Does Sanitation Affect Health Outcomes? Evidence from India

Das, Amarendra and Das, Bibhunandini

Centre of Advanced Study in Economics, Utkal University, Bhubaneswar, India, Public Health Foundation of India, New Delhi, India

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Amarendra Das[1] and Bibhunandini Das[2]

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Abstract

In this paper we have attempted to unravel the disparity in sanitation facilities across rural and urban regions of Indian states and the impact of sanitation on health outcomes. Based on the 69th National Sample Survey data set which covers more than 95 000 households we find a wide disparity in the access to sanitation facilities across rural and urban areas of Indian states and across states. While the north-eastern and southern states perform better in sanitation indicators, the eastern and central part of India performs poorly. So far as the relationship between the sanitation and health outcome is concerned our analysis shows that better sanitation facilities do have a positive impact on the health outcomes. From our analysis of four diseases (stomach problem, malaria, skin diseases and fever) that are more caused due to sanitation facilities we observed that better sanitation facilities in terms of access to toilets and bathroom access to regular safe drinking water, practice of storing drinking water in metal or non-metal container, absence of flies and mosquitoes, having separate kitchen and proper disposal of wastes reduces the incidence of diseases

[1]Assistant Professor, Centre of Advanced Study in Economics, Utkal University, Bhubaneswar-751004, Email: dasamarendra@gmail.com

[2]Research Associate, Public Health Foundation of India, New Delhi, Email: bibhu31@gmail.com

'Almost one tenth of the global disease burden could be prevented by improving water supply, sanitation, hygiene and management of water resources' – World Health Organisation

'The effects of poor sanitation seep into every aspect of life – health, nutrition, development, economy, dignity and empowerment. It perpetuates an intergenerational cycle of poverty and deprivation' –Ministry of Drinking Water and Sanitation, Government of India

1. Introduction

The significance of water and sanitation for better health outcomes have been pointed out by many individual researchers and international agencies such as World Health Organisation (WHO) and United Nations (UN). For example the United Nations states that water and sanitation (W&S) related improvements are crucial to meet the Millennium Development Goals (MDG), reduce child mortality, and improve health and nutritional status in a sustainable way. In addition, they [W&S] induce multiplesocial and economic benefits, adding importantly to enhanced well-being (WHO, 2008). The Millennium Development Goal 7 [ensure environmental sustainability] sets the targets to reduce by half

- the proportion ofpeople without sustainable access to safedrinking water and basic sanitation(target 10),
- the proportion of the population with sustainable access to an improved water source (indicator 30)
- the proportion of the population with access to improved sanitation (indicator 31)

Contradicting the popular notion on the impact of sanitation on health outcomes, Clasen et al (2014) have found that increased latrine coverage may not necessarily reduce the exposure to faecal pathogens and prevent disease. Based on a cluster-randomised controlled trial between May 20, 2010, and Dec 22, 2013, in 100 rural villages in Odisha, India. They concluded that as efforts to improve sanitation are being undertaken worldwide, approaches should not only meet international coverage targets, but should also be implemented in a way that achieves uptake, reduces exposure, and delivers genuine health gains.In this context we feel that there is a greater need to undertake more empirical research to examine the impact of sanitation on health outcomes. Using the large scale household survey data collected by the National Sample Survey Office of India, in this paper we attempt to examine the effect of sanitation on various health outcomes.

The remainder of this paper is organised as follows. Section 1.1 provides a summary view of the sanitation campaign in India. In section 2, based on the insights from literature weexplain how sanitation impacts health outcome. Section 3 discusses the data sources and variables used in the analysis. Section 4 presents the methodology employed in analysing the factors that determine the likelihood of diseases. Section 5 presents Indian sanitation scenario followed by discussion on state wise conditions of households in terms of diseases. Section 6 discusses the results of maximum likelihood estimation of different diseases. Section 7 summarises findings of the study and provides some concluding remarks.

1.1 Government Initiatives for Health and Sanitation in India

The relevance of sanitation for better health outcome has been recognised by the government of India from the 1980s. This is witnessed from the launch of Rural Sanitation Programme (RSP) by the Government of India in 1986 to provide sanitation facilities in rural areas. It was a supply driven, high subsidy and infrastructure oriented programme. As a result of these deficiencies and low financial allocations, the RSP had little impact on the gargantuan

problem[3]. In order to improve the effectiveness of this scheme through community participation, generation of awareness Government of India further launched Total Sanitation Campaign (TSC) approach in 1999. The primary objectives of TSC are seven fold: (1) Bring about an improvement in the general quality of life in the rural areas, (2) Accelerate sanitation coverage in rural areas, (3) Generate felt demand for sanitation facilities through awareness creation and health education, (4) Cover schools/ Anganwadis in rural areas with sanitation facilities and promote hygiene education and sanitary habits among students, (5) Encourage cost effective and appropriate technologies in sanitation, (6) Eliminate open defecation to minimize risk of contamination of drinking water sources and food and (7) Convert dry latrines to pour flush latrines, and eliminate manual scavenging practice, wherever in existence in rural areas.
In order to boost the TSC, the government also launched an incentive scheme in the name of Nirmal Gram Puraskar in the year 2003. The scheme aimed to felicitate those Village Panchayats, Blocks and Districts which has full coverage of sanitation, maintenance of clean environment and free from open defecation. These initiatives clearly reflect the worries of the government on the issue of poor sanitation since the mid-1980s. On October 02 2014, on the birth anniversary of the father of Nation, Mahatma Gandhi the Prime Minister of India has launched the 'Clean India Mission' (*Swachh Bharat Abhiyan*) for transforming the campaign for sanitation into a social movement.

Against this backdrop, we take a stalk of the sanitation provisions in India across rural and urban regions of different states and examine the effect of sanitation on health outcomes.

2. Sanitation and Health: Insights from Existing Studies

It has been time and again argued that sanitation plays a critical role in improving human health and overall well-being. This section briefly outlines the role of sanitation on health by reviewing the existing literature. Studies mostly focus on the consequences of open defecation and unsafe drinking water. WHO considers water, sanitation and hygiene are the most basic human needs among others and prerequisite to human wealth and development. Further, it estimates that improving water, sanitation and hygiene could prevent around 9.1 per cent of the global burden of disease and 6.3 per cent of all death (WHO, 2012). Open defecation is considered to be the reason of persistent burden of diarrhoea and intestinal parasite infection among children, specifically below 5 years (World Bank, 2013). Patil*et al* (2013) in its randomized controlled study of a rural sanitation behaviour change programme in Madhya Pradesh found that toilet use has clearly lagging behind toilet construction. There needs to improve a lot in both toilet construction and sanitation related behavioural change in the intervention villages. By measuring the economic impacts of inadequate sanitation in India the Water and Sanitation Programme of the World Bank found that the total annual economic impact of inadequate sanitation in India was $48 per person in India which accounts 6.4% of India's gross domestic product (WSP, 2011).

Coffey *et al*(2014) presented evidence from their survey in Bihar, Haryana, Madhya Pradesh, Rajasthan and Uttar Pradesh that open defecation dire consequences on health and human capital crisis. A recent study by Bedi*et al* (2015) on health and economic impact of unsafe drinking water shows that the per capita economic cost of water-related diseases lead to extra monetary burden on the households.Barnard *et al*(2013) in their study on impact of Indian

[3] Department of Drinking Water and Sanitation, Government of India (2010) http://rural.nic.in/sites/downloads/our-schemes-glance/SalientFeaturesTSC.pdf

TSC on latrine coverage and use in Orissa found that among the households with latrine, more than a third was not being used by any member of the household.Chambers and Medeazza (2013) linked the persistent undernutrtion largely with open defecation and explain that much of the undernutrtion would disappear in India with hygienic conditions.Bhutta*et al* (2008) in their study showed that sanitation and hygiene not only prevent but also reduce stunting. Hence to improve the nutritional status, effective Water, Sanitation and Hygiene (WASH) interventions are vital. Esrey(1996) analysed data from 4 Sub-Saharan Africa (Burundi, Ghana, Togo and Uganda), 1 from Asia (Sri Lanka), 1 from North Africa (Morocco) and 2 from America (Bolivia and Guatemala) to test whether incremental health effects regarding diarrhoea and nutritional status result from incremental improvements in water and sanitation conditions. From the study, the author conclude that '*improvements in water and sanitation together were synergistic in producing larger impacts than either alone, particularly in rural areas'*.Gupta (2005) emphasised on improvement of public health services through assuring food safety, vector control, monitoring waste disposal, water systems and health education to improve personal health behaviour.

3. Data Sources and Variables Construction

The National Sample Survey Organisation (NSSO), India carried out a comprehensive survey on drinking water, sanitation, hygiene and housing condition in the year 2012. The study period was July, 2012 to December, 2012. The study has covered total 95,548 households all over India. Out of which, 53,393 households are from rural and 42,155 are urban households.

Hypothesis and Variable Construction

The key goal of public health services is to reduce a population's exposure to disease through well sanitation, assuring food safety, vector control, monitoring waste disposal and water systems (Gupta, 2005).It has also been highlighted that the persistent under-nutrition is mainly due to open defecation, population density, lack of sanitation and hygiene (Chambers and Medeazza, 2013). Against this, the present study attempts to understand the factors that determine the different household diseases.It is hypothesised that poor sanitation, drinking water along with some of the other household characteristics affect the illness of the household members.

Drinking Water

Making drinking water available and accessible to households could be considered as the integrated public health action for keeping them disease free. For urban planners, water availability, its access by poor and its quality have been emerged as one of the key concerns (Satapathy, 2014).Along with availability and access the study also emphasised on the continuous water supply plays a vital role in ensuring the quality of water (*ibid*, 2014). Taking insights from this, the present study hypothesises that households with sufficient safe drinking water are likely to be less affected by diseases than their counterparts. The data has given 13 different source of drinking water and for the analysis we have classified these sources into safe and unsafe drinking water. Bottled water, piped water into dwelling, piped water to plot, public tap or standpipe, tube well or bore-well, protected well and spring fall under the safe source of drinking water. Against this, unprotected well, rainwater collection, tank/pond water, unprotected spring, other surface water and water from other sources like tanker-truck, cart with small tank or drum fall under unsafe drinking water. These two indicators are interacted with the variable whether the drinking water is sufficient throughout the year or not. Hence, in the analysis; we have four categories households with sufficient safe drinking water throughout the year, households with insufficient safe drinking water,

households with sufficient unsafe drinking water and households with insufficient unsafe drinking water.Households with insufficient drinking water are taken as the base category.

Quality of Drinking Water

'*Public health demands the continuity and quality of water supply than mere coverage*' (Satapathy, 2014).The national water policies in India (1987, 2002 and 2012) emphasized that both surface water and ground water should be monitored for quality and a phased programme should be undertaken for improvements in water quality. WHO (2004) reported that in spite of increase in access to drinking water, the adverse impact of unsafe drinking water on health continues.On this basis, we have included quality of drinking water in the analysis. The data source classifies the quality of drinking water in four different categories: bad in taste, bad in smell, bad in taste and smell, bad due to other reasons and drinking water without defect. For the analysis, the variable has entered as dummy variable and we have clubbed the four categories into two groups: bad quality drinking water,taken as zero and drinking water without any defect, taken as one. We are hypothesising that households with good quality drinking water (without any defect) will be less likely to have illness.

Drinking Water Purification

If the defective drinking water will be properly purified, then the possibility of falling illness will reduce among the households. Hence, other than availability of drinking water and the quality of drinking water, we have included whether the households are practicing drinking water purification or not. If the households are purifying the drinking water, then it is taken as one, else it is zero. The variable has been entered as dummy variable in the analysis and households that are not purifying the drinking water are taken as the base category. We are hypothesising households those purify the drinking water are less likely of illness.

Water Storage

Households' water treatment and safe storage interventions can lead to dramatic improvements in drinking water quality and reduction in water borne diseases like diarrhoeal disease (WHO, 2012).Hence, in our analysis we have included a variable that explains how the drinking water is stored. We have constructed a variable with three categories- by clubbing the households who store the drinking water in non-metal container, metal container and households who don't store drinking water. Households who don't store drinking water are taken as base category.

Access to Latrine

In India open defecation widely leads to faecal-transmitted infection, mainly among children (Government of India, 2012). Along with other factors like lack of sanitation and hygiene, itis also evident that open defecation does affect the undernutrtion in India (Chambers and Medeazza, 2013). This says the importance of latrine in a household in order to make the members disease free. Hence, households with access to latrine are hypothesised as less likely to diseases than the households without latrine. The variable has entered in dummy form. If the households are accessing any kind of latrine, then we have given one and households without any latrine are assigned as zero. Households without any latrine are taken as base category.

Access to Bathroom

A household's access to bathroom could be considered another infrastructure that will help the household to maintain cleanliness.Here we take a dummy variable which takes one if the households have facility of bathroom and zero if not.

Garbage Collection

If there is proper arrangement made for collecting garbage from the households, then the households will be more likely to maintain the hygienic condition. In our data source, three different kinds of arrangements are given. We have clubbed these categories and created a variable. If any kind of arrangements are made for collecting garbage from the households, then we have scored one else it is zero.

Garbage Deposit

After removing the garbage from the households, if it is not deposited properly and openly dumped, then the chances of diseases increase. Hence, we have includeda variable that explains the site where garbage is deposited. If it is deposited to bio-gas plant or manure pit, then it is taken as one while if garbage is deposited in community dumping spot, households' individual dumping spot or any other then it is taken as zero. It is hypothesised that if the garbage is deposited to bio-gas plant or manure pit, then they are less likely to suffer from diseases.

Drainage Systems

A well-functioning drainage system is a basic infrastructure for maintaining sanitation and hygiene conditions of the households.Households without drainage or open drainage are expected to be more vulnerable in terms flies, mosquitos and insects. In our study, we have attempted to analyse the impact of this factor. Here we take a dummy variable which takes one if the households have well drainage systems that is underground or covered pucca, and zero if the households have open or no drainage systems.

Disposal of Waste Water

Other than drainage systems, we have included another variable that explains how the households disposing waste water. The variable is entered in dummy form and we have given one if the household is reusing safely after treatment of waste water and it takes zero if it is disposed to open low land areas, ponds, river, drain or other places.

Flies or Mosquito

The problems of flies or mosquito become the cause for many diseases. If the household is facing the problemflies or mosquito then the household could be considered as more vulnerable for different diseases. The dummy variable takes the form one if the household faced the problems of flies or mosquito and zero if not. Our data has categorised the households who are facing the problem of flies or mosquito in two groups: households those are facing severe problem of flies or mosquito and those are facing moderate problem of same. In our analysis, we have clubbed these two groups into one group.

Animal Shed/Poultry Farm

Animal or bird excreta can cause contamination of water used for bathing and recreation (Dufour, 2012) and also reasons for many water-related diseases. The households that have

animal shed or poultry farm, they are expected to be more vulnerable for diseases. The variable enters in dummy form and takes one if there is existence of animal shed or poultry farm, else zero.

Ventilation

Ventilation of the dwelling unit signifies the living condition of the households. If the members of the households are living in a better house with proper cross ventilation, they are expected to have lesser risk for diseases. We form the variable that takes one if the household has either good or satisfactory ventilation to the house while without ventilation it is zero.

Quality of food

To be disease free the households are not only required to access safe drinking water but also need to have quality food. To maintain the quality food, it is required that food should be cooked in hygienic conditions. We have attempted to capture this variable by taking a proxy variable that explains whether the households have separate kitchen in the house or not. It is hypothesised that if the households will have separate kitchen with or without water facility then the quality of food will be relatively better and the members will be less likely to diseases.

Other than variables that explain the water, sanitation and hygiene conditions of the household, we have taken some of the households' characteristics in our analysis as the unit of observations are households.

Economic Conditions of the Households

The income of the household determines the economic status of that particular household (Das, 2014). As our data source does not provide information in income of the household, in order to capture the economic conditions, we have taken consumption expenditure of the household as proxy to income. The monthly per capita consumption expenditure is taken as to specify the economic conditions of the households.

Education

Along with economic conditions of the households, education level of the household reflects the awareness of the household about the importance of sanitation and health. It is also discussed that education leads to better public sanitation (Doron and Jeffrey, 2014). Hence, we have included the variable education in the analysis. We have taken education of the male-household head as majority head are male. The data provides head of the household in two groups- male and female and the education level in 10 groups. We clubbed the education level in three groups- households those have primary or secondary education, households those have higher secondary education and households those are illiterate. Illiterate households are taken as base category.

Household Size

Household size implies total number of members living in a household. The variable is entered as continuous variable in the equation.

Religion

The variable religion implies whether the household belongs to Hindu, Muslim, Christian or any other religion.

Age

The variable age implies the head of the household's age. The household head's age is given in two group- one if the head of the household is less than 18 years and two if the head's is 18 or more than 18 years. Household head's age below 18 years is the base category in the analysis.

Social Group

Doron and Jeffrey (2014) in their recent paper identifies 11 features that play a crucial part in determining people's acceptance of and access to controlled ways of dealing with human waste. Out of those, caste is one of the features. In our study, we have taken social group as one variable that explains the caste of the households. The variable has four groups- schedule tribe (ST), schedule caste (SC), other backward class (OBC) and others. Households that belong to schedule tribe are considered as base category.

4. Methodology

To assess the sanitation performance, the study focuses on three indicators- drinking water from protected sources throughout the year, access to latrine and access to bathroom. In order to find out the aggregate performance of sanitation, a sanitation index has been constructed and a comparison is made across all the states. The index is constructed in two steps. First, we normalise all the indicators by using the formula

$$\frac{Actual - Minimum}{Maximum - Minimum}$$

Where, 'Minimum' is the lowest value in the series and 'Maximum' is the highest value in the series. In the second step by assigning equal weighs to all the indicators, we got a single value for each state by taking the simple average of the normalised value.

To understand, whether the sanitation affects health outcome or not, we have done a logit regression analysis with the dependent variable that explains whether the members of the household are suffering any kind of diseases or not. If the members are suffering from any diseases then it is one, otherwise it is zero. With the binary variable to be estimated, the empirical model specified for the study is logit model and to identify the specific attributes of households in one or the other by quantitative and qualitative variables across the two groups (households with diseases and without diseases), the estimable equation is depicted in equation 1.

$$\begin{aligned} Y_i = \beta_1 + \beta_2 DW + \beta_3 Quality of DW + \beta_4 DW Purification + \beta_5 Water Storage \\ + \beta_6 Access to Latrine + \beta_7 Access to Bathroom + \beta_8 Garbange Collection \\ + \beta_9 Garbage Deposit + \beta_{10} Ventilation + \beta_{11} Flies + \beta_{12} Drainage \\ + \beta_{13} Disposal of Waste Water + \beta_{14} Animal Shed + \beta_{15} Kitchen \\ + \beta_{16} Access to Electricity + \beta_{17} Education + \beta_{18} Religion \\ + \beta_{19} Household Size + \beta_{20} MPCE + \beta_{21} Social Group + \beta_{22} Age \\ + U_i \dots \dots \dots (1) \end{aligned}$$

Where DW implies drinking water and MPCE is monthly per capita consumption expenditure.

5. Where do Indian States Position themselves in different Sanitation Indicators?

It can be said that India is a hub of open defecation, as it accounts for 60 per cent of the world's open defecation (Coffey *et al*, 2014). Estimation shows that 50 per cent of India's population defecate and urinate outdoors (Doron and Jeffery, 2014).With high population density, open defecation cause for many fatal diseases particularly among children. Further the problem is acute in rural areas as contaminated water and poor sanitation are the cause of top killer diseases that affect children below four years (Alok, 2010).

In this section we attempt to position Indian states in different sanitation indicators. Our study relies on three different sets of sanitation indicators-source of drinking water, access to latrine and bathroom.Table 1 presents the state wise percentage of households that have access to latrine, bathroom and safe drinking water and provides the rank of each state among 28 states.At all India level, out of 100 households more than 89 households are using drinking water from protected sources[4]. In Punjab out of 100 households, more than 99 households are getting drinking water from protected sources. In Kerala, only 40 per cent of households have access to safe drinking water.However, this data needs to be read carefully because in Kerala, most of the households use warm water for drinking purpose. Out of 28Indian states 16 have a greater proportion of households that have access to drinking water from safe sources than the national average; those are Andhra Pradesh, Arunachal Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Karnataka, Maharashtra, Mizoram, Punjab, Tamil Nadu, Tripura, Uttar Pradesh, Uttaranchal and West Bengal.

At national level the rate of access to latrine is only 61.1 per cent which implies 39 per cent of households defecate openly. In terms of access to latrine, the north eastern state Mizoram shows impressive performance where 99% households have access to latrine followed by Manipur and Nagaland. The states that have higher percentage of households having access to latrine higher than the national average are Arunachal Pradesh, Assam, Goa, Haryana, Himachal Pradesh, Jammu & Kashmir, Kerala, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Punjab, Tamil Nadu, Tripura, Uttaranchal and West Bengal.

At national level out of hundred households, only 54 households have access to bathroom. Mizoram stands first in the row with more than 92 % households have access to bathroom followed by Goa and Sikkim with 90.6 % and 90.0 % access respectively. The other states that have higher access to bathroom than the national average are Andhra Pradesh, Arunachal Pradesh, Assam, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Punjab, Sikkim, Tamil Nadu and Uttaranchal.

[4]Our data source has provided 13 principal source of drinking water. We have clubbed these sources into safe and unsafe sources of drinking water. Households that are relying on bottled water, piped water into dwelling, piped water to yard, public tap or standpipe, tube well, protected well and spring are clubbed into households that rely on safe source.

Table 1: State wise Performance in Water and Sanitation Indicators						
States	Safe Drinking Water		Latrine		Bathroom	
	% HH have	Ranks	% HHs Have	Rank	% HHs Have	Rank
Andhra Pradesh	93.60	11.00	58.30	19.00	64.30	13.00
Arunachal Pradesh	98.90	2.00	85.90	8.00	74.70	8.00
Assam	87.20	21.00	87.90	7.00	62.00	15.00
Bihar	97.60	3.00	34.50	26.00	23.20	27.00
Chhattisgarh	95.90	6.00	41.90	25.00	35.40	23.00
Goa	89.20	17.00	79.50	10.00	90.60	2.00
Gujarat	91.90	14.00	59.30	18.00	57.90	18.00
Haryana	93.10	12.00	78.50	12.00	81.90	6.00
Himachal Pradesh	96.60	5.00	73.20	14.00	69.70	11.00
J & K	87.80	20.00	71.00	15.00	72.90	10.00
Jharkhand	74.00	26.00	32.50	27.00	30.20	25.00
Karnataka	94.70	8.00	54.80	20.00	63.20	14.00
Kerala	40.30	28.00	92.70	6.00	87.00	5.00
Madhya Pradesh	89.10	19.00	44.30	23.00	46.60	21.00
Maharashtra	91.80	15.00	62.90	17.00	59.70	17.00
Manipur	64.60	27.00	98.70	2.00	61.10	16.00
Meghalaya	79.30	25.00	96.60	5.00	68.50	12.00
Mizoram	90.90	16.00	99.40	1.00	92.40	1.00
Nagaland	84.00	23.00	98.50	3.00	89.80	4.00
Odisha	86.60	22.00	30.50	28.00	22.90	28.00
Punjab	99.30	1.00	79.10	11.00	73.90	9.00
Rajasthan	83.70	24.00	45.00	22.00	53.60	20.00
Sikkim	89.20	18.00	97.70	4.00	90.00	3.00
Tamil Nadu	93.90	9.00	51.90	21.00	54.60	19.00
Tripura	92.00	13.00	82.90	9.00	27.60	26.00
Uttar Pradesh	97.50	4.00	42.60	24.00	34.50	24.00
Uttaranchal	93.80	10.00	77.50	13.00	78.30	7.00
West Bengal	95.60	7.00	68.90	16.00	44.80	22.00
All India	89.6		61.1		54.3	
Source: 69th Round of NSS						

Having discussed the state wise variation in sanitation, Table 2 reports the variation across rural and urban regions of 28 Indian states.

Table 2: State wise Rural-Urban Variation in Sanitation						
States	**Drinking Water**		**Latrine**		**Bathroom**	
	Rural	Urban	Rural	Urban	Rural	Urban
Andhra Pradesh	92.22	95.04	32.48	84.22	42.97	85.70
Arunachal Pradesh	98.36	99.73	76.32	100.00	60.47	95.70
Assam	85.52	92.33	85.40	95.77	55.93	80.56
Bihar	96.90	99.36	19.67	71.71	13.63	47.36
Chhattisgarh	95.63	96.21	26.42	61.11	19.00	55.68
Goa	79.17	99.31	77.08	81.94	86.11	95.14
Gujarat	89.40	94.29	34.00	83.81	38.99	76.20
Haryana	91.78	94.55	67.98	89.81	76.86	87.44
Himachal Pradesh	95.68	100.00	69.96	85.07	66.70	80.56
J & K	82.25	95.00	58.15	87.98	60.69	88.93
Jharkhand	66.99	84.49	13.30	61.10	14.74	53.22
Karnataka	94.84	94.53	25.25	83.62	43.50	82.36
Kerala	29.44	51.25	87.44	97.91	79.73	94.26
Madhya Pradesh	83.94	95.45	18.12	76.28	22.27	76.32
Maharashtra	85.70	98.02	37.67	88.37	39.55	80.05
Manipur	59.65	70.58	97.63	100.00	58.86	63.66
Meghalaya	73.53	90.28	94.85	99.77	60.17	84.26
Mizoram	82.95	98.61	98.93	99.83	86.68	98.09
Nagaland	84.47	83.33	97.54	100.00	86.93	94.35
Odisha	82.88	95.36	15.55	65.63	8.84	55.97
Punjab	99.16	99.53	71.72	86.65	71.72	76.04
Rajasthan	78.38	91.66	21.38	79.91	34.59	81.67
Sikkim	85.21	95.83	96.88	98.96	86.04	96.53
Tamil Nadu	94.02	93.84	24.62	79.80	30.94	78.92
Tripura	86.70	99.65	86.94	76.97	13.78	47.45
Uttar Pradesh	96.63	99.09	20.06	82.50	16.24	66.80
Uttaranchal	90.00	98.28	68.96	87.50	71.46	86.27
West Bengal	94.43	96.88	53.06	86.78	24.75	67.31
All India	**86.71**	**93.25**	**42.42**	**84.72**	**36.87**	**76.26**
Source: 69th Round of NSS						

At all India level out of 100 households, more than 86 rural households have access to drinking water from protected source while more than 93 urban households are relying on safe sources for drinking water. When it comes to the access to latrine and bathroom, the situation becomes worse as only 42.42 per cent of rural households have access to latrine. This implies that more than 57 per cent of rural households openly defecate. Almost similar picture is observed in case of access to bathroom among rural households. Out of hundred rural households only 36.87 households have access to bathroom. However, at all India level urban households perform relatively better in terms of access to latrine and bathroom. Out of 100 hundred urban households, more than 84 have access to latrine and more than 76 households have access to bathroom. Overall for all three sanitation indicators urban households are in better position than the rural households.

From the rural-urban scenario, it is evident that access to latrine and bathroom scenario is very depressing for some of the states like Jharkhand, Odisha and Bihar. In Jharkhand, out of 100 rural households, only 13 households have access to latrine. Almost similar situation is observed for Odisha and Bihar. Out of 100 rural households only around 16 and 20 households have access to latrine. Out of 100 rural households, around 9 households have access to bathroom in Odisha while for Bihar it is around 14 and for Jharkhand it is around 15 households. In comparison to rural area though the urban situation is better for these states still these states have to improve a lot in terms of access to latrine and bathroom. In

Jharkhand out of 100 households, 61 households have access to latrine while for Odisha it is around 66 and for Bihar it is around 72. When it comes to access to bathroom comes, less than 60 households out of 100 have access to bathroom for these states. In Bihar, 47 urban households have reported access to bathroom while in Jharkhand 53 households and in Odisha around 56 households have reported access to bathroom.

5.1 A Composite Picture

For a comprehensive understanding on overall sanitation conditions of the states, in this section we attempt to present a composite index with three parameters discussed above. The indicators are per 100 households. Table 3 presents the Total Sanitation Index (TSI) values for and ranks of each states.

Table 3: State wise Total Sanitation Index

States	Index Scores	Rank
Andhra Pradesh	0.634	14
Arunachal Pradesh	0.848	4
Assam	0.730	11
Bihar	0.345	26
Chhattisgarh	0.429	24
Goa	0.838	5
Gujarat	0.599	19
Haryana	0.813	6
Himachal Pradesh	0.749	10
J & K	0.704	12
Jharkhand	0.235	28
Karnataka	0.618	16
Kerala	0.608	17
Madhya Pradesh	0.456	23
Maharashtra	0.624	15
Manipur	0.650	13
Meghalaya	0.759	9
Mizoram	0.953	1
Nagaland	0.897	3
Odisha	0.262	27
Punjab	0.813	7
Rajasthan	0.463	22
Sikkim	0.923	2
Tamil Nadu	0.558	21
Tripura	0.568	20
Uttar Pradesh	0.437	24
Uttaranchal	0.795	8
West Bengal	0.603	18

Source: 69th Round of NSS

TSI ranks are provided to each state in descending order, that is, the best performing state is ranked as one and the worst performing state gets the last rank. From the composite picture, it appears that north-eastern states are doing better than the other major states of India. The state Mizoram takes the first position in overall sanitation conditions followed by Sikkim and Nagaland. In contrast, Jharkhand is the worst performer at 28th position in the row followed by Odisha and Bihar. Though the access to safe drinking water is quite satisfactory for all these worst performing states, access to latrine and bathroom conditions is quite miserable for these states. Probably this is the reason, for these states are lagging behind other states in health indicators such as maternal and infant mortality rates.

5.2 Prevalence of Disease across States

This section portrays the picture of prevalence of four diseases namely (stomach problem, malaria, skin disease and fever) across 28 states. Our data sources provided four specific types of illness that households have reported during last 30 days. By taking these four specific diseases, we have constructed another variable that explains if the household members suffered from any one of the 4 diseases during last 30 days.

Table 4: State wise Variation in Diseases

States	Stomach	Malaria	Skin Disease	Fever	Any One
Andhra Pradesh	7.20	2.23	3.11	29.48	35.21
Arunachal Pradesh	29.78	14.13	6.31	41.24	55.81
Assam	38.92	2.04	12.07	43.20	65.69
Bihar	39.36	3.75	10.73	47.70	67.35
Chhattisgarh	16.78	8.67	4.11	35.47	51.07
Goa	11.81	2.43	3.82	25.35	35.76
Gujarat	5.76	4.12	2.68	25.04	31.97
Haryana	20.96	6.49	5.98	37.87	51.20
Himachal Pradesh	15.11	1.13	6.92	30.45	41.05
J & K	27.31	0.46	13.84	32.77	50.00
Jharkhand	32.02	12.80	10.45	40.22	62.94
Karnataka	6.86	0.49	2.77	30.27	34.41
Kerala	5.55	0.13	5.73	29.37	33.91
Madhya Pradesh	24.59	12.76	8.49	40.60	58.66
Maharashtra	12.39	3.70	3.12	30.72	39.35
Manipur	14.80	1.48	8.50	24.44	36.99
Meghalaya	25.88	9.46	6.41	34.38	52.32
Mizoram	19.05	8.52	5.53	18.28	41.26
Nagaland	22.57	0.81	6.83	32.29	49.42
Odisha	15.12	11.17	5.02	40.23	53.95
Punjab	25.09	2.73	14.08	45.39	60.31
Rajasthan	20.13	10.75	9.71	43.62	57.76
Sikkim	11.98	0.00	2.60	16.02	24.61
Tamil Nadu	4.58	0.88	3.53	18.90	24.00
Tripura	13.12	2.61	3.36	30.46	37.07
Uttar Pradesh	34.00	9.06	11.99	51.21	67.83
Uttaranchal	26.91	2.25	12.05	38.96	52.70
West Bengal	24.03	0.84	10.10	35.90	49.57
All India	**19.39**	**4.86**	**7.18**	**35.45**	**47.82**

Source: 69th Round of NSS

At all India level it is reported that out of 100 households, only 19 have reported to have stomach problem, while 35 households reported that their household members suffered from fever during last 30 days. The percentages of households reporting malaria and skin diseases are relatively lower as only 5% households reported of having malaria and 7% households reported of suffering from skin diseases. However, when it comes to the households that have reported of any one of these diseases during last 30 days, at all India level, out of 100 households around 48 households reported in affirmative.For a few states, more than 60 % of householdshave reported of suffering from any one of the diseases during last 30 days. The states, where more than 60 households reported about their suffering from different diseases are Assam, Bihar, Jharkhand, Punjab and Uttar Pradesh. In addition to these states, in states like Arunachal Pradesh, Chhattisgarh, Haryana, Jammu & Kashmir, Madhya Pradesh, Meghalaya, Odisha, Rajasthan and Uttaranchal, 50 % or more than 50 % households have reported that their members are suffering from any one of those four diseases.

Having analysed the overall state wise variation in diseases Table 5presents the rural urban differences in the prevalence of diseases across 28 states.

Table 5: State wise Rural-Urban Variation in Diseases

States	Stomach		Malaria		Skin Disease		Fever		Any One	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Andhra Pradesh	8.16	6.23	2.78	1.69	2.98	3.24	33.44	25.49	39.95	30.45
Arunachal Pradesh	35.34	21.51	14.94	12.90	6.74	5.65	44.81	35.75	60.11	49.46
Assam	39.35	37.57	2.49	0.66	12.71	10.05	44.76	38.36	67.01	61.64
Bihar	42.53	31.33	4.15	2.72	10.50	11.30	50.10	41.67	71.23	57.61
Chhattisgarh	16.46	17.17	9.25	7.95	4.88	3.16	35.16	35.86	51.32	50.76
Goa	6.94	16.67	1.39	3.47	2.08	5.56	21.53	29.17	28.47	43.06
Gujarat	5.50	6.01	3.81	4.42	2.31	3.03	28.60	21.61	34.72	29.31
Haryana	21.82	20.02	9.21	3.55	6.58	5.33	40.79	34.72	56.03	45.97
Himachal Pradesh	15.16	14.93	1.25	0.69	7.10	6.25	31.38	27.08	42.03	37.50
J & K	27.63	26.90	0.54	0.36	13.04	14.88	35.24	29.52	52.17	47.14
Jharkhand	34.70	28.04	15.54	8.71	11.30	9.19	43.19	35.80	67.63	55.97
Karnataka	7.54	6.20	0.50	0.48	2.38	3.15	33.73	26.89	37.80	31.10
Kerala	5.78	5.32	0.21	0.05	6.25	5.21	31.84	26.90	36.22	31.60
Madhya Pradesh	25.91	22.98	14.74	10.33	9.68	7.02	44.40	35.95	64.61	51.36
Maharashtra	12.79	11.99	3.87	3.52	2.98	3.26	35.19	26.22	43.83	34.82
Manipur	18.16	10.79	2.11	0.73	7.72	9.42	27.89	20.21	39.91	33.51
Meghalaya	27.70	22.45	10.17	8.10	7.35	4.63	36.40	30.56	56.37	44.68
Mizoram	21.85	16.32	13.85	3.30	4.44	6.60	20.96	15.63	47.96	34.72
Nagaland	23.86	20.54	1.14	0.30	6.82	6.85	30.49	35.12	49.05	50.00
Odisha	16.32	12.31	13.38	5.97	5.55	3.79	42.93	33.71	58.60	42.99
Punjab	23.50	26.70	3.56	1.89	15.07	13.07	50.19	40.53	64.04	56.53
Rajasthan	22.13	17.16	12.65	7.93	10.95	7.87	47.64	37.66	62.99	50.00
Sikkim	9.79	15.63	0.00	0.00	2.92	2.08	15.21	17.36	23.33	26.74
Tamil Nadu	5.40	3.75	0.89	0.88	3.79	3.26	20.42	17.33	26.26	21.67
Tripura	14.34	11.34	3.77	0.93	4.41	1.85	30.93	29.75	38.54	34.95
Uttar Pradesh	35.96	30.47	10.00	7.38	13.25	9.76	54.27	45.61	71.93	60.57
Uttaranchal	29.58	23.77	3.13	1.23	14.79	8.82	41.88	35.54	57.50	47.06
West Bengal	27.94	19.61	1.11	0.53	11.91	8.06	41.20	29.89	56.01	42.32
All India	**22.15**	**15.89**	**5.94**	**3.49**	**8.13**	**5.98**	**39.63**	**30.12**	**53.43**	**40.70**

Source: 69th Round of NSS

As expected at all India level higher percentage of rural households has reported that their household members suffered from different diseases compared to the urban households. At all India level, 22 % rural households have reported of suffering from stomach problem while around 16 % urban households reported of having stomach problem. When it comes to fever, around 40 rural households have accounted in comparison to 30 urban households. The rural-urban distribution show that out of 100 households, 53 rural households have reported of suffering from any one of the four diseases in comparison to around 41 urban households.

6. Interplay of Sanitation and Diseases: An Econometric Analysis

In order to establish the relationship between sanitation and prevalence of diseases we have undertaken a regression analysis considering the prevalence of disease as the dependent variable and the access to sanitation along with some socio economic variables as the independent variables. Tables6 to10 present the maximum likelihood estimationsfor the prevalence of any of the four diseases as the dependent variable and a number of independent variables such as sanitation and socio economic characteristics.

Table 6: Maximum Likelihood Estimation of Diseases				
Independent Variables		Dependent Variable: Did any members of the household suffer from any one of the four diseases (stomach problem, malaria, skin diseases, fever) in last 30 days?; No-0, Yes-1		
		Co-efficient	P Value	Odd Ratio
Constant***		-.834	.000	
Drinking Water (DW)	Sufficient Safe DW**	-.099	.028	.905
	Insufficient Safe DW	.061	.206	1.06
	Sufficient Unsafe DW***	-.193	.000	.824
Quality of DW***		-.425	.000	.653
DW Purification***		-.161	.000	.850
Storage	Non-metal***	-.324	.000	.722
	Metal***	-.319	.000	.726
Access to Latrine***		-.057	.004	.944
Access to Bathroom***		-.161	.000	.851
Garbage Collection***		-.143	.000	.866
Garbage Deposit		.021	.473	1.02
Ventilation***		-.052	.002	.948
Flies/Mosquito***		.804	.000	2.23
Drainage		.000	.970	1.00
Disposal of Waste Water		-.163	.573	.849
Education Male	Primary/Secondary***	.062	.003	1.06
	Higher Secondary**	-.049	.053	.951
Access to Electricity***		.357	.000	1.43
Animal Shed***		.320	.000	1.37
Kitchen	Separate with water pipe***	-.287	.000	.750
	Separate without water pipe***	-.058	.000	.942
Religion	Hindu***	-.259	.000	.771
	Muslim***	-.127	.002	.880
	Christian***	-.227	.000	.796
Household Size***		.156	.000	1.16
MPCE**		-3.06	.033	.999
Social Group	SC***	.095	.000	1.09
	OBC	-.037	.129	.963
	Others	.012	.640	1.01
Age***		.416	.000	1.51
Log Likelihood		-61547.667		
LR $x^2_{(30)}$		9087.87		
Total Observations		95481		

Note: * Statistically significant difference means at the 1 per cent, ** at the five per cent and * at the 10 per cent level.**

Table 6 discusses the factors that determine the prevalence of diseases among any one members of household in last 30days from either stomach problem or malaria or skin diseases or fever. The estimates show that if the households have access to drinking water from safe sources throughout the year, their chances of falling in anyone of these four diseases reduce 10 per cent than the households who access insufficient unsafe drinking water. Similarly, the households who even access drinking water from unprotected sources throughout the year, their chances of suffering from anyone illness reduces by 18% than the households who access insufficient drinking water. However, we did not get any significant result for the households that avail drinking water from safe sources but insufficient throughout the year.From this we can infer that regular access to drinking water is crucial to improve the

health outcome.When the drinking water is without any defect, then the likelihood of diseases reduces by 35 per cent in comparison to the households who access bad quality drinking water. Similarly, if the households have the practice of purifying the drinking water, then their chances of suffering from any kind of illness reduces by15% than the households who do not purify drinking water. The estimation shows that if the households use any metal or non-metal container for storing water then the chance of suffering from any diseases reduces by 28 % than the households who don't store in metal or non-metal container.

As hypothesised access to latrine and bathroom has significant impact on illness of household members. The households that have access to latrine have 6% less chance of falling ill in comparison to their counterparts who don't have access to latrine. Similarly, the estimation proved that the households that have access to bathroomhas 15% less chance of suffering from illness than the households that doesn't have access to bathroom.

Other than these sanitation indicators, we have included some hygienic indicators like arrangement made for garbage collection from households, garbage deposit, drainage system of the households, and disposal of waste water, whether the households have animal shed or poultry farm in their house, whether the households are suffering from flies or mosquito problem in their house and proper ventilation. We found a mixed result for these variables. If arrangements are made for garbage collection, then the probability of suffering from illness reduces by 14 % than the households where no arrangements are made. Similarly if the households' dwelling unit have good or satisfactory ventilation, the probability of illness comes down by 6%. The result on existence of animal shed or poultry farm shows that if the households have any kind of animal shed or poultry farm then their chances of suffering from diseases increases by 37 per cent than the households who don't have animal shed or poultry farm. Similarly, if the households face problems of flies or mosquito then their chance of illness increases by 127 times than the households who don't face problem of flies or mosquitoes. However, we did not find any significant results for the drainage system of the households and how the households are disposing waste water.

In addition to water, sanitation and hygienic indicators; we have included certain households' characteristics like education, religion, social group, household size and the economic status of the households in our analysis. The estimation on education shows that if the head of households have primary or secondary education then their chances of illness increases by 6 per cent while if the households have secondary education then their chances reduces by5% than the illiterate households. The result on social group shows that if the households belong to SC, then their chance of illness increases by 9% than the ST households. We did not find any significant result for other backward caste (OBC) and other communities. The one unit increase in household size increases the probability of illness by 16 percentages. Similarly one per cent increase in income reduces the probability of illness by 1% times.

Having analysed the factors that determine the probability of households suffering from illness, we attempt to discuss the maximum likelihood estimation of some specific diseases. As we discuss the factors that determine specific diseases, in the analysis we have not included all the variables, analysed in any kind of disease. Table 7 explains the maximum likelihood estimation of stomach problem.

Table 7: Maximum Likelihood Estimation of Stomach Problem				
Independent Variables		Dependent Variable: Did any members of the household suffer from stomach problem in last 30 days?; No-0, Yes-1		
		Co-efficient	P Value	Odd Ratio
Constant***		-1.25	.000	.286
Drinking Water (DW)	Sufficient Safe DW***	-.172	.001	.841
	Insufficient Safe DW	-.045	.423	.955
	Sufficient Unsafe DW***	-.310	.000	.732
Quality of DW***		-.589	.000	.554
DW Purification***		-.293	.000	.745
Storage	Non-metal***	-.364	.000	.694
	Metal***	-.410	.000	.663
Access to Latrine**		-.054	.020	.947
Access to Bathroom***		-.201	.000	.817
Garbage Collection***		-.199	.000	.819
Garbage Deposit***		-.102	.006	.902
Ventilation***		-.071	.000	.931
Flies/Mosquito***		.638	.000	1.89
Drainage**		-.053	.025	.948
Disposal of Waste Water		.209	.547	1.23
Education Male	Primary/Secondary	.033	.201	1.03
	Higher Secondary	.043	.172	1.04
Kitchen	Separate with water pipe***	-.260	.000	.770
	Separate without water pipe	-.013	.481	.986
Religion	Hindu***	-.238	.000	.788
	Muslim	-.076	.130	.926
	Christian	.063	.273	1.06
Household Size***		.131	.000	1.14
MPCE***		-6.93	.002	.999
Social Group	SC	.047	.142	1.04
	OBC***	-.085	.005	.918
	Others***	.084	.009	1.08
Age***		.256	.002	1.29
Log Likelihood		-44724.959		
LR $x^2_{(28)}$		4489.67		
Total Observations		95497		

Note: * Statistically significant difference means at the 1 per cent, ** at the five per cent and * at the 10 per cent level.**

The households with stomach problem and households without stomach problem are regressed with independent variables- drinking water, quality of drinking water, drinking water purification, and storage of drinking water, access to latrine, access to bathroom, garbage collection, garbage deposit, ventilation, flies or mosquitoes, drainage, disposal of waste water, education, quality of food, religion, household size, economic status of the households, social group and age of the head of the household. The estimation shows that if the household has access to drinking water throughout the year irrespective of the sources- protected or unprotected, then the probability of stomach problem reduces by 16% and 27% respectively. As hypothesised, if there are no defects in drinking water, then the chance of stomach problem reduces by 45 per cent. Similar result is observed in case of drinking water purification. If the households practices drinking water purification, then the probability of stomach problem comes down by 26 per cent. Households that store drinking water in metal

or non-metal containerhave 34 % and 31% less chances of suffering from stomach problem respectively.

The chances of stomach problem for households that have access to latrine and bathroom reduce by6% and 19 % respectively in comparison to households without latrine and bathroom. Other sanitation indicators like arrangements for garbage collection and garbage deposit have significant impact on stomach problem. If arrangements are made for collecting garbage and depositing in either bio-gas plant or manure pit than dumping it outside then chances of suffering from stomach problem for those households reduce by 19% and 10% respectively. Households with good or satisfactory ventilation to the dwelling unit have lesser chance of suffering from stomach problem in comparison to the household with bad ventilation. Similarly, for the households that are inflicted by flies or mosquitoes problem, the chances of suffering from stomach problem increases by 89 per cent. If the households have well drainage system that is either underground or covered '*pucca*' then the probability of stomach problem reduces by 6% in comparison to the households with open '*katcha*' drainage. The estimation on quality of food that is how the food is cooked for the family shows that if the households have separate kitchen with pipe, then the chances of stomach problem reduce by 23% than the households without separate kitchen. One unit increase in household member leads to 14 per cent increase in probability of suffering from stomach problem. The households belonging to OBC category have 9% less chances of having stomach problem compared to ST households

Table 8 discusses the maximum likelihood estimation of malaria. As malaria is a mosquito-borne infectious disease, in the analysis we have included those sanitation indicators that facilitatesthe spread of mosquitoes.

Table 8: Maximum Likelihood Estimation of Malaria

Independent Variables		Dependent Variable: Did any members of the household suffer from Malaria in last 30 days?; No-0, Yes-1		
		Co-efficient	P Value	Odd Ratio
Constant***		-4.82	.000	.008
Access to Latrine***		-.434	.000	.647
Garbage Collection		-.045	.171	.955
Garbage Deposit***		.315	.000	1.37
Flies/Mosquito***		1.51	.000	4.54
Drainage***		.191	.000	1.21
Disposal of Waste Water***		1.14	.009	3.14
Education Male	Primary/Secondary**	.100	.034	1.10
	Higher Secondary	.066	.249	1.06
Religion	Hindu***	-.358	.000	.699
	Muslim***	-.341	.000	.710
	Christian***	-.363	.000	.695
Household Size***		.126	.000	1.13
MPCE***		-.000	.006	.999
Social Group	SC***	-.395	.000	.673
	OBC***	-.338	.000	.712
	Others***	-.605	.000	.545
Age*		.306	.067	1.35
Log Likelihood		-17639.388		
LR $x^2_{(19)}$		1843.83		
Total Observations		95493		

Note: * Statistically significant difference means at the 1 per cent, ** at the five per cent and * at the 10 per cent level.**

The result shows that households who face the problem of flies or mosquito throughout the year, their probability of suffering from malaria increases by 354 times than the households without flies or mosquito problem. Households that have access to latrine, have 36% less chances of suffering from malaria. Similar to our earlier findings, the estimation on education shows that the probability of households with primary or secondary education increases by 10 per cent than the illiterate households.

Table 9: Maximum Likelihood Estimation of Skin Diseases				
Independent Variables		Dependent Variable Did any members of the household suffer from Skin Diseases in last 30 days?; No-0, Yes-1		
		Co-efficient	P Value	Odd Ratio
Constant***		-3.54	.000	.028
Drinking Water (DW)	Sufficient Safe DW	.009	.910	1.00
	Insufficient Safe DW	.098	.268	1.10
	Sufficient Unsafe DW	.049	.592	1.05
Quality of DW***		-.538	.000	.583
DW Purification***		-.264	.000	.767
Storage	Non-metal	-.004	.935	.995
	Metal	-.066	.234	.935
Access to Latrine		.034	.334	1.03
Access to Bathroom		-.055	.121	.945
Garbage Collection***		-.079	.004	.923
Garbage Deposit*		-.098	.081	.905
Ventilation		-.044	.152	.956
Flies/Mosquito***		.688	.000	1.99
Drainage		-.049	.169	.951
Disposal of Waste Water		-.610	.400	.542
Education Male	Primary/Secondary***	.124	.002	1.13
	Higher Secondary***	.135	.006	1.14
Access to Electricity***		.296	.000	1.34
Animal Shed***		.389	.000	1.47
Kitchen	Separate with water pipe**	-.119	.018	.887
	Separate without water pipe**	-.077	.010	.925
Religion	Hindu***	-.386	.000	.679
	Muslim**	-.145	.038	.864
	Christian**	-.199	.019	.819
Household Size***		.113	.000	1.12
MPCE		7.39	.685	1.00
Social Group	SC***	.206	.000	1.22
	OBC	.060	.202	1.06
	Others***	.157	.002	1.17
Age**		.312	.025	1.36
Log Likelihood		-23710.412		
LR $x^2_{(30)}$		1916.72		
Total Observations		95481		

Note: * Statistically significant difference means at the 1 per cent, ** at the five per cent and * at the 10 per cent level.**

Table 9 reports the factors that determine the likelihood of skin diseases. It is found that sources of drinking water do not have any significant impact on the likelihood of skin disease. However, the quality and purification of drinking water do have significant impact

on skin diseases. If there is no defect in the drinking water then the chance of skin disease reduces by 42 per cent. From the estimation we did not find any significant impact of access to latrine and bathroom on skin disease.

The estimation of other sanitation indicators show that if the households have arrangements for garbage collection, then the probability of having skin diseases reduces by 8% than the households who don't have proper arrangements for garbage collection. Further, if after the collection garbage is deposited to bio-gas plant or manure pit, then the chances of skin disease reduce by 10% than if it is dumped outside in dumping spot. If the households face problem of flies or mosquitoes throughout the year, then the probability of skin diseases increases by 99 per cent. The estimation on households with animal shed shows that the probability of skin disease increases 47 per cent for households who have animal shed or poultry farm in comparison to households without animal shed or poultry farm. If the households have separate kitchen with or without water pipe then the probability of having skin disease reduce by 12% and 8% respectively than the household without separate kitchen.

It is evident from the analysis that education does not prevent a household to have skin disease. The result on education show that if the head of the household's education have primary or secondary education then the chance of skin disease increases by 13 per cent than the illiterate. Similarly the probability of households with higher secondary education also increases by 14 per cent. This might be due to the fact that household with education report skin disease more than the illiterate households. The result on household size shows that one per cent increase in household size, the probability of skin disease increases by 12 per cent.

Table 10 reports the likelihood estimation of fever. If the households access drinking water throughout the year from protected or unprotected sources then the probability of fever reduces by 8% and 14% respectively than the households with insufficient drinking water from unprotected sources. When the drinking water does not have any defect, then the incidence of fever reduces by 21% compare to their counterparts who have access to bad quality drinking water. Similarly if the households purify drinking water, the probability also reduces by 12% in comparison to households who do not purify drinking water. If the households store drinking water in a non-metal or metal container then the chances reduce by 30% and 28% than the households who do not store drinking water.

It is evident from the analysis that households who have access to latrine, their chances of suffering from fever increases 7% compared to households without access to latrine. Access to bathroom also has significant impact on households reporting fever. The households who have access to bathroom, their probability of reporting fever reduces by 14% than the households without having access to bathroom. For the household reusing, after treatment of waste water, the probability fever incidence comes down by 52% than disposing waste water to open areas. Similarly the result on other sanitation indicators show that if the household is residing in a properly ventilated house then the chances of suffering from fever reduce by 7% compared to a house without ventilation. If the household is facing problem of flies or mosquitoes, then the probability of reporting fever increases by 97 per cent. Further, the probability of fever for households with animal shed or poultry farm increases by 26 per cent compared to households without animal shed. If the household is preparing food in separate kitchen with pipe, then the chances of fever reduces by21% than the households who don't have separate kitchen.

Table 10: Maximum Likelihood Estimation of Fever				
Independent Variables		Dependent Variable Did any members of the household suffer from fever in last 30 days?; No-0, Yes-1		
		Co-efficient	P Value	Odd Ratio
Constant***		-1.44	.000	
Drinking Water (DW)	Sufficient Safe DW*	-.074	.102	.928
	Insufficient Safe DW	.073	.134	1.07
	Sufficient Unsafe DW***	-.143	.005	.866
Quality of DW***		-.231	.000	.793
DW Purification***		-.121	.000	.885
Storage	Non-metal***	-.355	.000	.701
	Metal***	-.317	.000	.727
Access to Latrine***		-.062	.002	.939
Access to Bathroom***		-.148	.000	.862
Garbage Collection***		-.125	.000	.882
Garbage Deposit		.018	.547	1.01
Ventilation***		-.071	.000	.930
Flies/Mosquito***		.679	.000	1.97
Drainage		.020	.287	1.02
Disposal of Waste Water**		-.719	.044	.487
Education Male	Primary/Secondary	.020	.355	1.02
	Higher Secondary***	-.131	.000	.876
Access to Electricity***		.160	.000	1.17
Animal Shed***		.232	.000	1.26
Kitchen	Separate with water pipe***	-.229	.000	.795
	Separate without water pipe	-.022	.171	.977
Religion	Hindu***	-.118	.002	.888
	Muslim	-.045	.285	.955
	Christian***	-.205	.000	.814
Household Size***		.131	.000	1.14
MPCE		-1.14	.393	.999
Social Group	SC***	.161	.000	1.17
	OBC**	.058	.021	1.05
	Others**	.059	.027	1.06
Age***		.412	.000	1.51
Log Likelihood		-59124.983		
LR $x^2_{(30)}$		5895.61		
Total Observations		95481		

Note: * Statistically significant difference means at the 1 per cent, ** at the five per cent and * at the 10 per cent level.**

The result on household characteristics shows that the chances of fever for households with higher education reduce by 13% times than illiterate households. With one unit increase in the size of the household the probability of suffering from fever increases by 14 per cent.It is found that if the household belongs to SC, OBC or other caste, then the probability of reporting fever increases by 17%, 5% and 6% times than the households belonging to schedule tribe.

7. Conclusion

From our analysis of the 69th round of NSSO survey data on sanitation facility and disease prevalence we observed that there is wide disparity in across states in the access to safe drinking water and sanitation facilities. There is marked differences between rural and urban India in the access to sanitation facilities. So far as the relationship between the sanitation and health outcome is concerned our analysis showed that better sanitation facilities do have a positive impact on the health outcomes. From our analysis of four diseases (stomach problem, malaria, skin diseases and fever) that are more caused due to sanitation facilities we observed that better sanitation facilities in terms of access to toilets and bathroom access to regular safe drinking water, practice of storing drinking water in metal or non-metal container, absence of flies and mosquitoes, having separate kitchen and proper disposal of wastes reduces the incidence of diseases. Therefore, we can conclude that in order to reduce the prevalence of diseases there is a greater need intensify the Clean India campaign to ensure the access to the toilets by each household and provide safe, regular and sufficient drinking water to each households.

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