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ACCESS TO RURAL SANITATION IN INDIA: EMPIRICAL EVIDENCE FROM NATIONAL SAMPLE SURVEY

Duryodhan Muduli*

Abstract

This study examines the socioeconomic and demographic determinants of access to sanitation services in rural areas among the major states of India. It employs unit level data from the National Sample Survey Organisation (NSSO) 78th round (2021-22) Multi-Indicator Survey (MIS), encompassing 144,991 households. Utilising the binary logistic regression model, the analysis investigates the influence of household socioeconomic characteristics and regions on the likelihood of accessing safe sanitation facilities. The study reveals that higher income levels, better educational attainment, and socially non-marginalised section households exhibit a positive association with a higher probability of accessing improved sanitation services not shared with any other households. Substantial regional disparities in access to better sanitation were observed, with households in the southern, northern, and western regions demonstrating a greater probability of accessing basic sanitation than those in the eastern region. Thus, the study highlights the need for targeted policy intervention addressing deprivation in accessing improved sanitation facilities in pursuit of closing socio-economic and regional inequality.

Keywords: Access, Sanitation, Rural India, Regional disparity

Introduction

Basic access to sanitation is crucial to public health and sustainable development. Acknowledging the importance of improved sanitation, the UN General Assembly declared it a fundamental right in 2010 (United Nations, 2010). The type of sanitation access significantly impacts the economic, health, and living standards of people (Hutton et al., 2017; Andres et al., 2021). Thus, providing basic human development infrastructure like improved sanitation is indispensable for the overall development of human beings. Especially in developing countries, achieving better standards of living, health, and well-being have become complex and challenging tasks. According to the WHO UNICEF report (2021), approximately 2.8 billion people worldwide lack access to safe sanitation facilities. Furthermore, the World Health Organisation (WHO) has estimated that approximately 2 billion people consume water contaminated with human faeces. This poses a great threat to human health and poses a challenge to achieve universal access to basic sanitation at the global level (SDG 6.2).

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Generally, sanitation is defined as a system that separates and safely disposes of human excreta and urine. Basic access to sanitation facilities refers to the use of improved types of toilet infrastructure not shared with any other household (WHO UNICEF, 2021). The improved toilets include flush-to-piped sewer systems, septic tanks, pit latrines, pit latrines with slabs, and composting toilets. Thus, using unimproved toilets, such as flush/pour flush to elsewhere (open drain, open pit, open field, etc.), pit latrines without slab/open pits, and other (hanging latrines), and open defecation practices are highly associated with diarrhoea prevalence, especially in children under 5 years of age, resulting in repeated intestinal infections causing malnutrition, and poor physical growth (Bartram et al., 2005).

Considering the importance and need for basic access to sanitation, in 2015, the United Nations introduced the Sustainable Development Goals (SDGs). SDG 6.2 strives to achieve universal access to improved sanitation services across the globe (United Nations, 2024). It means making efforts to meet the challenges of the SDG Agenda 2030, which aims to achieve complete elimination of open defecation. Amidst the excessive prevalence of open defecation, India also introduced Swachh Bharat Abhiyan (SBA) in 2014 to make India open defecation-free (ODF) by 2019 (PIB GoI Ministry of Jal Shakti 2022). According to a report by the Ministry of Jal Shakti, Government of India, all villages declared themselves Open Defecation-free (ODF) and made India ODF on October 2, 2019. However, the report of the National Annual Rural Sanitation Survey 2019-20 (NARSS) highlighted the discrepancies between the claims of the government of India and the results reported by the survey (NARSS GoI, 2019-20). During 2021-22, the publication of the National Family Health Survey round-5 (NFHS-5) 2019-21 reinforced the false claim of ODF status in India (NFHS 2019-21).

The persistent challenges associated with open defecation practices and inequality in access to better sanitation facilities across socioeconomic and demographic groups of the population have emerged as a bigger threat for developing countries such as India, where a major proportion of the population belongs to the poor and marginalised sections in society. Several government programmes have been implemented to eradicate open defecation and ensure equality in access to improved sanitation all over India. Some of the recent plans and policies include the Central Rural Sanitation Programme (CRSP), the Community Led Total Sanitation (CLTS) scheme, and the Swachh Bharat Mission (SBM). To ensure effective implementation of the sanitation programme, it is necessary to monitor the programme with respect to its primary objectives.

Any policy or programme intervention must strive to identify vulnerable groups in the population and improve access to basic sanitation services. Therefore, there is an urgent need to assess the status of access to basic sanitation and identify the factors that determine accessibility. Numerous studies have explored the determinants of access to basic sanitation services globally. However, studies on the determinants of sanitation in rural India are limited. Existing studies have been limited to state-level analyses (Tiwari & Nayak, 2013) and urban households (Poonia & Punia, 2019). Furthermore, studies that are old and outdated cannot provide an extensive evaluation of access to safe sanitation in India. The present study fills the research gap in determining the socioeconomic and demographic factors of household access to sanitation services in rural areas across the major states of India.

Review of Literature

This section is an attempt to describe various strategies followed under different sanitation programmes in India since independence. Further, it discusses various literature exploring the drivers and barriers of access to sanitation and the prevalence of open defecation in rural India. A summary of sanitation programmes in the recent past and supporting literature and reports on monitoring and assessment enables insightful information on the distribution of sanitation facilities across various heterogeneous socio-economic and demographic groups, like castes, religions, wealth/income groups, different age groups, genders, disabilities, different education levels, etc. Following a structured framework, this section is divided into the following sub sections including a review of sanitation policy in post-independence period, the Central Rural Sanitation Programme which follows a subsidy driven approach to provide sanitation facility, Total Sanitation Campaign (TSC) based on the community participation approach, Nirmal Bharat Abhiyan (NBA) following an integrated and convergence approach, and Swachh Bharat Mission (Clean India Mission) based on sustainable sanitation and demand-driven approach to sanitation policy. Apart from that, socio-economic, demographic and geographic factors influencing household sanitation are also critically discussed in this section below.

Access to Sanitation during the Five-year Plans Period

The Environmental Hygiene Committee formed during 1948-49 recommended a plan to provide water supply and sanitation in India, along with certain areas with the utmost priority. However, no efforts were made in this regard. In 1954, during the first five-year plan, the country had started its first ever national water supply and sanitation programme as part of the government's health plan (Kulkarni et al., 2022). Since the country was at the inception phase of its development process, building institutional systems at the administrative level was more important for the successful delivery of water supply and sanitation. Thus, the execution and implementation of the programme marked a failure specifically attributed to the lack of public health engineering (Kedia M et al., 2022). In the subsequent five-year plan period, funding was provided to strengthen the State Public Health Engineering Department (PHED), but due to very low fund allocation for rural areas, the country witnessed a poor performance in providing sanitation services. This poor progress in sanitation access is substantiated by the fact that only 1 per cent of the rural population had sanitation access by 1980 (Bharat et al., 2020). Thus, until 1986, there was no such explicit sanitation programme implemented in India to curb the rural sanitation problem.

Subsidy-driven Approach

In 1986, the government of India implemented its first-ever nationwide rural sanitation programme, called the Central Rural Sanitation Programme (CRSP). The programme aimed to accelerate rural sanitation coverage in India and followed a supply-driven approach by providing a 100 per cent subsidy for the construction of toilets, with a special focus on double-pit pour-flush toilets. The programme also marked an institutional shift; the responsibility of rural sanitation, regulated by the Central Public Health and Environmental Engineering Organisation, had been transferred to the Ministry of Rural Development (MoRD, 2011). Furthermore, this significant institutional change paves the way to introduce the notion of

'total sanitation,' which follows a more comprehensive and broad definition of sanitation, stressing environmental hygiene and considering sanitation beyond household toilets, including school & institutional sanitation, and sanitation value chains, such as solid/liquid waste management. Focusing on creating awareness about sanitation usage, a mass-level campaign approach was initiated. However, in spite of such efforts, the country managed to raise household toilet coverage by only 1 per cent per year. Thus, the status of toilet coverage during the 2001 census stood at just 22 per cent for rural India (MoRD, 2011).

Fulfilling the requirement of monitoring and assessing the sanitation programme, in 1996-97, the government of India had made an attempt and revealed that there was an urgency to raise awareness about access to improved sanitation through education and communication rather than just providing a subsidy for toilet construction. This lack of demand for toilets resulted in a slower rate of increase in access to toilet facilities in rural India. On the other hand, lower levels of education, inaccessibility to information on hygiene and sanitation, lack of promotion of sanitation in general, lack of availability of open space for defecation purposes, lack of markets for hardware, and inadequate infrastructure to provide skilled masons or technicians to build well-designed toilets in particular play a huge role in the slower rate of decreasing open defecation in India (Ganguly et al., 2012). Thus, India failed to achieve the predetermined targets for rural sanitation, attributed to a lack of demand for household sanitation.

Community Participation Approach

The Total Sanitation Campaign (TSC) was launched in 1999 by the government of India with the support of the World Bank. This programme targeted accelerating rural sanitation coverage and attained the status of clean village. Moreover, it focuses on raising awareness and community participation following a demand-driven strategy rather than an infrastructure-centric strategy (supply-driven approach). One of the main instruments for demand generation for sanitation was information, education, and communication (IEC). Further, to encourage the masses to adopt sanitation behaviour and contribute to achieving an open defecation-free environment, Nirmal Gram Puraskar was awarded as part of the incentive to the Gram Panchayat by the government of India in October 2003 (MoRD, 2007). Under this programme, masons were also trained to build well-designed toilet infrastructure, and building materials were arranged at the marketplaces, such as rural sanitary marts and production centres. Thus, TSC tried to overcome most of the issues that hindered implementation during CRSP.

Due to underutilisation of available funds, the TSC failed to achieve its targets, and household toilet coverage only rose from 22 per cent in 2001 to 31 per cent in 2011. Apart from these, lack of initiatives by local self-government, lack of community participation, lack of awareness, and lower numbers of individual toilet construction and community toilet construction were found to be major reasons for underutilisation of available resources (Hueso et al., 2013). Further, the same study revealed the ineffective implementation of the TSC sanitation programme in rural India (Hueso et al., 2013). Although, in principle, TSC was a demand-driven, community-centric sanitation programme, it is far different from the guiding principles. In practice, the programme is a supply-led, infrastructure-centric, government-led, subsidy-based sanitation programme, which resulted in poor sanitation performance in rural India. This discrepancy between theory and practice is attributed to low political priorities, distorted

monitoring and accountability, technocratic and paternalistic inertia, and corruption (Kulkarni et al., 2022). Another study by Gupta (2008) discovered that many of the households responded that the reasons for not constructing a toilet were lack of money/funds, feeling of no necessity, and lack of knowledge (Gupta et al., 2008). Hence, the programme failed to create potential demand for household sanitation.

Another effort made towards ensuring a clean village is the introduction of Nirmal Gram Puraskar (NGP) by the government of India to acknowledge the achievement of villages and award them with the status of open defecation-free village. As per the report of the Ministry of Rural Development (MoRD), in 2004 about 28,002 gram panchayats were awarded with clean village status. And the 2011 census report highlighted that the population having access to a toilet in India stood at 47 per cent, whereas rural area toilet coverage recorded only 30 per cent of the population. This fact is reaffirmed by another report from the World Health Organisation (WHO) and the UNICEF Joint Monitoring Program (WHO UNICEF JMP, 2012).

This uncovers the issue of unsustainable sanitation in rural areas. The reasons accounted for were poor construction, dysfunctional toilet construction, lack of water at the place of the toilet, lack of awareness among people, and low maintenance of the toilet infrastructure (Sengupta et al., 2017; Hueso et al., 2013).

Integrated and Convergence Approach

Even after huge efforts and large investments through various programmes, as discussed above, the government of India is unable to achieve open defecation-free status. After experiencing failure in achieving targets of TSC, another sanitation programme was launched in 2012 named Nirmal Bharat Abhiyan (NBA) (MoRD, 2011). Complementing the partially achieved targets of the previous sanitation programme, NBA aimed to achieve 100 per cent sanitation coverage in rural India by 2022 (NBA GoI, 2012; Seth et al., 2023). The programme kept continuing following the strategy of a community-led and people-centric approach, the same as TSC. The main focus was on sustainable behaviour change and IEC activities. Moreover, financial assistance was continued to be given for the construction of toilets, giving an additional push toward the targets and raising the community and collective behaviour change in rural areas (Routray et al., 2017). This community participation approach of the sanitation and hygiene programme had proved to be very effective in African countries (Tseklevs et al., 2022). In India, compared to the previous sanitation programme, NBA had a broader vision to achieve environmental hygiene in rural villages by capturing more beneficiaries, including the non-creamy layer of PAL families along with BPL families, small farmers, landless labourers, physically handicapped people, and women as the sole earners of the family. The programme was implemented with the involvement of Panchayati Raj Institutions (PRIs), Non-government Organisations (NGOs), and rural communities. Another important merit point of NBA was adopting the strategy of convergence of programmes with various schemes such as Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Sarva Shiksha Abhiyan (SSA), National Rural Health Mission (NRHM), Indira Awaas Yojana (IAY), and National Rural Livelihood Mission (NRLM). It is reported that even such an innovative strategy failed to sustain the NBA programme, which is highlighted by the fact that only 6 per cent of the toilets were constructed in convergence (Kulkarni et al., 2022). Additionally, the problem of identifying potential beneficiaries in villages amounts

to the reasons for failure of this particular sanitation programme in rural India. Apart from this, caste, gender, and local politics become impediments to the creation of demand for sanitation and effective implementation of NBA (Seth et al., 2023; Routray et al., 2017; Kulkarni A et al., 2022).

NBA in India failed to achieve the predetermined targets mainly due to the misalignment between the planning of the programme, its implementation on the ground, and the targeted population (Routray et al., 2017). For NBA, unlike other sanitation programmes in India, the duration of implementation was very short, which might have caused it to fail to achieve an impactful result in rural India. Soon after, in 2014, NBA was renamed as Swachh Bharat Mission (Clean India Mission) with a target of achieving an open defecation-free India by 2019.

Behaviour Change and Sustainable Sanitation Approach

The provision of basic human development infrastructure for all and challenges pertaining to achieving basic human rights to sanitation around the world, consequently inequality in access to basic needs of human life, i.e., drinking water and sanitation, have gained much attention with the introduction of sustainable development goals by the United Nations. In addition to this, the consistent failure of sanitation programmes in India triggered the undertaking of an initiative resolving rural sanitation by addressing the problem of behaviour change and unsustainable, unaffordable, and inadequate toilets. In 2014, the government of India launched its flagship mission—Swachh Bharat Mission—with an optimistic aim of achieving universal access to sustainable sanitation facilities and eliminating open defecation in India. With the help of strong financial and technical support from the World Bank, India has launched its biggest behaviour change campaign. Under this scheme, households receive an incentive of 12,000 rupees for each constructed toilet. It targeted to achieve an open defecation-free India by 2019. The Department of Drinking Water and Sanitation, Government of India survey report (NARSS, 2018-19) demonstrates that since the implementation of the Swachh Bharat Mission Gramin (SBM rural), there is a reduction of open defecation by 94 per cent. The government also claimed the construction of 9.2 crore toilets and declared India as Open Defecation-free (ODF) on 2nd October, 2019.

The flagship mission of rural sanitation has no doubt helped in reducing open defecation by providing Individual Household Latrines (IHHL) (Spears et al., 2017); besides that, a reduction in the instances of sexual harassment against women has been reported (Kanika et al., 2020). There is much other literature and recent survey reports that demonstrate that there has been a rapid increase in toilet coverage in India (Spears et al., 2017; Seth et al., 2024; Prakash et al., 2022). Yet, this increasing coverage of household toilets does not necessarily imply regular usage of the facility and consequently fails to realise the public health gains attributed to the infrastructural and socio-behavioural challenges (Saith et al., 2018). The challenges related to infrastructure highlight poor toilet construction when it is outsourced to a third party, lack of knowledge on usage, and poor maintenance, which leads to unsustainable sanitation in rural India (Rajendrakumar et al., 2025; Tiwari et al., 2022). Manual pit emptying in rural India reinforces the caste hierarchy and social inequality in the society (Coffey et al., 2017; Kulkarni et al., 2022).

Socio-economic and Demographic Factors Influencing Access to Sanitation

There are several pieces of literature which have already identified the socio-economic, demographic and geographic factors influencing access to safe sanitation in India and as well as other countries around the world. In India, studies mostly revolve around the secondary data extracted from Indian Human Development Survey (IHDS), National Family Health Survey (NFHS), and National Statistical Survey (NSS). Apart from that, many of the studies have also used information available in the Ministry of Jal Shakti, Department of Drinking Water and Sanitation.

Regular monitoring and assessment of sanitation programmes helps policy makers understand the current status of targets and take necessary actions to achieve the goal. Social and economic inequality influences access to sanitation services in lower and middle income countries, with India's unique socio-economic heterogeneity playing a significant role. Studies by Guran (2023), Kumar (2015), Aneesh (2021), Mondal (2022), and Ashrit (2024), using various secondary data sources, attempted to explore the factors influencing sanitation facilities in India and found out that income level, social indicators like caste, religion etc, place of residence, gender of household head, age and other related factors like dignity, privacy, and shame are the major ones. However, the existence of disparity in usage of improved sanitation facilities is still higher among the socially and economically better-off section compared to the vulnerable section of the population (Derejo et al., 2022; Gaffan et al., 2022; Jia et al., 2025; Dickin et al., 2021). Further, access to sanitation facility and prevalence of open defecation follows a spatial pattern among Indian districts, with states like Odisha, Jharkhand, Tripura, Assam, and Rajasthan lagging behind in achieving universal sanitation coverage of SDG 6.2 (Roy et al., 2023; Biswas et al., 2024). Apart from regional aspects, there are many more studies which have highlighted similar findings uncovering the socioeconomic correlates of sanitation service in India (Seth et al., 2021; Rahul et al., 2022; Abubakar et al., 2017; Jain et al., 2023).

Various studies exploring various aspects of socioeconomic, regional, demographic dimensions associated with the sanitation programme implemented in India also highlighted structural, psychological, educational, cultural factors responsible for slow progress in sanitation access and slower decline in open defecation in India in the last two decades (Novotny et al., 2018; Gupta et al., 2019; Chaudhury et al., 2023; Pachori et al., 2016).

Based on the above literature, it is observed that having a basic sanitation facility is very much instrumental in shaping physical, mental health, and also environmental health. Moreover, the post-Covid era is influencing the hygienic behaviour of people all over the globe, and the notion of physical distancing has been a catalyst in shaping the toilet usage of the people irrespective of the place of residence, the social identity (caste, religion, and ethnicity, etc.), the age of the individual, the gender, and the income group. Rural areas are characterised by higher poverty and low levels of human development indicators, coupled with a high prevalence of open defecation practices. Hence, they influence the human development of people living in rural areas. Hence, it is imperative to assess the status of access to basic sanitation services and the underlying factors associated with it. The study contributes to the existing literature in terms of monitoring the toilet usage in rural Indian states and explore its socio-economic and demographic determinants. Further, an in-depth analysis of the influence of gender of household head

interacting with other socio-economic indicators uncover a gender aspect of sanitation coverage in rural India. Exploring the same aspect of determinants of sanitation in rural India, makes the study unique and different. Thus, the study tries to explore socio-economic determinants of rural sanitation with a special focus on the gender of the head of household.

Data and Methodology

This study used information on household access to sanitation and other amenities, along with other socioeconomic and demographic characteristics. Information on about 144,991 households is collected from the NSSO 78th round 2021-22 Multi Indicators Survey (MIS). Only the major states of India are considered for the analysis. The study excludes northeastern states because their peculiar geographical characteristics are different from those of the major states (Dasgupta & Roy et al., 2021; NITI Ayog, 2018). The union territories are also excluded from the analysis because they follow governance patterns that are different from the states of India (Jain et al., 2018).

Outcome Variable

The primary dependent variable was basic access to sanitation in the major states of India. Based on the categorical nature of the dependent variables it is coded as '1' if there is access and '0' if there is no access.

In the present study, access to basic sanitation refers to the usage of improved toilet facilities that are not shared with any other households. Improved toilets where there is sharing with other households are considered below basic access, which is usually referred to as limited access to sanitation. This study focused only on basic access to sanitation facilities.

Explanatory Variables

The study examines how different socio-economic variables are associated with the basic access to sanitation services in rural India. Various theoretically relevant socioeconomic explanatory variables were included in the analysis, such as consumption expenditure, gender of the head of household, education of the head of household, caste categories, age and household size. Considering consumption expenditure as the proxy of economic status of a household, it is divided into three categories, namely poor, middle, and rich, by K-means clustering method. This K-means clustering method divides the whole sample into three equal groups based on the consumption expenditure given in the data set. Further, to explore the association of different geographical regions with accessibility of sanitation services, these regions are included in the study. The variable region is classified into eastern, western, northern, central and southern regions based on the location of the major states. Eastern region includes states like Odisha, Bihar, Jharkhand, Assam, West Bengal, while the western region states are Rajasthan, Maharashtra, Gujarat, and the northern region comprises Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Uttar Pradesh, Punjab, Haryana; Madhya Pradesh and Chhattisgarh are considered as part of the central region. The southern region states are Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, and Telangana.

Table 1: A Detailed Description of the Outcome and Explanatory Variable Used in the Study

Outcome Variable	Description
Sanitation	Improved: types of toilet facility include flush/pour flush into piped sewer system, septic tanks, twin leach pits, single pits, ventilated improved pit latrines, pit latrines with slabs, and composting latrines. Unimproved: toilet with flush or pour flush to somewhere else (open drain, open pit, open field), no toilet facility/open defecation
Explanatory Variables	Description
Income groups	(i) Poor, (ii) Middle, (iii) Rich
Gender of head of household	(i) Male, (ii) Female
Education of head of household	(i) No formal education/illiteracy, (ii) Primary, (iii) Secondary, (iv) Higher secondary
Social Categories	(i) Scheduled caste, (ii) Scheduled tribe, (iii) Other Backward Class (OBC), (iv) Others
Drinking water sources	(i) Improved sources: piped into dwelling, yard/plot, public tap/standpipe, tubewell, borewell, protected dug well, protected spring, rain water, bottled water, water tanker truck/cart (ii) Unimproved sources: Unprotected well, unprotected spring, surface water sources (lake, canal, pond, rivers and others)
Sufficiency of water	(i) Yes, (ii) No
Regions	(i) Eastern states, (ii) Western, (iii) Northern, (iv) Central, (v) Southern

Statistical Analysis

To explore the socio-economic factors associated with basic access to sanitation the study has carried out the following statistical estimation. The study includes the descriptive statistics (frequency and percentage) given for all dependent variables and explanatory variables. Then, Pearson Chi-square test was used to test whether there is statistically significant relationship between the dependent variables (basic access to sanitation service) and household socioeconomic, demographic and geographic factors. Binary logistic regression model is applied to identify the associated explanatory factors with basic access to sanitation. Further, in order to examine the underlying socioeconomic indicators influencing basic access to sanitation in each region of India, binary logistic regression is applied in each of the regions. The statistical analysis result was presented as table and summary statistics in odds ratio and marginal effects with significance level. The statistical analysis was done using Stata 17.

Statistical modelling of access to basic sanitation (categorical dependent variable) is explained by socioeconomic and geographical indicators (independent variables). Logistic regression model is applied to examine the association between dependent and independent variables.

$$\text{Let } p_i = \text{pr} \left(y = \frac{1}{x=x_i} \right)$$

P_i is the probability of access to basic sanitation, this model can be written as

$$\log \left(\frac{p_i}{1-p_i} \right) = \text{logit} (p_i) = \beta_0 + \beta_i x_i$$

The above equation is simple representation with one independent variable. Here, p_i is the probability of having basic access to sanitation, and x_i is the vector of independent variables. For example, if x_i is the rich income group. When $x_i = 1$ rich income household, β_1 shows the log of odds of obtaining basic sanitation in case of rich income household. We can write the pattern in terms of odds as:

$$\log \left(\frac{p_i}{1-p_i} \right) = \exp (\beta_0 + \beta_i x_i)$$

Or in terms of the chance of the outcome (e.g. access to basic sanitation) occurring as:

$$p_i = \exp (\beta_0 + \beta_i x_i) / (1 + \exp (\beta_0 + \beta_i x_i))$$

All the explanatory variables are taken into consideration based on the empirical literature available. The result section illustrates the descriptive analysis and logistic regression result of the association between access to basic sanitation and household socioeconomic indicators in rural India.

Empirical Results and Discussion

Descriptive Statistics

This section discusses the percentage of the sampled households having access to basic drinking water, sanitation and hygiene services in rural India across different socioeconomic and demographic variables. The values were validated with the chi-square test, which is the sum of the difference between the observed and expected categorical response between two or more independent groups; the larger the value, the larger will be the difference, and vice versa.

Table 2: Percentage of the Population having Access to Basic Sanitation Services

Variables	Frequency percentage (N= 626,824)	Access (In %) (N= 421,863)	No access (In %) (N= 204,961)
Sanitation		67.30	32.7
Income Groups			
Poor	31.72	57.56	42.44
Middle	32.55	68.28	31.72
Rich	35.74	80.15	19.85
<i>Pearson chi-square statistics</i>		$\chi^2= 2.7e+04^{***}$	
Gender of the head of the household			
Male	87.70	67.23	32.77
Female	12.81	65.07	37.00
<i>Pearson chi-square statistics</i>		$\chi^2= 47.3358^{***}$	
Education of the head of the household			
No formal Education/Illiteracy	37.76	63.25	36.75
Primary	23.12	69	31
Secondary	34.11	73.79	26.21
Higher Secondary	5	83.93	16.07
<i>Pearson chi-square statistics</i>		$\chi^2= 1.1e+04^{***}$	
Social Category			
Scheduled tribe	11.41	57.11	42.89
Scheduled caste	23.54	63.43	36.57
Other Backward Class (OBC)	45.06	71.05	28.95
Others	19.99	78.34	21.66
<i>Pearson chi-square statistics</i>		$\chi^2= 1.5e+04^{***}$	

Drinking water sources			
Improved	95.28	69.45	30.55
Unimproved	4.72	62.47	37.53
<i>Pearson chi-square statistics</i>		$\chi^2= 1.0e+03^{***}$	
Sufficiency of water			
Sufficient	91.55	69.83	30.17
Not Sufficient	8.45	61.44	38.56
<i>Pearson chi-square statistics</i>		$\chi^2= 2.3e+03^{***}$	
Regions			
Eastern	29.34	59.08	40.92
Western	17.88	71.81	28.19
Northern	25.92	72.84	27.16
Central	8.92	67	33
Southern	17.94	78	22
<i>Pearson chi-square statistics</i>		$\chi^2= 1.4e+04^{***}$	

Source: Author's Calculation using NSSO -78th Round Data, N= Total sample

The association between household access to sanitation facilities, wealth categories, gender of the head of the household, social category, highest level of education of the head of the household, and different geographical regions are presented in Table 2.

Access to basic sanitation facilities in rural India varies significantly based on socioeconomic and regional factors. Wealth is a key determinant, with a progressive rise in access among poor, middle, and rich income groups. The gender of the household head also affects access. Scheduled tribe people are the most vulnerable, with only 57.11% accessibility. Scheduled caste, Other Backward Class, and Others have higher accessibility. Regional differences also exist, with southern states having higher access. Overall, access to sanitation services is severely influenced by these factors.

Table 3: Percentage of Population having Access to Basic Sanitation Services across Different Regions in India

Variables	Eastern Region (N=187125)	Western Region (N=121249)	Northern Region (N=146087)	Central Region (N=53026)	Southern Region (N=119337)
Income Groups					
Poor	50.69	65.18	58.53	59.98	69.09
Middle	62.49	68.76	68.76	70.49	75.79
Rich	71.84	76.74	84.6	76.28	84.94
<i>Pearson chi-square statistics</i>	<i>6.80E+03***</i>	<i>1.60E+03***</i>	<i>8.00E+03***</i>	<i>694.1999***</i>	<i>4.50E+03***</i>
Gender of the head of the household					
Male	57.45	70.63	70.29	64.21	77.37
Female	53.6	65.41	67.68	56.92	74.1
<i>Pearson chi-square statistics</i>	<i>37.9407***</i>	<i>20.5575***</i>	<i>11.3883***</i>	<i>8.5196***</i>	<i>44.3288***</i>
Education of the head of the household					
No formal Education/Illiteracy	50.73	64.39	69.53	65.28	71.57
Primary	61.43	70.12	70.87	67.62	79.54
Secondary	64.57	78.16	75.52	68.22	84.36
Higher Secondary	76.59	87.79	84.62	79.33	91.13
<i>Pearson chi-square statistics</i>	<i>4.90E+03***</i>	<i>2.90E+03***</i>	<i>958.3432***</i>	<i>216.7196***</i>	<i>2.80E+03***</i>
Social Category					
Scheduled tribe	53.09	53.25	69.31	62.63	64.19
Scheduled caste	52.68	64.74	69.01	66.53	69.29
OBC	59.33	77.41	69.95	71.2	80.42
Others	68.22	82.27	84.36	66.26	90.67
<i>Pearson chi-square statistics</i>	<i>3.40E+03***</i>	<i>5.20E+03***</i>	<i>3.00E+03***</i>	<i>129.7838***</i>	<i>5.30E+03***</i>
Drinking water sources					
Improved	59.44	72.9	73.04	48.77	91.31
Unimproved	51.03	53.45	53.88	69.29	77.38
<i>Pearson chi-square statistics</i>	<i>172.9637***</i>	<i>1.70E+03***</i>	<i>82.9404***</i>	<i>902.8751***</i>	<i>814.925***</i>
Sufficiency of water					
Sufficient	60.56	72.74	72.89	68.4	78.7
Not Sufficient	38.18	66.15	71.88	60.05	75.36
<i>Pearson chi-square statistics</i>	<i>2.50E+03</i>	<i>502.1558</i>	<i>6.4292</i>	<i>139.4294</i>	<i>134.9384</i>

Source: Author's Calculation using NSSO -78th Round Data, N= Total sample

Table 3 shows the proportion of households having access to basic sanitation facilities across different regions of India. Poor income groups, households with illiterate heads, and socially deprived households are the most vulnerable. Education level is positively associated with sanitation access, but disparities are pronounced in all regions except the southern and western regions. Female-headed households show lower access to better sanitation services due to patriarchal power dynamics. Southern regions have higher access to sanitation compared to other regions. SC, ST, and OBC categories are the most vulnerable, while southern regions have the most privilege. Infrastructural inequality also influences access to basic sanitation. Improved access to drinking water source is associated with higher access to basic sanitation, and water quantity is crucial for daily household activities and personal hygiene.

The above summary depicts the deep-rooted inequality in access to basic sanitation in rural India. Eastern and central region states are reported to be the most vulnerable, whereas southern states are most privileged or affluent regions in term of access to basic sanitation access. The descriptive analysis highlights that states like Odisha, Jharkhand, Bihar, Madhya Pradesh, and Uttar Pradesh recorded lower access to household toilets and subsequently those are the states with a higher prevalence of open defecation practice. Indeed, comparing the status of access to improved sanitation now and before the implementation of the Swachh Bharat Abhiyan (SBA), since 2014 the poor states have made tremendous progress and are approaching to close the inequality gap in access to the basic services with respect to income/wealth categories, social categories, gender groups (Kumar et al., 2024; Gupta et al., 2020). However, there are studies which defy and challenge the achievements of the states or the country concerning the basic access to sanitation services and self-proclaimed open defecation-free status of the states in India (Gupta et al., 2020). Majority of the studies highlighted the persistent inequality in access to the improved toilet facility (Kumar et al., 2017; Mondal et al., 2022; Saroj et al., 2020; Chaudhuri et al., 2017; Kumar et al., 2024; Kumar et al., 2024) and identified the issue of slippage of the open defecation-free status of the villages still exist even after a decade of implementation of the Swachh Bharat Abhiyan (SBA) (Prakash et al., 2022; Apanga et al., 2022;). This problem has been aggravated the inequality in access to, and sustainability of, improved sanitation services, especially in rural area (Reddy et al., 2010; Jerneck et al., 2016).

Thus, even five years after the declaration of Open Defecation-free (ODF) status and execution of ODF++, India is still lagging behind in achieving universal access to improved sanitation (Seth et al., 2021; Kanyagui et al., 2022; VerKuilen et al., 2023). In order to achieve the target, it is imperative from the policy perspective to assess/monitor the status of access to sanitation and the factors affecting/influencing the accessibility. Consequently, the policy can be modified and target that section of the population who are unable to secure basic sanitation amenities.

Socio-economic Determinants of Access to Basic Sanitation in Rural Area

Table 4: Binary Logistic Regression Result of Socioeconomic Determinants of Basic Access to Sanitation Services

Socio-economic Indicators	Marginal Effect
Income groups	+Poor
Middle	0.093***
Rich	0.195***
Gender of Household Head	+Male
Female	0.029***
Education of Household Head	+Illiterate
Primary	0.072***
Secondary	0.102***
Higher secondary	0.175***
Social Groups	+Scheduled tribe
Scheduled caste	0.017***
Other Backward Class (OBC)	0.052***
Others	0.143***
Sources of drinking water	+Unimproved
Improved	0.049***
Sufficiency of water	+No
Yes	0.086***
Regions	+Eastern
Western	0.052***
Northern	0.085***
Central	0.042***
Southern	0.139***
Constant	0.328***
N	144,991
Pseudo R ²	0.068
Log Likelihood	11660.97
Pr	0.00
LR chi2 (15)	-87320.13

Source: NSSO; Author's Calculation, +: Reference category, ***p≤0.01, ME: Marginal Effect

The logistic regression results in the above table report the key determinants of household access to basic sanitation facility. The significant determinants of basic access to sanitation are income, gender of the household head, education of the household head, social category, types of water source the household has access to, sufficiency of water, and geographical regions.

The study found that income is a significant determinant of access to basic sanitation in major Indian states. Middle and rich-class households are 9.3% and 19.5% more likely to have access to better sanitation services, respectively. The gender of the household head also affects access, with female-

headed households being more likely to have access (2.9%). Higher education levels also positively affect service accessibility. Social category and primary sources of drinking water also affect access. Improved sources increase the probability of accessing sanitation facilities by 5%. The study categorises major states into five regions, with the central, western, northern, and southern regions showing higher probability of access to basic toilet facilities.

Figure 1: Predicted Probability by Gender of Household Head Interacts with Socio-economic Indicators

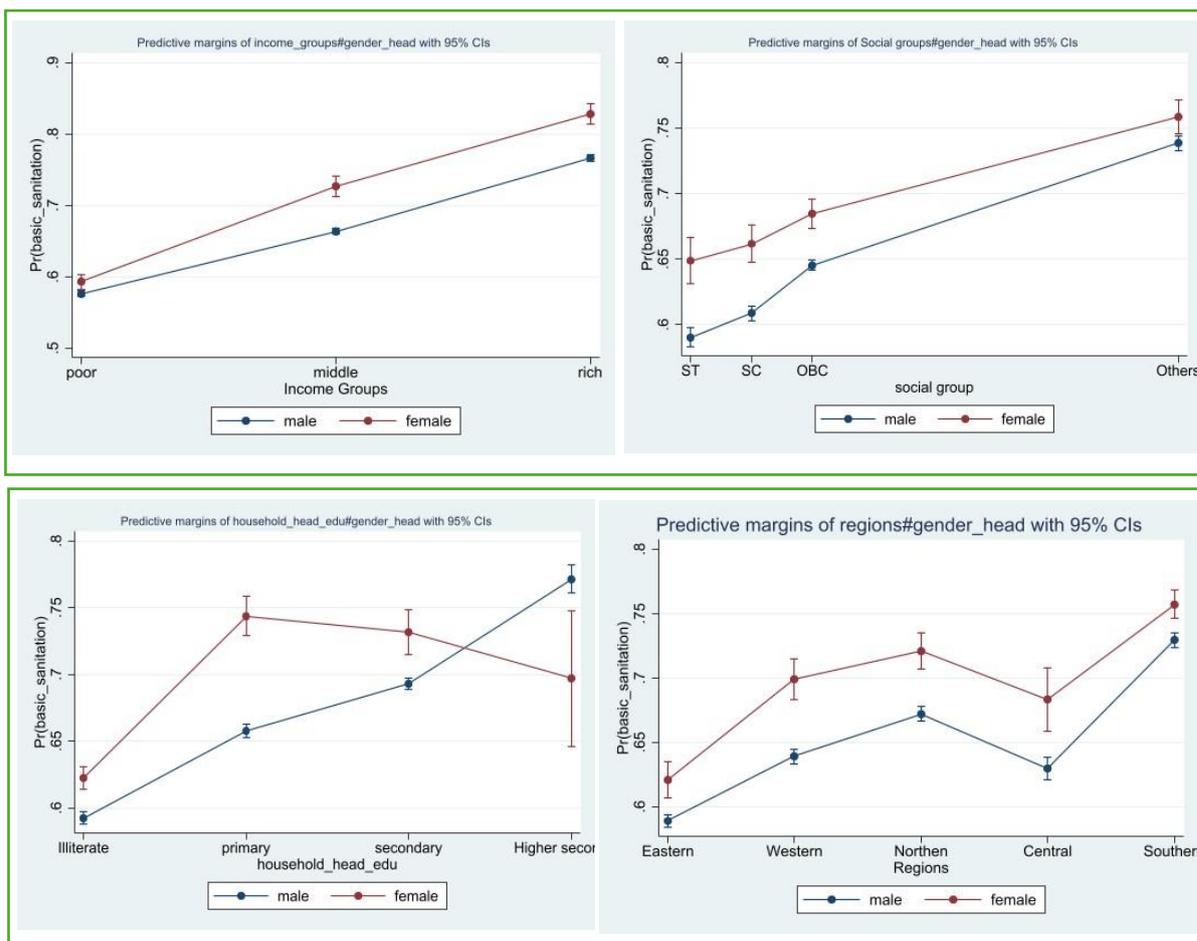


Figure 1 shows the interaction between gender of household head and socio-economic indicators such as income, social groups, education, and regions. Female-headed households have a higher probability of having access to safe toilet facilities across all income groups, with poor income households with female heads having minimal sanitation access. Middle and rich income groups have higher sanitation access probabilities, while upper caste groups have the highest probability. Female-headed households have a higher gap in sanitation access compared to male counterparts in lower social groups. Lower caste groups have lower education levels, and higher educated female-headed households have higher sanitation access probabilities. Regions with better human development and other development indicators have higher sanitation access probabilities. This finding corroborates with the study by Biswas (2024), Kumar (2024), Ranjan (2022), and Ranjan (2025).

This implies that income and control over household resources, along with the level of education, play an important role in influencing the access to sanitation in India. The nexus between the gender of the household head and the education of the household head, while the female head of the household having primary education shows the highest gap in the probability of having safe sanitation compared to the female head having no education and secondary education. This justifies that female-headed households with better education or little education show a greater impact on the likelihood of having a safe sanitation facility in the household. Regions with higher human development exhibit a higher probability of having access to basic sanitation among the female-headed households compared to male-headed households.

The regression results show that income is one of the most important factors influencing access to sanitation facility and its sustainability. Studies like (Biswas et al., 2024; Gurung et al., 2023; Prakash et al., 2022) also advocated that when the income of a family rises, the likelihood of owning and using sanitation facility also rises. It is justified to state that a higher income family can afford to own better sanitation facility and can pay for its sustainability (Bankole et al., 2023). Again, it is interesting to interpret the result that compared to male headed households, female headed households show a higher likelihood of having access to better sanitation. Since women are given the job of maintaining hygiene at the household and compared to male counterparts they are more sensitive toward privacy and personal hygiene, women headed households show higher probability in accessing improved sanitation. This finding is consistent with Gurung et al., (2023), Burt et al., (2016), Kayser et al., (2019) who showed the positive relationship between female headed households and better access to toilet facility in rural India. Education being an important component in advancing the wellbeing of the individual, it also influences the odds of owning an improved toilet. The higher level of education of the household head is associated with improved type of toilet facility at the household. In general, it is believed that a better educated individual has better knowledge of sanitation and personal hygiene, and its benefits on human health. This finding is in line with Kumar et al., (2024), Gaffan et al., (2022), Gurung et al., (2023). Compared to backward social category (scheduled tribe), scheduled caste (SC), Other Backward Class (OBC) and Others shows higher likelihood of using basic sanitation facility at a household. Basically, higher strata of the social categories are characterised by higher income/wealth, better education which consequently shape a better standard of living and well-being. This agrees with many studies done by Saroj et al., (2020); Chaudhuri et al., (2017), Kumar et al., (2024). Another important determinant of access and usage of better sanitation service is the type of drinking water source a household has access to.

The regression result suggests that compared to unimproved drinking water source, irrespective of time to fetch drinking water, households having access to improved drinking water source are more likely to have better toilet facility. This finding is consistent with studies like Sheel et al., (2024), Schiel et al (2021). In Indian culture, cleansing the nether region with water after defecation plays a significant role in shaping the idea of purity and pollution (Spears et al., 2015; Spears et al., 2019). Thus, having better water sources is believed to influence the access to better sanitation facility. Also, there are studies which illustrate that having a source of water within household premises increase the probability of owning and using better sanitation facility at the household. (Tiwari et al., 2022). While having improved water

source is important, ensuring its sufficiency is equally necessary in order to serve the purpose health benefits of having access to sanitation facility (Saith et al., 2018).

Table 5: Binary Logistic Regression Result of Socio-economic Determinants of Basic Access to Sanitation across Different Regions of India

Regions	Eastern	Western	Northern	Central	Southern
	ME	ME	ME	ME	ME
Income Groups (Rich: Reference category)					
Middle	0.131***	0.029***	0.107***	0.080***	0.086***
Rich	0.225***	0.110***	0.236***	0.164***	0.177***
Social Groups (ST: Reference category)					
SC	-0.017**	0.051***	-0.063***	0.002	0.083***
OBC	0.003	0.122***	-0.075***	-0.020**	0.177***
Others	0.081***	0.222***	0.036**	0.015	0.269***
Education of Household Head (Illiteracy: Reference category)					
Primary	0.105***	0.078***	0.006	0.045***	0.071***
Secondary	0.132***	0.136***	0.035***	0.046***	0.109***
Higher Sec	0.232***	0.221***	0.084***	0.124***	0.172***
Gender of household head (Male: reference category)					
Female	0.026***	0.035***	0.019***	-0.001	0.025***
Sources of Drinking water (Unimproved source: Reference category)					
Improved	0.024**	0.165***	0.127***	0.163***	-0.072***
Sufficiency of water (No: Reference category)					
Yes	0.179***	0.069***	0.032**	0.080***	0.074***
Constant	0.287***	0.259***	0.778*	0.425***	0.679***
Logistic Regression Result					
N	43,478	27,780	31,884	12,153	29,696
LR chi2 (11)	3302.44	2309.04	2460.66	450.5	2956.04
Prob>chi2	0	0	0	0	0
Pseudo R2	0.0555	0.0646	0.0638	0.0271	0.0873

Source: NSSO; Author's Calculation, ***p ≤0.01, **p ≤0.05, *p ≤0.1, ME: Marginal Effect

The logistic regression results in the table 5 report the key determinants of household access to basic sanitation facility in rural areas across different regions. The necessity of examining socioeconomic determinants of basic access to sanitation with respect to each of the regions considered is attributed to the results reported from the table 2. Further, heterogeneous characteristics of regions of India with respect to economic status, social groups, education level, and other human development indicators stimulate us to dig deeper into the analysis. The socioeconomic indicators and education level are highly instrumental in shaping perception towards accessing and usage of toilet facility, especially in rural areas. Consequently, the percentage of population accessing and using the sanitation facility distributed in an asymmetrical manner.

Income significantly influences access to basic sanitation in India, with middle-class households showing a higher probability of accessing services compared to poor households. Social group

membership also significantly influences sanitation access. Scheduled tribe, scheduled caste, other backward classes, and others have higher probability of access to basic sanitation services in all regions except the Northern region. Higher education levels of household heads are associated with better sanitation access. Gender inequality affects access to basic human development infrastructure, with female-headed households having a higher probability of access. Access to improved drinking water sources is higher in western region, followed by central, northern, and eastern regions. However, in the southern region, the likelihood of access to sanitation is lower due to high prevalence of dug wells as drinking water sources.

Figure 2: Interaction of Gender of Head of Household with Socio-economic Indicators across Regions in India

Figure 2a: Eastern Region

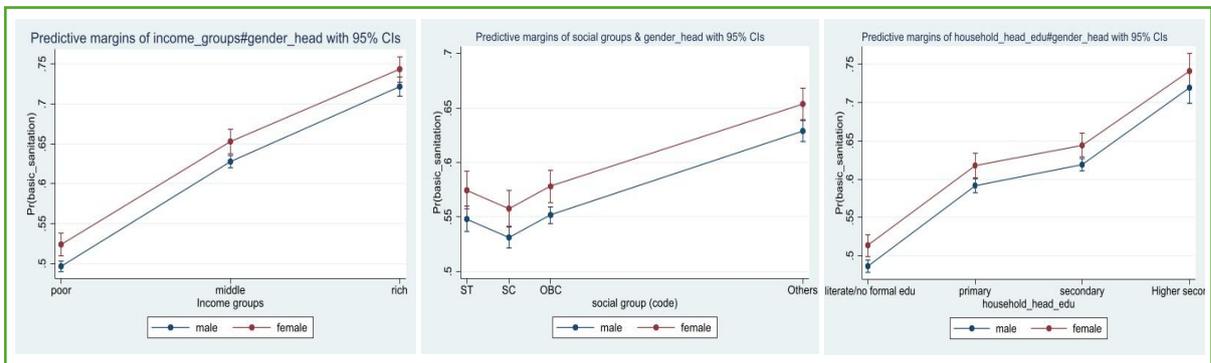


Figure 2b: Western Region

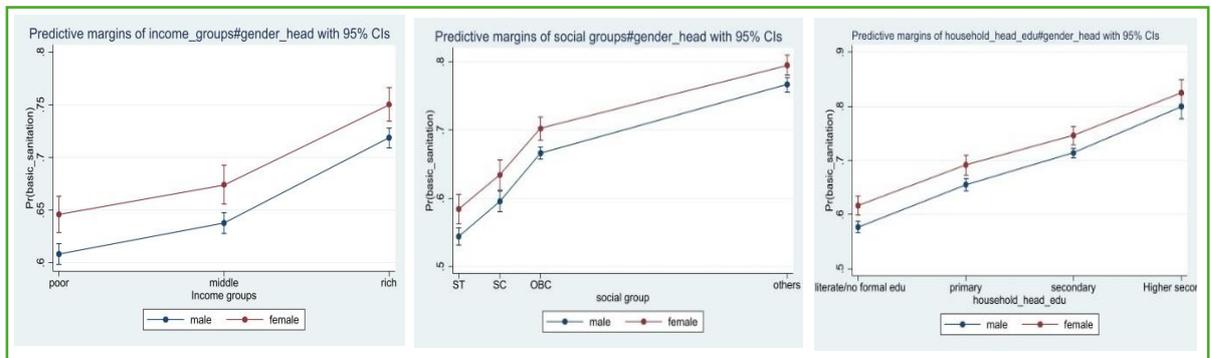


Figure 2c: Northern Region

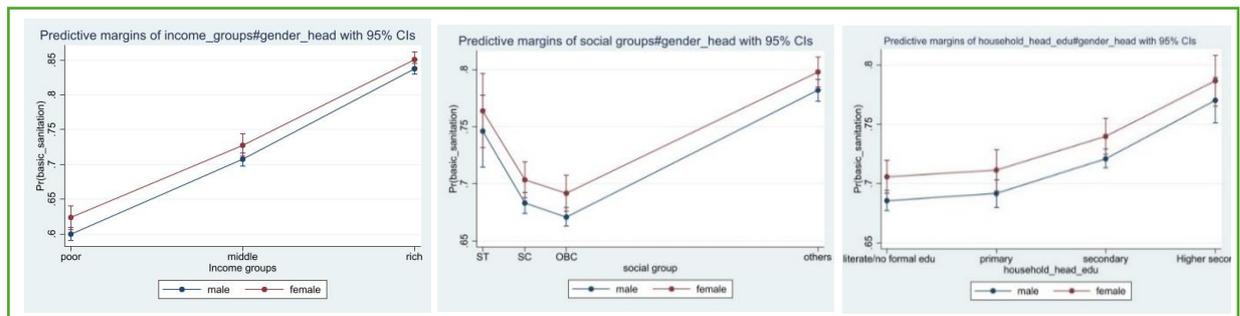


Figure 2d: Central Region

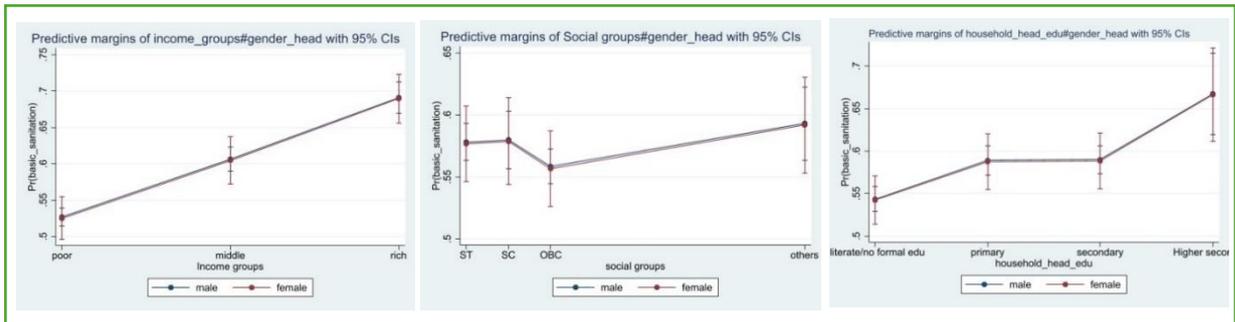


Figure 2e: Southern Region

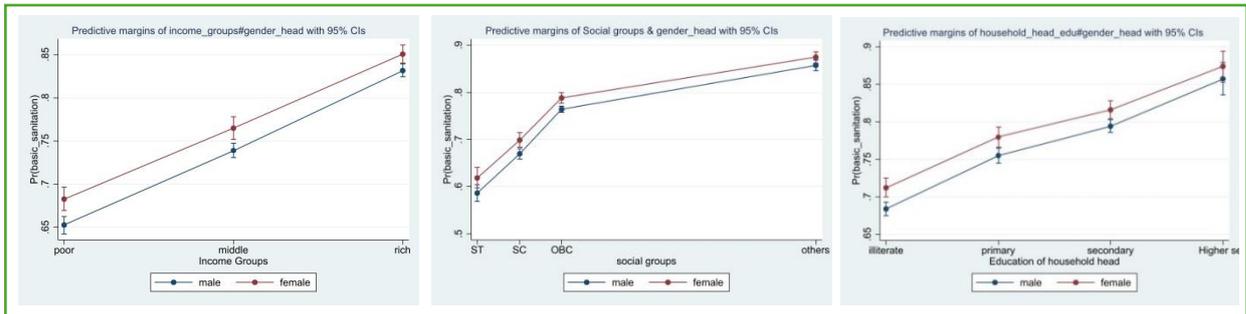


Figure 2 illustrates the predicted probability by gender of household head and socio-economic indicators across each of the regions considered. In Table 5, it is observed that the gender of the household head is one of the important predictors of access to sanitation in rural India. In addition, consider the subordinate role of women in household management, such as taking care of children, fetching water, and preparing food, most of which are unpaid jobs. Since access to and use of an improved toilet facility is more important for a woman, her decision-making and economic power in a household play a crucial role in having access to a better sanitation facility. Hence, exploring the gender of the household interacting with other socioeconomic determinants of sanitation at a disaggregated level adds on to the existing literature to a greater extent. Such an extensive analysis would help in unveiling the role of gender in having access to different types of sanitation facilities at the household. The predicted probability of sanitation access between male- and female-headed households across all income categories, female-headed households recorded a higher likelihood of access to basic sanitation compared to male-headed households. Further, Southern Region female-headed households with respect to income groups show higher probability than other regions. Central region states turn out to be exceptional, where the likelihood of sanitation access is indifferent between male- and female-headed households across income groups, social groups, and education of the head of household. Interaction of the gender of the household head and social groups also influences the sanitation access. This trend can be observed from the predictive margin figure of each of the regions. It shows that households belonging to other groups have a higher probability compared to all others, while in the case of the eastern and northern regions, households belonging to scheduled tribes have a higher probability of sanitation access compared to scheduled caste households. And in all the regions, OBC group households have higher predictive margins compared to ST and SC households. It is more likely to see the education level of the household head

have a positive influence on sanitation access. Moreover, having a similar level of education, female-headed households recorded a higher likelihood of sanitation access compared to male-headed households. The predictive probability rises with the rise in levels of education of the household head across all the regions except the central region, which exhibits a similar level of likelihood of having access to a sanitation facility between female-headed and male-headed households.

Inequality in access to basic sanitation among all the regions of India is observed from the result of this study. Geographic location also serves as one of the determinants of access to sanitation services. According to the study's classification of states into various regions, states in the western, central, northern, and southern regions are more likely to use safe sanitation compared to states in the eastern region. This finding is also in line with Kumar et al. (2024); Biswas et al. (2024); and Mondal et al. (2022), which strengthens the argument of the role of geographical location in access to better sanitation service. Further, this study jumps into in-depth analysis and highlights that female-headed households are more aware of and concerned about the sanitation facility at the household and are able to secure safe sanitation with their discretionary decision-making power in the household. Even though women from male-headed households may also be concerned about having household sanitation facilities, their subordinate role in a male-headed household makes them fail to realise the need to have a safe toilet facility at home.

In India, various programmes have been initiated to empower women and encourage them to be involved in various household decision-making processes. Consequently, a major proportion of women in rural areas take part in household decision-making concerning self-health care, physical mobility, household purchasing, etc. (Majumder et al., 2024; Madan et al., 2024). Still, inequality is observed in the level of participation in various decision-making processes. In addition, lower decision-making power and a lower rate of participation in the decision-making process with respect to expenditure on the education of children and money management, especially among young women (Raz et al., 2025), highlight the causes of not having proper sanitation facilities among male-headed households. Further, lower awareness among people resulting from lower autonomy of women on decisions about children's education aggravates the issues of sanitation access and its resulting benefits. Thus, dispossession of household resources and lack of decision-making power among women cause unsafe toilet use or open defecation. Hence, not only does the goal of making India ODF get obstructed, but it also serves as an obstacle to achieving sustainable development goal 6.2 of universal sanitation coverage. The goal of an open defecation-free India and SDG's universal sanitation coverage can be achieved through one of the ways of empowering women in the households in terms of decision-making power concerning their healthcare, safety, privacy, and autonomy over money management in India.

Conclusion and Policy Implications

The findings from the study reveal disparities in access to safe sanitation facilities in rural areas across different socioeconomic groups among different regions in India. Furthermore, the study identifies socioeconomic and demographic indicators that influence the basic access to sanitation. The empirical result of the study highlights that people belonging to socially and economically marginalised sections have a lower probability of having access to basic sanitation. This in turn causes deterioration of health

and negatively impacts economic well-being, posing a greater threat to human development. The socio-economic and regional inequality in access to sanitation facilities reflects the policy-level failure of the flagship mission, Swachh Bharat Mission (SBM), in rural India. The ineffective implementation of the programme underlines the inability to reach the appropriate beneficiary of the programme at the ground level due to the flaws in the governance system and the failure to create awareness among people about sanitation, which in turn has failed to create sanitation demand in rural areas, one of the major obstacles in achieving universal elimination of open defecation. The current programme has adopted Information Education Communication (IEC) and Behaviour Change Communication (BCC) to foster the adoption of toilet use. However, the result suggests that a majority of the people in rural areas are still struggling to adapt to using household latrines and are practicing open defecation. This illustrates that the government has to reach out to the deprived section of the population and make them aware of the benefits and warn against the disadvantages of unsafe sanitation and open defecation. As part of the policy implications, the results of the study suggest that empowering women can enable them to obtain decision-making autonomy, which, in conjunction with strengthening sanitation awareness through various sanitation campaigns and the spread of education, may possibly solve the problem of open defecation and accelerate the sanitation coverage in rural India. The Swachh Bharat Mission, although focusing on sanitation coverage of women and children, has failed to provide a sustainable sanitation solution. One of the solutions in this aspect can be strengthening the convergence and integrated approach of sanitation policy, which was adopted during Nirmal Bharat Abhiyan (NBA), along with a demand-driven approach to sanitation. This dual strategy will not only enhance women's autonomy in decision-making but also create sanitation awareness among the masses, especially women and children. As a result, universal sanitation coverage and ODF India can be achieved.

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Appendix

Binary Logistic Regression Result of Socioeconomic Determinants of Basic Access to Sanitation Services

Socio-economic Indicators	Odds Ratio
Income groups	
Poor	R ⁺
Middle	1.524***
Rich	2.599***
Gender of the Head of the Household	
Male	R ⁺
Female	1.153***
Education level of household head	
Illiterate/no formal education	R ⁺
Primary	1.396***
Secondary	1.622***
Higher secondary	2.412***
Social Categories	
Scheduled tribe	R ⁺
Scheduled caste	1.084***
Other Backward Class (OBC)	1.272***
Others	2.014***
Drinking Water Sources	
Unimproved	R ⁺
Improved	1.261***
Sufficiency of drinking water	
No	R ⁺
Yes	1.492***
Regions	
Eastern	R ⁺
Western	1.272***
Northern	1.488***
Central	1.215***
Southern	1.962***
Constant	0.328***
N	144,991
Pseudo R ²	0.068
Log Likelihood	11660.97
Pr	0.00
LR chi2 (15)	-87320.13

Source: NSSO; Author's Calculation, R⁺- Reference category, ***p≤0.01, OR: Odds Ratio

Binary Logistic Regression Result of Socio-economic Determinants of Basic access to Sanitation across Different Regions of India

Basic Sanitation	Eastern Region	Western Region	Northern Region	Central Region	Southern
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
Income groups					
Middle	1.748	1.145	1.626	1.393	1.552
Rich	2.735	1.705	3.510	2.039	2.795
Social Groups					
scheduled caste	0.930	1.247	0.721	1.007	1.473
other backward class (OBC)	1.015	1.721	0.680	0.919	2.430
others	1.429	2.896	1.232	1.066	4.677
Education of Household Head					
primary	1.566	1.422	1.029	1.210	1.468
secondary	1.763	1.894	1.199	1.215	1.870
Higher secondary	2.842	3.111	1.581	1.714	2.993
Gender of Household Head					
female	1.121	1.189	1.107	0.994	1.158
Drinking Water Source					
improved sources	1.110	2.098	1.836	1.962	0.634
Sufficiency of Drinking Water					
yes	2.167	1.383	1.177	1.396	1.500
Constant	0.287	0.259	0.778	0.425	0.679
No of Observations	43,478	27,780	31,884	12,153	29,696
LR chi2 (11)	3302.44	2309.04	2460.66	450.5	2956.04
Prob>chi2	0	0	0	0	0
Pseudo R2	0.0555	0.0646	0.0638	0.0271	0.0873
Log likelyhood	-28088.8	-16718.8	-18043	-8073.14	-15454.2

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