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Original Research Article

Ecological study for prioritization of districts of Odisha for swacch bharat mission implementation based on a new modified environmental sanitation index using census 2011 and AHS 2012 data

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ABSTRACT

Background: Open defecation practices and contaminated drinking water are the two major sources of excreta-related infections. Swacch Bharat Mission (SBM) is a cleanliness campaign launched in India in 2014 for duration of five years. Primary Objectives: 1. Determine the effect of open defecation and drinking water sources on the incidence of diarrheal diseases in Odisha. 2. Categorisation of the districts according to a Modified Environmental Sanitation Index (M.E.S.I).
Methods: Type of study: Ecological study. Study instrument: Secondary data collected from Census of India-2011 and Annual Health Survey report, 2012. A Modified E.S.I (M.E.S.I.) score was calculated for Odisha using ESI template developed by Balamurugan and Ravichandran. Statistical analyses were done using GNU PSPP Statistical Analysis Software Release 0.9.0.
Results: According to the Census of India, 2,129,276 (22.04%) households in Odisha used latrines, including water closet and pit latrines. From the AHS-2012 data it was found that the overall incidence of diarrhea /dysentery in Odisha was 5.92 per 1000 population. Association with diarrheal disease incidence was estimated after classifying districts into 4 categories according to the use of latrines as <10%, 10-20%, 20-30% and >30%. The mean incidence of diarrheal diseases was lower in districts that had higher use of toilets. The variables from each broad category were classified into positive and negative indicators for ESI calculation and MESI score was calculated. Based on the M.E.S.I, the districts were ranked. Dhenkanal, Kandhamal, Nayagarh were ranked worst.
Conclusions: Districts should be prioritized based on MESI score for effective SBM implementation.

Keywords: Swach bharat, Sanitation index, Ecological study

INTRODUCTION

Sanitation is a determinant of health and includes personal, domestic and environmental hygiene and access to safe drinking water.[1] But diarrhoeal diseases remain a major cause of morbidity and mortality in India. In 2013 alone, 10.7 million cases and 1535 deaths were reported from India.[2] About 88% of diarrhea-associated deaths are attributable to unsafe water, inadequate sanitation, and insufficient hygiene.[3-5] Open defecation practices and contaminated drinking water are the two major sources of excreta-related infections.[6]

Swacch Bharat Mission (SBM) is a cleanliness campaign launched in India in 2014 for duration of five years. The objectives are centred on elimination of open defecation, along with improved sanitation practices.[7] The project is being implemented with district as its unit of

implementation.[8] The budget allocated as centre's share for Odisha under this scheme is 385 crore rupees.[9] With limited time and human resources, the SBM will be most beneficial if implemented with special focus on low performing units/districts. Identification of such districts scientifically needs to be done for this purpose.

Based on rules of United Nations Development Program, an Environmental Sanitation Index (ESI) has been developed by Balamurugan and Ravichandran for the state of Tamil Nadu.[10,11] It was hypothesised that a sanitation ranking index would have significant correlation with burden of diarrheal disease.

Under these circumstances, the present study was planned with the following objectives:

1. Determine the effect of open defecation and drinking water sources on the incidence of diarrheal diseases in Odisha.
2. Categorisation of the districts according to a Modified Environmental Sanitation Index (M.E.S.I) based on Census 2011 and AHS 2012 data
3. Prioritize districts in Odisha for SBM implementation based on M.E.S.I.
4. Suggest additional measures to improve the public health impact of SBM.

METHODS

This Ecological study was conducted with units as the districts of Odisha, India. Secondary data was gathered from Census of India-2011 and Annual Health Survey report, 2012.[12,13]

From Census, data was collected on two broad indicators:

- Use of household toilets.
- Access to drinking water.

These were categorized under 11 variables: Use of latrines; source of drinking water- treated tap water, untreated tap water, covered well, uncovered well, hand-pumps, tube wells, others; location of the source- within, near and away from the premises. It was assumed that those having household latrines are not practicing open defecation.

Incidence of diarrhea/dysentery was obtained from Annual Health Survey factsheet, 2012.Association with diarrheal disease incidence was estimated after classifying districts into 4 categories according to the use of latrines as:<10%, 10-20%, 20-30% and >30%.

Based on the E.S.I template of Balamurugan, a Modified E.S.I (M.E.S.I.) score was calculated for Odisha using the following steps:

1. 11 variables were created from two broad categories, use of latrines and access to drinking water.
2. Correlations between these variables and incidence of diarrheal diseases were estimated.
3. Based on this, variables were categorized as positive and negative influencers of diarrheal disease.
4. ESI score was calculated for each positive variable as:
$$ESI(+)scor = \frac{Actualvalue - Minimumvalue}{Maximumvalue - Minimumvalue}$$
5. ESI index was calculated for each negative variable as:
$$ESI(-)scor = \frac{Maximumvalue - Actualvalue}{Maximumvalue - Minimumvalue}$$
6. Aggregated M.E.S.I. score was calculated by: M.E.S.I. = ½ (∑ ESI of Access to drinking water + ESI of Usage of Toilet).
7. M.E.S.I. scale was validated for other states by relating the M.E.S.I. score with incidence of diarrheal disease.

"Units" were not given in the Index values. For categories having multiple variables, a Pearson's r value of greater than ±0.30 was considered as the minimum requirement for any degree of correlation.[14] Each of the individual indicator's ESI score lies between zero and one. Districts of Odisha are ranked according to their aggregated (Urban and Rural) M.E.S.I. score. Lower the M.E.S.I. score, poorer is the rank.

RESULTS

Census of India, 2011 covered a total of 9.66 million households in Odisha. It was revealed that out of these 2,129,276 (22.04%) used latrines, including water closet and pit latrines. (Rural= 1,146,552; 14.08%: Urban= 982,744; 64.78%). The district of Khordha had the maximum proportion of latrine use at 47.04% and Debagarh had the lowest at 9.18%. Hand pumps were the source of drinking water in 41.45% households (Rural=49.17%; Urban=12.79%) followed by tube wells in 19.97% and uncovered wells in 17.30%.

From the AHS-2012 data it was found that the overall incidence of diarrhea /dysentery in Odisha was 5.92 per 1000 population. This incidence was greater in rural areas (Females=6.49; Males=6.10) as compared to urban (Females=4.45; Males=3.55). The district of Nayagarh had the greatest incidence of diarrheal diseases at 21.76 per 1000 and Jagatsinghpur the lowest at 1.09 per 1000.

The mean incidence of diarrheal diseases was lower in districts that had higher use of toilets. For districts with <10%, 10-20%, 20-30% and >30% latrine use, the mean incidence of diarrheal disease was 7.64, 6.86, 5.62 and 3.21respectively. Lower incidence of diarrhoea was observed with use of latrines in case of rural areas as compared with urban. However, no significant difference was found in this decrease of incidence.

Linear association was estimated between incidence of diarrhoea and use of latrines/sources of drinking water as shown in Table 1.

The variables from each broad category were classified into positive and negative indicators for M.E.S.I. calculation as shown in Table 2.

Table 1: Associations of diarrheal incidence.

Sl. No.	Independent variables		Correlation with Incidence of diarrhea: Pearson's correlation coefficient (r)	
			Rural	Urban
1	Use of latrines (Any type)		-0.11	-0.24
2.a	Source of Drinking Water	Treated tap water	0.09	-0.48
		Untreated tap water	0.13	-0.04
		Covered well	0.36	0.47
		Uncovered well	0.30	0.36
		Hand pump	-0.32	0.02
		Tube well	0.43	0.18
		Others	-0.12	0.30
2.b	Location of source of drinking water	Inside premises	-0.15	-0.16
		Near	0.16	-0.02
		Away	0.11	0.35

Table 2: Indicators of M.E.S.I calculation.

Table-2: Indicators of M.E.S.I calculation	
Negative indicators	**Positive indicators**
1. Drinking tube well water 2. Drinking well water- both covered and uncovered **3.** Source away from home	1. Use of any type of latrines 2. Drinking treated tap water 3. Drinking hand pump water

Table 3: Rural and urban ranks of districts according to their M.E.S.I.

Rank for prioritization	Rural		Urban		Aggregate	
	District	M.E.S.I.	District	M.E.S.I.	District	M.E.S.I.
1	Dhenkanal	0.73	Dhenkanal	1.00	Dhenkanal	0.64
2	Kandhamal	0.75	Nayagarh	1.10	Kandhamal	0.91
3	Kendujhar	1.00	Bargarh	1.28	Nayagarh	0.94
4	Anugul	1.01	Kalahandi	1.35	Kendujhar	1.11
5	Nayagarh	1.05	Kendujhar	1.37	Mayurbhanj	1.13
6	Mayurbhanj	1.07	Jharsuguda	1.37	Anugul	1.14
7	Khordha	1.17	Kandhamal	1.52	Gajapati	1.18
8	Debagarh	1.18	Balangir	1.54	Debagarh	1.22
9	Jharsuguda	1.29	Nabarangapur	1.58	Balangir	1.43
10	Sambalpur	1.31	Mayurbhanj	1.62	Jharsuguda	1.45

The worst performing district, having the lowest M.E.S.I. is ranked 1st.

E.S.I score was calculated for each positive and negative indicator, for every district. From these ESI values, aggregated M.E.S.I score was calculated for rural and urban regions of each district, separately. Based on this score, the districts were ranked. The district of Jagatsinghpur fared the best and Dhenkanal fared worst. Table 3 shows the 10 bottom ranked districts as per the M.E.S.I. score for SBM prioritization categorized into rural and urban areas.

Significant negative correlation was found between diarrheal incidence and M.E.S.I. score of the districts for both rural and urban areas. as shown in Figures 1 and 2.

DISCUSSION

The present study was conducted basing on the census, 2011 and AHS, 2012 data.It is a known fact that, absent, inadequate, or inappropriately managed water and sanitation services expose individuals to preventable health risks.

In this study to prioritize the districts for SBM implementation, districts were categorized depending on the Modified Environmental Sanitation Index (M.E.S.I.) score. M.E.S.I. score is based on modification of ESI developed by Balamurugan and Ravichandran.[10]

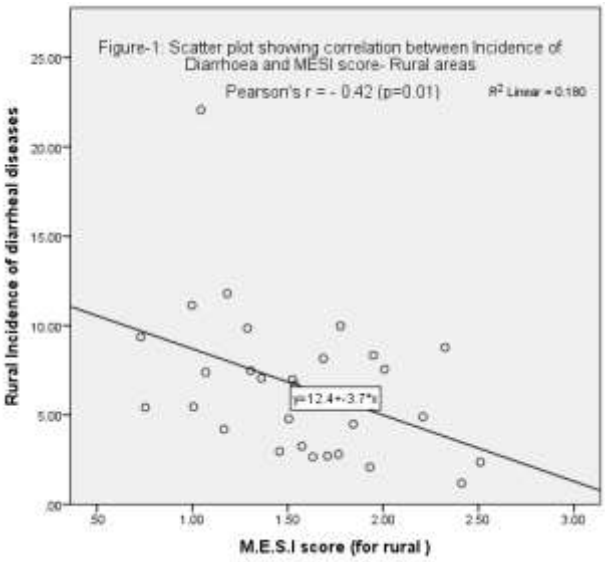

Figure 1: M.E.S.I. score for rural.

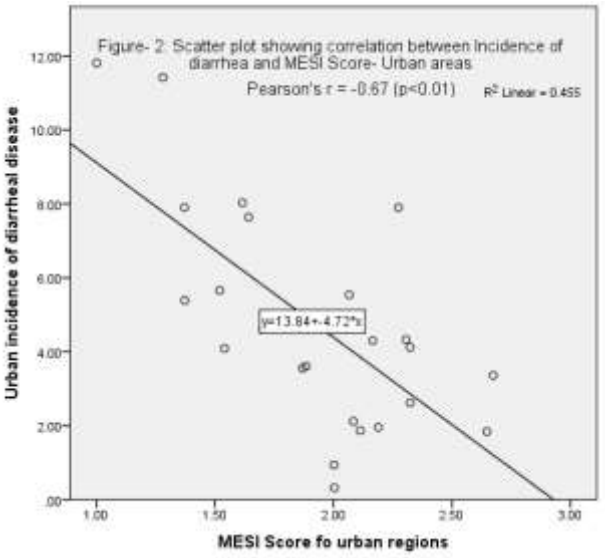

Figure 2: M.E.S.I. score for urban regions.

In ESI, an assumption was made regarding the association of risk factors for poor sanitation while categorizing the 11 variables as positive and negative indicators. But these associations may vary according to population and region under study. Hence in this study, association of these variables was estimated with diarrheal burden in the first step and then they were classified depending on the Pearson's r-value into positive and negative indicators. This was done to provide a scientific basis for categorization of indicators.

National Health Profile estimates show that in 2011, there were more than 10.2 million cases of Acute Diarrheal diseases reported in India along with 1269 deaths. Odisha alone contributed 6.3 lakh cases and 143 deaths.[15] This situation has remained mostly unchanged in Odisha with 6.56 Lakh cases and 243 deaths in 2015.[16]

In this study, the mean incidence of diarrhoea was lower in districts that had higher proportion of use of latrines. A study from Indonesia by Semba et al shows that lack of an improved latrine was associated with a child history of diarrhoea (OR= 1.23, P < 0.0001) and under-five child mortality (OR = 1.29, P < 0.0001).[17]

Use of latrines, drinking treated tap water and hand pump water were positive indicators for diarrheal burden and drinking well or tube well water and location of source away from premises were negative indicators in this study. As other studies have shown, shallow wells and tube wells in densely populated areas may not be a safe source of drinking water as many factors contribute to their contamination.[18,19] In ESI score calculation, tube well was considered as safe source of water whereas here correlation findings show that it was unsafe.[10]

WHO estimates that diarrhoea can be reduced significantly if water quality can be ensured up to the point-of-consumption. Consistent safe drinking water can reduce diarrhoeal disease by between 28% and 45%.[20]

In other Cochrane reviews, Cairncross et al proposed diarrhoea risk reductions of 17 and 36%, associated respectively, with improved water quality and excreta disposal.(21) Similar findings have been reported by other cluster RCTs by Christensenand Arnold.[22,23] W.H.O reports concur that building latrines and supplying clean water decreases the incidence of diarrhoea.[24]

Previous sanitation campaigns like the Total Sanitation campaign and Nirmal Bharat Abhiyan were unable to significantly reduce the practice of open defecation. Hence SBM was launched in mission mode with a specific time frame. Prioritization of districts for implementation of SBM would ensure optimum utilization of resources. For this scientific ranking of districts based on M.E.S.I. is needed. Lower the M.E.S.I of a district, poorer is the sanitation condition leading to greater incidence of diarrhea.

The districts of Dhenkanal, Kandhamal and Nayagarh were found to have lower M.E.S.I. score with diarrhoea incidence of 9.6, 5.4 and 21.7 per 1000 respectively. Improvement in M.E.S.I. Score was related to lower diarrheal load and this was greater in urban as compared to rural regions owing to a more significant correlation.

Recommendations

For SBM to be more effective in the field of public health, the following recommendations are proposed from this study-

1. Districts should be prioritized on basis of M.E.S.I. score for implementation of SBM in a time bound setting.
2. Identification of unsafe sources of drinking water and subsequent replacement of the same.

3. To enhance public awareness regarding use of toilets and safe drinking water practices.

Limitation of the study

In this study, it was assumed that households having access to latrines do not practice open defecation, (as per census) which might not be accurate in all cases.

Many factors like literacy, standard of living, purchasing power, industrial/slum locations and cultural habits influence sanitation practices that have not been taken into account for M.E.S.I. calculation.

Hence a composite index needs to be created to assess the sanitation status of a region/population.

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REFERENCES

1. GOI T sanitation campaign and unicef working document. A handbook of village health and sanitation committee: Accelarating results through convergence. 2010.
2. Brown J, Cairncross S, Ensink JHJ. Water, sanitation, hygiene and enteric infections in children. Arch Dis Child. 2013;98(8):629–34.
3. DGHS. National health Profile- 2013 (Jan-Dec). Govt of India, MOHFW. 2013.
4. UNICEF. Progress for Children a Report Card on Water and Sanitation. Water. 2006.
5. Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? Lancet. 2016;361(9376):2226–34.
6. WHO. e-Library of Evidence for Nutrition Actions (eLENA) Water , sanitation and hygiene interventions and the prevention of diarrhoea Biological , behavioural and contextual rationale. 2011.
7. Park K. Park's Textbook of Preventive and Social Medicine. 23rd edition. M/s Banarasidas Bhanot Publishers; 2015.
8. Government of India. Guidelines for Swatch Bharat Mission (SBM). 2014.
9. Water D. Ministry of Drinking Water and Sanitation.
10. Approved State and Component Wise Share of GoI Contribution as per Cabinet Note. 2015. Available from http://swachhbharaturban.gov.in/writereaddata/Enhanced_Central.pdf. Accessed on 23 January 2017.
11. Division VS, Office of the Registrar General & Census Commissioner IND. Census of India : Houselisting and Housing Census Data Tables (District Level) – Odisha. Available from: http://www.censusindia.gov.in/2011census/hlo/District_Tables/HLO_Distt_Table_Odisha.html. Accessed on 23 January 2017.
12. Division VS, Office of the Registrar General & Census Commissioner IND. Annual health survey 2011-12 fact sheet, 2011.
13. Balamurugan J, Ravichandran M. Environmental Sanitation Index for the State of Tamilnadu, India. Int Res J Environ Sci. 2014;3(5):2319–414.
14. UNDP. United Nations Development Programme, Human Development Report 1990, Oxford University Press, New York. 1990.
15. Rumsey DJ. Statistics for dummies- 2nd edition. 2011. Available from: http://www.dummies.com/how-to/content/how-to-interpret-a-correlation-coefficient-r.html. Accessed on 20 January 2017.
16. Division VS, Office of the Registrar General & Census Commissioner IND. Census of India 2011 Availability and Type of Latrine Facility : 2001-2011. 2011.
17. Central Bureau of Health Inteilligence - Minstry of Health and Famlily Welfare. Health status indicators. National Health Profile. 2011.
18. CBHI. National Health Profile. Cent Bur Heal Inteilligence - Minstry Heal Famlily Welf. 2015; 26–38.
19. Semba RD, Kraemer K, Sun K, De Pee S, Akhter N, Moench-Pfanner R, et al. Relationship of the presence of a household improved latrine with diarrhea and under-five child mortality in Indonesia. Am J Trop Med Hyg. 2011;84(3):443–50.
20. Wu J, Yunus M, Streatfield PK, van Geen A, Escamilla V, Akita Y, et al. Impact of tubewell access and tubewell depth on childhood diarrhea in Matlab, Bangladesh. Environ Health. 2011;10(1):109.
21. Van Geen A, Ahmed KM, Akita Y, Alam MJ, Culligan PJ, Emch M, et al. Fecal contamination of shallow tubewells in Bangladesh inversely related to arsenic. Environ Sci Technol. 2011;45(4):1199–205.
22. World Health Organization. Preventing diarrhoea through better water, sanitation and hygiene. 2014;1–32. Available from: http://apps.who.int/iris/bitstream/10665/150112/1/9789241564823_eng.pdf?ua=1&ua=1. Accessed on 23 January 2017.
23. Cairncross S, Hunt C, Boisson S, Bostoen K, Curtis V, Fung ICH, et al. Water, sanitation and hygiene for the prevention of diarrhoea. Int J Epidemiol. 2010;39(1):1-3.
24. Christensen G, Dentz HN, Pickering AJ, Bourdier T, Arnold BF, Colford JM, et al. Pilot cluster randomized controlled trials to evaluate adoption of water, sanitation, and hygiene interventions and their combination in rural western Kenya. Am J Trop Med Hyg. 2015;92(2):437–47.
25. Arnold BF, Null C, Luby SP, Unicomb L, Stewart CP, Dewey KG, et al. Cluster-randomised controlled trials of individual and combined water, sanitation, hygiene and nutritional interventions in rural Bangladesh and Kenya: the WASH Benefits

study design and rationale. BMJ Open. 2013;3(8):003476.
26. WHO. WHO | Building latrines and keeping water clean decreases diarrhoea and under-nutrition in Mali. World Health Organization. Available from: http://www.who.int/features/2015/water-sanitation-mali/en/. Accessed on 23 January 2017.

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