect people are delinked from the political processes of the country (Banerjee & Somanathan, 2007; Mehta, 2012).

Taken together, our findings challenge the persisting focus on states and districts as the key units of policy discussion and data collection for health and developmental indicators including WASH in India. In recent reflections about the SBM, India's Prime Minister Narendra Modi has emphasised the importance of political leadership and public participation in sanitation policy (*The Deccan Herald*, 2018). Encouraging the collection of WASH data at PC level then, is a natural progression towards realising these participatory and political functions. This will link administrative data collection and policy performance in India with the country's political and electoral processes. Moving from districts to PCs might also generate a healthy competition between MPs for the performance of their PCs on national policy priorities like WASH. It might also encourage collaborations between MPs of neighbouring constituencies. It is thus recommended that PC-level data be routinely collected and estimated to provide legislators a strong evidence base to evaluate performances of their constituencies.

Limitations

This is an observational study where PC-level estimates were generated from the NFHS-4 clusters that were linked to potential PCs. Given the random displacement of GPS coordinates for the NFHS-4 clusters (i.e., up to 2 km for urban clusters and up to 5 km for rural clusters), there are concerns for potential misclassification. However, the displacement was restricted to be contained within district, and the resulting measurement error is most likely to be random when aggregated (Blossom, Swaminathan, Joe, Kim, & Subramanian, 2019). Nevertheless, field-based PC-level data collection is necessary to validate these findings. Moreover, NFHS-4 indicators on WASH used in this analysis are self-reported and may be prone to different biases of the responders. Since sanitation policy has received considerable media attention in the last five years in India, additional confirmation biases may have been introduced in the responses. The indicators are also crude measures that do not necessarily capture the quality of WASH conditions. Lastly, given the exploratory nature of this work, we did not adjust for covariates related to social, economic and cultural factors associated with individual responders, and/or community-level covariates like administrative budget, social and political history and gender norms that could affect WASH conditions in different PCs. Further, heterogeneity in PC performance could be informed by differential performance of district administrations, which we did not account for.

Conclusion

For perhaps the first time in independent India, sanitation has captured national policy attention in this scale. However, the continued success of any policy in a democracy warrants not only political commitment, but also political accountability. Collecting robust data on the performance of important policies like SBM at the PC level, can provide MPs the evidence base to understand the gaps that require immediate action. This will enable sanitation to be a matter of direct discussion and delivery between the electorate and the elected, thus allowing SBM to continue thriving as the people's movement it was envisaged to be. Furthermore, the high within-state, between-PC variation across three important WASH indicators identified in this study indicates the need to better understand the drivers and implications of between-PC variation in WASH performance. The continued implementation of WASH interventions based on state or district overall performance might blind side critical PC-level heterogeneity.

Declaration of Conflicting Interests

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Contributors' Statement

Chatterjee, Kim, and Subramanian conceptualised and designed the study. Chatterjee led the analysis and interpretation of data and drafted the initial manuscript. Swaminathan and

Kumar contributed to analysis and interpretation of data and reviewed the manuscript for important intellectual content. Kim and Subramanian contributed to analysis and interpretation of data, reviewed the manuscript for important intellectual content and provided overall supervision. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Supplementary Material

The supplementary data for the article is available online.

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