

Swachh Bharat Mission – Preliminary estimations of potential health impacts from increased sanitation coverage

Background

In 2011, the Government of India's Census found that 53.1% of households nationally, and 69.3% of households in rural areas, had no water closet or latrine and practised open defecation (1). To mitigate the situation, the Government launched a nationwide programme in 2014 named the Swachh Bharat Mission (SBM) (2,3). The programme aims to make India free from open defecation and ensure 100% scientific management of municipal solid waste by 02 October 2019.

WHO is the Custodian Agency or co-Custodian Agency for reporting on several SDG indicators, including the proportion of population using safely managed sanitation services (Indicator 6.2.1), the proportion of wastewater safely treated (Indicator 6.3.1), and the mortality from unsafe water, sanitation and hygiene (Indicator 3.9.2). WHO has therefore developed methods and tools to estimate health gains based on the latest available evidence linking sanitation and mortality from diarrhoeal disease.

This report presents initial estimates of the expected health gains from reduced diarrhoeal disease due to increased sanitation coverage following the Swachh Bharat initiative.

Methods

The standard methods for estimating health impacts from environmental risks are Comparative Risk Assessment (CRA) methods (4). WHO has been reporting the diarrhoea mortality from water, sanitation and hygiene by country using CRA methods (5), including for SDG reporting.

To estimate health gains from improvements in sanitation two types of data are needed:

- the proportion of the population using basic sanitation services (use of improved sanitation facilities which are not shared)¹(6),

¹ Information on the definitions of improved and basic sanitation is provided in the latest report of the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) (6). Improved sanitation facilities are those designed to hygienically separate excreta from human contact. These include wet sanitation technologies (flush and pour flush toilets connecting to sewers, septic tanks or pit latrines) and dry sanitation technologies (ventilated improved pit latrines; pit latrines with slabs; or composting toilets).

- the proportion of the population living in communities in which at least 75% of the population uses basic sanitation services (called “community coverage”, since evidence shows that in high-coverage communities the risk of diarrhoea is smaller (7)).

For this report, the following input data were used:

- Burden of total disease from diarrhoea for India: WHO Cause-specific mortality and disease burden by country, 2000-2015 (8,9) with a projection up to the year 2019 based on the continuation of the most recent trends.
- Exposure-response relationship, based on a systematic review of the epidemiological literature (7).
- Population figures: 2017 Revision of World Population Prospects (10).
- Several different sanitation scenarios, drawn from different data sources and representing different time periods:
 - Scenario 1 (2014, pre-SBM): based on the Rapid Survey on Children (RSOC) survey (11)
 - Scenario 2 (2015/16): based on the National Family Health Survey 2015/2016 (NFHS) survey (12).
 - Scenario 3 (2017/18): based on SBM administrative reporting (13).
 - Scenario 4 (August 2018): a hypothetical case of 85% of the population using basic sanitation services.
 - Scenario 5 (December 2018): a hypothetical case of 90% of the population using basic sanitation services.
 - Scenario 6 (March 2019): a hypothetical case of 95% of the population using basic sanitation services.
 - Scenario 7 (October 2019): a hypothetical case of 100% of the population using basic sanitation services.

Household and community sanitation levels in Scenarios 1 and 2 were based on the results of household surveys (11,12), while the Swachh Bharat Mission administrative reporting was used for estimating use of basic sanitation facilities at the household level for Scenario 3. To estimate the proportion of communities with sanitation coverage of at least 75% in 2017/2018 for Scenario 3, in August 2018 for scenario 4, December 2018 for scenario 5 and March 2019 for scenario 6, we assume the same relative change in the proportion of communities *without* sanitation coverage of at

least 75% as for the proportion of households *not* having access to basic sanitation. The relative change is calculated on the basis of the trend observed between the 2015/2016 survey and 2017/2018 administrative reporting or the 2018 and 2019 hypothetical scenarios. Finally scenario 7 assumed 100% use of basic sanitation facilities at both household and community scales. (Table 1)

Table 1: Input data for sanitation coverage at household and community scales

Scenario	Year	Household sanitation coverage with basic facilities, %	Communities with basic sanitation facility coverage \geq 75%, %	Source
1 (pre-SBM)	2014	41.8	12.8	RSOC 2014 (11)
2	2015/2016	48.5	28.2	NFHS 2015/2016 (12)
3	2017/2018	78.6 ¹	70.2 [*]	Swachh Bharat administrative reporting 2017/2018 (13)
4	August 2018	85 [#]	79.1 [#]	-
5	December 2018	90 [#]	86.1 [#]	-
6	March 2019	95 [#]	93 [#]	-
7	October 2019	100 [#]	100 [#]	-

Notes: ¹ preliminary figures from the NARSS household survey confirm these results with an estimated 77% of household coverage with basic facilities,* estimated; # hypothetical

The effect of sanitation on the reduction of diarrhoea appears to be higher when more than about three quarters of households in a community are covered with basic sanitation services. This has been indicated in a recent meta-analysis of sanitation intervention studies (7) and is further supported by studies of observational data (14,15). The precise share of households within a community that needs to be covered with basic sanitation services at which people would experience these increased health benefits is however not very well known as evidence remains limited and likely also depends on local circumstances.

Additionally to deaths and disease burden from diarrhoeal disease, deaths and disease burden from protein-energy malnutrition (PEM) are presented in Tables 2 and 3. Sanitation is not only linked to diarrhoea but also to malnutrition, through repeated diarrhoea episodes and general health status. An approximate estimate of the impact of sanitation on malnutrition has previously been estimated as about 25% of PEM being caused by water, sanitation and hygiene-related diarrhoeal disease

episodes (16,17). The results of such an estimate in relation with the improvements made under the Swachh Bharat project are highlighted in Tables 2 and 3. This estimate is however a likely underestimate, as it does not take into account the consequences of malnutrition on other health outcomes.

Results

In 2014 (Scenario 1, before the start of the Swachh Bharat Mission), there were an estimated 140 000 deaths from diarrhoeal disease attributable to unsafe sanitation out of a total of 443 000 diarrhoea deaths; about 39 000 of those attributable deaths occurred in children younger than five years. After the start of the Swachh Bharat Mission, mortality from unsafe sanitation is estimated to have declined to about 120 000 diarrhoeal deaths per year in 2015/2016 (Scenario 2), 50 000 deaths in 2017/2018 (Scenario 3) and – for the hypothetical scenarios 4, 5, 6 and 7 of 85% and 90% in 2018, and 95% and 100% access with safe sanitation in 2019 – 35 000 deaths, 23 000 deaths, 11 000 deaths and 0 deaths from unsafe sanitation in 2019. (Table 2, for estimates of incidence and disability-adjusted life years (DALYs) see Table 3)

Considering the change in population figures and numbers of total diarrhoeal deaths, and assuming that all factors related to diarrhoeal disease other than sanitation remained unchanged, the annual number of deaths avoided through the Swachh Bharat Mission would be about 12 000 in 2015/2016, 75 000 in 2017, 75 000, 91 000 or 103 000 in 2018 and 103 000, 112 000 or 122 000 in 2019, depending on the degree of coverage reached (Table 2). If scenario 5 is achieved in 2019, an estimated 305 000 deaths will have been avoided since the beginning of the Swachh Bharat Mission.

The population attributable fraction – which is the proportional reduction in death that would occur if exposure to a risk was removed – declined from 32% in 2014 to 29% (2015/2016), 13% in 2017, 13%, 9% or 6% in 2018 (depending on chosen scenario 3, 4 or 5) and 6%, 3% or 0% in 2019 (depending on chosen scenario 5, 6 or 7). (Table 2)

Assuming the same relationship between diarrhoea deaths and incidence attributable to unsafe sanitation as between total diarrhoea deaths and incidence for India, diarrhoea incidence per year is estimated to decline from 199 million in 2014 to 33 million until December 2018 and to 0 diarrhoea cases attributable to unsafe sanitation until October 2019 (18).

Table 2: Estimated annual deaths from sanitation-related diarrhoea and PEM*, 2014 (baseline) – 2019 (end) of Swachh Bharat

Estimates based on data available in June 2018

Scenario	Year	diarrhoea deaths per year attributable to unsafe sanitation, all ages	diarrhoea deaths, per year attributable to unsafe sanitation, <5years	PEM deaths per year attributable to unsafe sanitation, <5 years [‡]	PAF of unsafe sanitation on diarrhoea	PAF of unsafe sanitation on infectious diseases	PAF of unsafe sanitation on PEM [‡]	deaths (diarrhoea and PEM) per year avoided compared to baseline
1	2014	140 358	38 791	1 239	32%	11%	8%	-
2	2015	120 360	32 215	1 061	29%	10%	7%	12 522
	2016	120 360	32 215	969	29%	10%	7%	12 513
3	2017/2018	50 355	13 053	357	13%	5%	3%	75 777
4	August 2018	34 849	9 034	247	9%	3%	2%	91 393
5	December 2018	22 653	5 872	161	6%	2%	1%	103 675
6	March 2019	10 515	2 682	70	3%	1%	1%	112 387
7	October 2019	0	0	0	0%	0%	0%	122 971 [#]
Cumulative health impacts 1-7	2014-2019	-	-	-	--	-	-	307 162*

PAF: population attributable fraction; note: health impacts for 2018 are based on administrative reporting of Swachh Bharat Mission, health impacts for 2019 are based on the hypothetical scenario of 100% sanitation coverage in 2019.

*PEM: Protein-energy malnutrition; [‡]Approximate estimate only, based on limited epidemiological data, [#]Number does not exactly correspond to diarrhoea and PEM deaths in 2014 as population figures and numbers of total diarrhoeal deaths has changed, *Cumulative estimates use a proportional average for 2018 and 2019.

Table 3: Estimated annual incidence and DALYs from sanitation-related diarrhoea and PEM*, 2014 (baseline) -2019 (end) of Swachh Bharat

Estimates based on data available in June 2018

Scenario	Year	diarrhoea incidence per year attributable to unsafe sanitation, all ages	diarrhoea DALYs per year attributable to unsafe sanitation, all ages	diarrhoea DALYs, per year attributable to unsafe sanitation, < 5years	PEM DALYs per year attributable to unsafe sanitation, <5 years [‡]	PAF of unsafe sanitation on diarrhoea	PAF of unsafe sanitation on infectious diseases	PAF of unsafe sanitation on PEM [‡]	DALYs (diarrhoea and PEM) per year avoided compared to baseline
1	2014	199 million	6 979 413	3 552 724	250 655	32%	11%	8%	-
2	2015	173 million	5 663 317	2 742 902	218 470	29%	10%	7%	606 621
	2016	173 million	5 663 317	2 742 902	211 432	29%	10%	7%	605 895
3	2017/2018	73 million	2 280 511	1 059 669	87 582	13%	5%	3%	3 538 537
4	August 2018	51 million	1 578 273	733 365	60 613	9%	3%	2%	4 267 745
5	December 2018	33 million	1 025 948	476 720	39 401	6%	2%	1%	4 841 281
6	March 2019	15 million	467 176	212 627	18 197	3%	1%	1%	5 153 667
7	October 2019	0	0	0	0	0%	0%	0%	5 639 041 [#]
Cumulative health impacts 1-7	2014-2019	-	-	-	-	--	-	-	14 295 921 [*]

DALYs: disability-adjusted life years, PEM: protein-energy malnutrition, PAF: population attributable fraction; note: health impacts for 2018 are based on administrative reporting of Swachh Bharat Mission, health impacts for 2019 are based on the hypothetical scenario of 100% sanitation coverage in 2019.

*PEM: Protein-energy malnutrition; [‡]Approximate estimate only, based on limited epidemiological data, [#]Number does not exactly correspond to diarrhoea and PEM DALYs in 2014 as population figures and numbers of total diarrhoeal deaths has changed, *Cumulative estimates use a proportional average for 2018 and 2019.

The assessed and projected progress on sanitation coverage and health gains is shown in Figure 1.

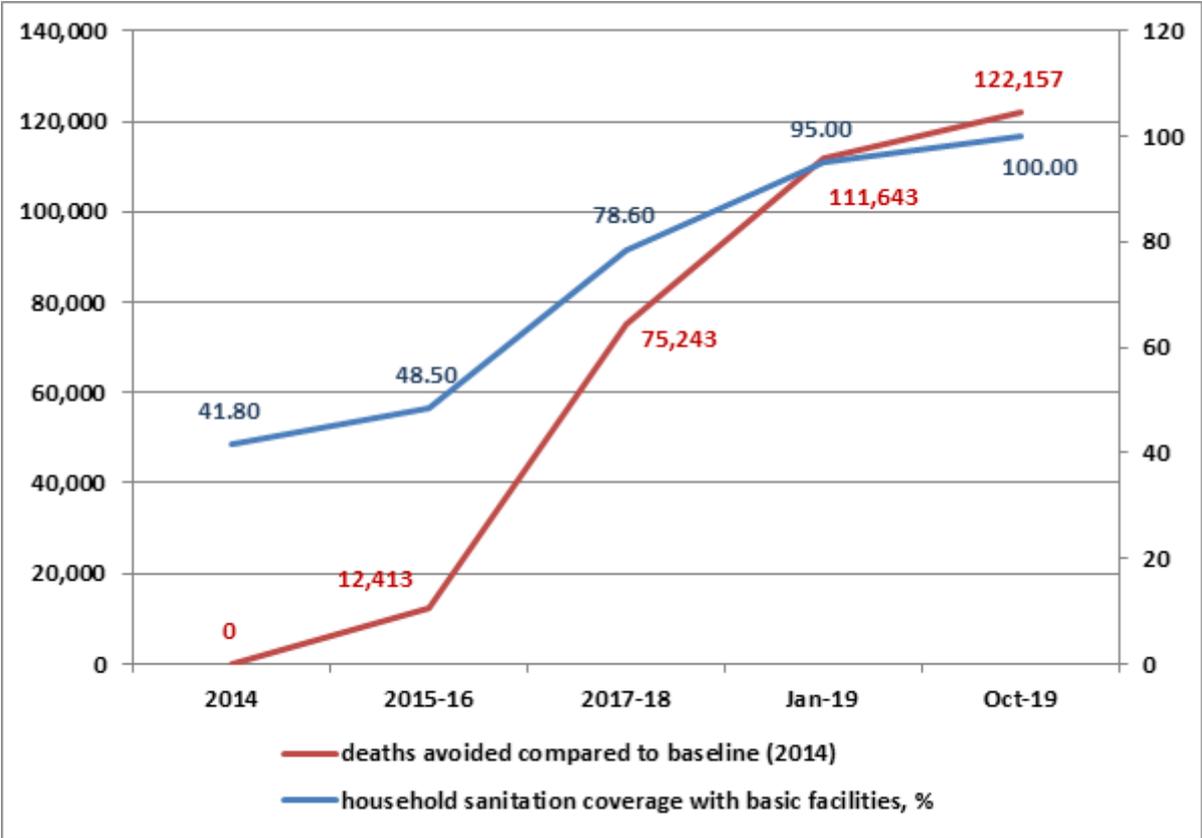


Figure 1: Preliminary projections of sanitation coverage and deaths avoided (per year) during the Swachh Bharat project, India, 2014-2019.

Limitations

The baseline scenario 1 is based on a single household survey (RSOC 2014) which could under- or over-estimate household or community sanitation coverage compared to the actual situation in 2014. However, results from this survey are consistent with other data sources from the 2011 Census, the 2012 National Sanitation Survey, and the 2015/16 NFHS.

Scenario 3 is based on administrative reporting rather than household survey results – though preliminary results from the NARSS household survey confirm results for household coverage with basic facilities, and required an estimation of community coverage based on an extrapolation of the trend for household sanitation coverage found in the household surveys used for Scenarios 2 and 3. Hence, the Scenario 3 estimates are not fully comparable to the results of scenarios 1 and 2. A more

appropriate comparison can be made in the future when new household surveys such as the National Annual Rural Sanitation Survey are completed and available.

The preliminary estimations of deaths avoided as shown in Table 2 take into account different population figures and different numbers of diarrhoeal deaths (from various factors) for the respective years, but do not take into account the change in household or community sanitation coverage that would have occurred had the Swachh Bharat Mission not been started. It is likely that some of the deaths would have been avoided even in the absence of the Swachh Bharat Mission due to more modest improvements in sanitation coverage along the lines of historical trends. The calculation of total deaths avoided since the beginning of the Swachh Bharat Mission assumes equal numbers of annual deaths for the years 2015/2016.

We have only calculated the health impacts from improvements in sanitation coverage. It is possible that the Swachh Bharat Mission led to additional health impacts through changes in personal hygiene (e.g., handwashing behaviour) and consumption of safe drinking water (e.g., reduced risk of faecal contamination of drinking water). Had the different scenarios considered the health impacts from hygiene and drinking-water, estimated health impacts would be larger.

Furthermore, there is evidence that improvements in drinking water supply, sanitation services and personal hygiene have positive health impacts in addition to reductions in diarrhoeal disease, e.g., improved nutritional status and reduced incidence of infectious diseases such as different neglected tropical diseases and acute respiratory infections (19–24). Therefore, it is possible that the Swachh Bharat Mission has contributed to additional health impacts which are not quantified for this assessment.

Conclusions

This analysis has shown that if the SBM aims are achieved, considerable health gains would be realized. Two related factors contribute to the health gains: the increase in basic sanitation coverage at the household level, and an increase in the number of communities where at least three quarters of the population uses private toilets. Reference to the administrative data of the SBM suggests that much progress has already been made, and that more than half of the health gains that full sanitation coverage is expected to yield have already been realized. However, this preliminary estimate relies on administrative data rather than household surveys, and these preliminary estimates of the actual health impacts should be regularly updated as survey data from the NARSS or other sources become available.

References

1. Census 2011 India [Internet]. 2015 [cited 2018 Mar 2]. Available from: <https://www.census2011.co.in/>
2. Ministry of Drinking Water and Sanitation. Swachh Bharat Mission - Gramin [Internet]. 2018 [cited 2018 Feb 27]. Available from: <http://swachhbharatmission.gov.in/sbmcms/index.htm>
3. Ministry of Housing and Urban Affairs. Swachh Bharat Urban [Internet]. 2018 [cited 2018 Feb 27]. Available from: <http://www.swachhbharaturban.in/sbm/home/#/SBM>
4. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ, the Comparative Risk Assessment Collaborating Group. Selected major risk factors and global and regional burden of disease. *Lancet*. 2002;360(9343):1347–60.
5. Prüss-Ustün A, Bartram J, Clasen T, Colford JM Jr, Cumming O, Curtis V, et al. Burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings: a retrospective analysis of data from 145 countries. *Trop Med Int Health*. 2014;19(8):894–905.
6. WHO, UNICEF. Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines [Internet]. Geneva: WHO, UNICEF; 2017 [cited 2018 Mar 18]. Available from: <https://washdata.org/sites/default/files/documents/reports/2018-01/JMP-2017-report-final-highlights.pdf>
7. Wolf J, Hunter PR, Freeman MC, Cumming O, Clasen T, Bartram J, et al. Impact of Drinking Water, Sanitation and Hand Washing with Soap on Childhood Diarrhoeal Disease: Updated Meta-Analysis and – Regression. *Trop Med Int Health* [Internet]. 2018 [cited 2018 Mar 18]; Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1111/tmi.13051>
8. WHO. Disease burden and mortality estimates: Cause-specific mortality, 2000-2015 [Internet]. WHO. 2018 [cited 2018 Feb 27]. Available from: http://www.who.int/healthinfo/global_burden_disease/estimates/en/
9. WHO. Disease burden and mortality estimates: Disease burden, 2000-2015 [Internet]. WHO. 2018 [cited 2018 Feb 27]. Available from: http://www.who.int/healthinfo/global_burden_disease/estimates/en/
10. United Nations, DESA/Population Division. World Population Prospects 2017 [Internet]. 2017 [cited 2018 Feb 27]. Available from: <https://esa.un.org/unpd/wpp/>
11. Ministry of Women & Child Development. Rapid Survey On Children (RSOC) 2013-14 [Internet]. 2018 [cited 2018 Feb 27]. Available from: <http://wcd.nic.in/acts/rapid-survey-children-rsoc-2013-14>
12. International Institute for Population Sciences. National Family Health Survey [Internet]. 2018 [cited 2018 Feb 27]. Available from: http://rchiips.org/NFHS/factsheet_NFHS-4.shtml
13. Ministry of Drinking Water and Sanitation. Swachh Bharat Mission (Gramin): Household Toilet Coverage across India [Internet]. 2018 [cited 2018 Feb 27]. Available from: <http://sbm.gov.in/sbmdashboard/IHHL.aspx>
14. Andres LA, Briceño B, Chase C, Echenique JA. Sanitation and Externalities: Evidence from Early Childhood Health in Rural India. The World Bank; 2014. (Policy Research Working Paper). Report No.: 6737.
15. Jung YT, Lou W, Cheng Y-L. Exposure-response relationship of neighbourhood sanitation and children’s diarrhea. *Trop Med Int Health*. 2017;22(7):857–65.

16. Checkley W, Buckley G, Gilman RH, Assis AM, Guerrant RL, Morris SS, et al. Multi-country analysis of the effects of diarrhoea on childhood stunting. *Int J Epidemiol*. 2008 Jan 8;37(4):816–30.
17. Prüss-Ustün A, Wolf J, Corvalán C, Bos R, Neira M. Preventing disease through healthy environments: A global assessment of the environmental burden of disease from environmental risks [Internet]. World Health Organization; 2016 [cited 2016 Mar 18]. Available from: http://www.who.int/quantifying_ehimpacts/publications/preventing-disease/en/
18. IHME. GBD Results Tool | GHDx [Internet]. 2018 [cited 2018 Apr 30]. Available from: <http://ghdx.healthdata.org/gbd-results-tool>
19. Stocks ME, Ogden S, Haddad D, Addiss DG, McGuire C, Freeman MC. Effect of water, sanitation, and hygiene on the prevention of trachoma: a systematic review and meta-analysis. *PLoS Med*. 2014;11(2):e1001605.
20. Grimes JE, Croll D, Harrison WE, Utzinger J, Freeman MC, Templeton MR. The relationship between water, sanitation and schistosomiasis: a systematic review and meta-analysis. *PLoS Negl Trop Dis*. 2014;8(12):e3296.
21. Strunz EC, Addiss DG, Stocks ME, Ogden S, Utzinger J, Freeman MC. Water, sanitation, hygiene, and soil-transmitted helminth infection: a systematic review and meta-analysis. *PLoS Med*. 2014;11(3):e1001620.
22. WHO. Water, Sanitation & Hygiene for accelerating and sustaining progress on Neglected Tropical Diseases, A global strategy 2015-2020 [Internet]. Geneva: World Health Organization; 2015 [cited 2017 Nov 22]. Available from: http://apps.who.int/iris/bitstream/10665/182735/1/WHO_FWC_WSH_15.12_eng.pdf
23. Rabie T, Curtis V. Handwashing and risk of respiratory infections: a quantitative systematic review. *Trop Med Int Health* TM IH. 2006 Mar;11(3):258–67.
24. Dangour AD, Watson L, Cumming O, Boisson S, Che Y, Velleman Y, et al. Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children. *Cochrane Database Syst Rev* [Internet]. 2013 [cited 2013 Aug 2];8. Available from: <http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD009382.pub2/abstract>