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Environmental Enteropathy (EE): A Critical Challenge in Indian Public Health

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Abstract

There is strong causal relationship between stunting and Environmental Enteropathy, a subclinical condition of the small intestines. The biological plausibility for Environmental Enteropathy being a strong causal pathway for stunting has important policy implication in improving WASH in India, which has the highest incidence of stunting in the world. Four states of India namely, Uttar Pradesh, Jharkhand, Bihar and Assam have high incidence of stunting. This paper focuses on the association of WASH with stunting in these states. Review of literature and statistical analysis of data from IMIS of the MDWS, GOI provide certain critical findings in this respect. It was observed that all these states have low sanitation facilities and low coverage of piped water supply. Also, there is little surveillance of bacteriological quality of water in these states. Further, sanitary survey of the water sources to assess the risk of contamination of the sources have also been very poor. It is likely that children in these states face higher incidence of Environmental Enteropathy, which being asymptotic makes it difficult to identify the children living in such condition for child specific interventions. The solution lies in improving status of sanitation and hygiene as well as water quality for everyone and its monitoring in an integrated manner. Involvement of the Panchayat and the community is also another critical need to reduce prevalence of stunting in India.

Keywords: Malnutrition, Panchayat, Sanitation, Stunting, Water Quality Surveillance.

Introduction:

One of the critical goals (Goal 6) to be achieved by the year 2030 under the Sustainable Development Goals is universal access to safe drinking water and sanitation. The drinking water source can only be safe when those are protected from contamination for which adoption of improved sanitation and good hygienic practices are essential. Water, Sanitation and Hygiene (WASH) also have critical roles towards improving public health. Indeed, access to safe water and sanitation are human rights, as recognized in 2010 by the United Nations General Assembly, though no such legal rights exist in India and there is no public health law to enforce providing water of acceptable standard by the service providers. For universal fulfilment of these rights to become reality, the country needs to put in place the right systems: well-resourced, capable institutions delivering services and changing behaviour in resilient and appropriate ways (UN-Water 2014). Currently, 2.1 billion people lack access to safely managed drinking water services and 4.5 billion people lack safely managed sanitation services worldwide (UN-Water 2014). According to the World Health Organization (WHO) and the United Nations Children's Fund Joint Monitoring Report (UNICEF, 2017), more than half of the open defecation that occurs anywhere in the world occurs in rural India (Coffey et al, 2015-16). With construction of large number of toilets after

launching the Swachh Bharat Mission (SBM) on the 2nd October 2014 access to toilets have started improving rapidly. However, unsafe hygiene practices are still widespread. Some of the recent studies conducted in several states found that even in districts declared as Open Defection Free (ODF) some HHs are still not having access to functional toilet and some others also were practicing open defecation in spite of having toilet. Adoption of hygienic practices like washing hands with soap and water during critical occasions at the households, village level institutions like the schools and the Anganwadi centres (AWCs) and the public places are even worse. However, total elimination of open defecation does not guarantee cutting the oral-faecal route without taking concurrent hygienic measures. With construction of large number of toilets, many of which are having septic tank, the problem of septage management has been growing. There is potential threat of contamination of the drinking water sources due to unhygienic septage management. Unavailability of soap and water for hand washing in the households, schools and AWCs along with lack of critical awareness to follow proper hand washing practices on critical occasions are also quite high as found in a few recent studies in several states of India. In these circumstances, the chances of exposed faecal matters reaching the people's food and drinking water sources will still continue leading to higher chances of exposure to diseases. The impact of poor sanitation, unsafe drinking water and poor hygiene are devastating for children, particularly those under five years of age. The drive for behaviour change communication under the SBM has remained mostly confined to construction and use of toilets with inadequate emphasis on proper hand washing and other hygienic practices. There is little awareness of good hygienic practices and the impact of WASH on nutrition. According to research, a strong association have been established between poor WASH and malnutrition particularly stunting (Ghosh et al, 2014, Coffey et al, 2017). The linkages between sanitation and nutrition i.e., sanitation-nutrition nexus is known to be significant but what is little known is the pathway how that affects the intestine resulting in Environmental Enteropathy with consequential low nutritional outcomes in children, particularly stunting under the age group of below five years.

Environmental Enteropathy (EE) and its association with stunting:

Recently, it has been hypothesised that tropical or Environmental Enteropathy (EE), a subclinical condition of the small intestines resulting from the ingestion of faecal bacteria which increases gut permeability and mal absorption of nutrients, may be a primary causal pathway from poor sanitation to stunting (Humphrey, 2009). A few studies conducted in this matter found that 39 per cent of weight and 43 per cent of length and height growth failure was associated with an indicator of subclinical intestinal permeability (the ratio of urinary lactulose to mannitol), rather than dietary inadequacy or diarrhoea (Chambers et al, 2013). Environmental Enteropathy may explain the fact that sanitation appears to have a greater association with improvements in growth than with reductions in diarrhoea (Brown et al., 2013) and biological plausibility for this causal pathway is high (UNICEF, 2015). Results from research studies in Bangladesh, India, Kenya and Zimbabwe shed light on this relationship and provide more definitive evidence that will help developing proper WASH and nutrition policy and programmes (DFID, 2013). Interestingly, although India's economy has been growing at impressive rate yet the country still has the highest number of stunted children in the world, (46.8 million children) representing one-third of the global total of stunted children under the age of five (UNICEF 2015). This indicates that the country needs to pay much more attention in reducing stunting by addressing the causal factors. Research shows that mere increase in food intake will not be effective in reducing stunting unless the child's environment is also improved through development of WASH facilities and adoption of hygienic practices for every inha-

bitant living anywhere in the country.

Adverse impact of stunting on health and other aspects of human development:

Stunting is defined as the percentage of children, aged 0 to 59 months, whose height for age is below minus two standard deviations (moderate stunting) and minus three standard deviations (severe stunting) from the median of the WHO Child Growth Standards. In India, 38 per cent of children younger than five years of age are stunted, a manifestation of chronic malnutrition. Stunting and other forms of under-nutrition are thought to be responsible for nearly half of all child death globally (Coffey et al, 2018). Stunting is associated with an underdeveloped brain, with long-lasting harmful consequences, including diminished mental ability and learning capacity, poor school performance in childhood, reduced earnings and increased risks of nutrition-related chronic diseases, such as diabetes, hypertension, and obesity in future. While stunting starts from pre-conception when an adolescent girl, who later becomes mother is undernourished and anaemic; it worsens when infants' diets are poor, and when sanitation and hygiene are poor (UNICEF 2015). The lifelong effects of stunting are said to result in at least 10 percent decrease in future income over the lifetime of stunted adults.

Incidence of stunting in India:

According to National Food Policy Research Institute-NFPRI, stunting prevalence in India is high (38.4%) and varies considerably across districts (from 12.4% to 65.1%) (GOI-NFPRI 2018). Significantly, 239 of the 640 districts in India have stunting levels above 40% (very high) and 202 districts have prevalence of 30–40% (GOI-NFPRI 2018). Only 29 districts have stunting levels between 10% and 20% (GOI-NFPRI 2018).

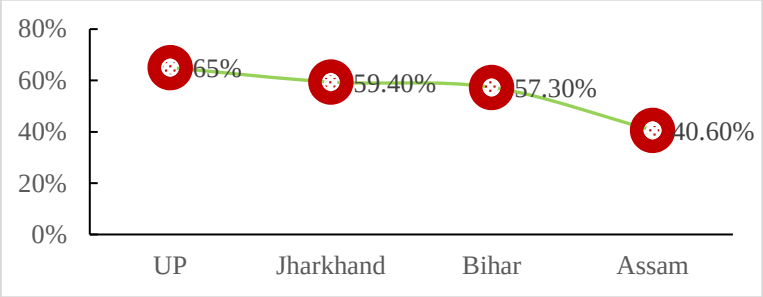
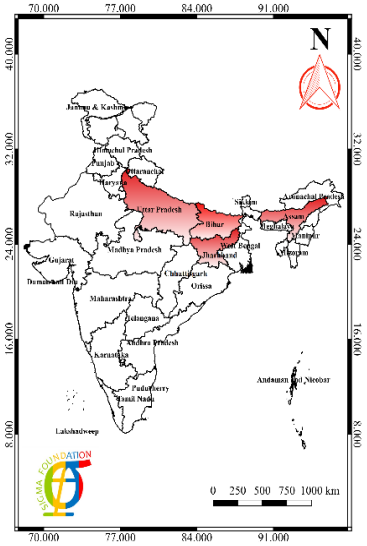


Figure 1: Prevalence of stunting

Stunting prevalence varies across states and high-stunting districts are heavily clustered in the north, east and centre of India. As per assessment of NFPRI, Uttar Pradesh had the highest prevalence (65%) of stunting followed by Jharkhand (59.40%), Bihar (57.30%) and Assam (40.60%). Figure 1 shows the stunting prevalence in these four states. Although there is considerable interstate variation of stunting, intrastate variance of stunting is also reasonably high. Incidentally these states had very high incidence of open defecation rate till a few years ago and quality of drinking water in these states are poor. Further, all these states are flood prone, which has impact on sustainability of both sanitation and water quality. The location of these states is shown in Map 1 for a better understanding.

Interventions for reducing incidence of stunting:

The current interventions to address stunting in India has remained mostly confined to arranging supplementary nutrition but not so much attention has been paid on improving WASH in a holistic manner. What has been achieved recently is physical access to toilet for the HHs though there are many gaps in functionality, usage and sustainability. The argument in this paper is that mere provision of toilet without cutting the oral-faecal route, which is leading to Environmental Enteropathy will not result in faster decline in stunting. The subsequent paragraphs describe the status of stunting along with the proximate factors like access to sanitation and safe drinking water in the four states with higher incidence of stunting and the need for a convergent approach involving the people to provide better living environment for the children. These states with high incidence of stunting are characterized by lower levels of immediate and underlying determinants and low levels of nutrition-specific intervention coverage. The other factors associated with stunting are women's education, women's age at marriage, coverage and quality of ante-natal care and adequacy of child diets. In the following few paragraphs the status of drinking water and sanitation, which are the major causes for Environmental Enteropathy and stunting other than food intake, have been presented for the said four states.



Map 1: High incidence of stunting

Materials and Methods:

The study began with review of various literature published on National and International Journals, Reports published by UNICEF and NFPRI and Government organizations especially from Niti Aayog. Analysis of the available reports helped to identify the critical issues related to stunting in the Indian context. The other components in this study was to go through various secondary data mostly focussed on household sanitation coverage under the SBM(G) uploaded in the Integrated Management Information System (IMIS) of the Ministry of Drinking Water and Sanitation (erstwhile Ministry-MDWS), number of water samples tested, availability and performance of the laboratories for water quality testing and sanitary survey of the drinking water sources. Data of stunting for 10 major states were collected from NFPRI, 2018 report. Association of access to sanitation and water of the states with the incidence of stunting for the 10 states was tested by performing Pearson Chi Square test using STATA. Due to certain limitations there were some issues which could not be studied at required depth. However, the objective of this paper

is to understand the proximate factors of stunting (other than food intake) by examining the status of some of the likely proximate factors in the four states with high incidence of stunting. The results discussed below clearly indicates ways for addressing stunting by reducing the chances of the children facing Environmental Enteropathy. This also calls for more research in this field.

Results:

Association of sanitation with stunting:

There is found to have association of stunting with access to sanitation but not with access to water. The number of samples being little (data of stunting as on 2018 for only 10 states were available) the strength of the association between access to sanitation and stunting could not ascertained (the correlation was found to be significant at 75% level of confidence) . Also, though there was apparently no association with access to water but quality of water, which is affected by sanitation, also becomes an important factor in determining the possibility of stunting of children. The status of sanitation and water quality related aspects of the four states are discussed below.

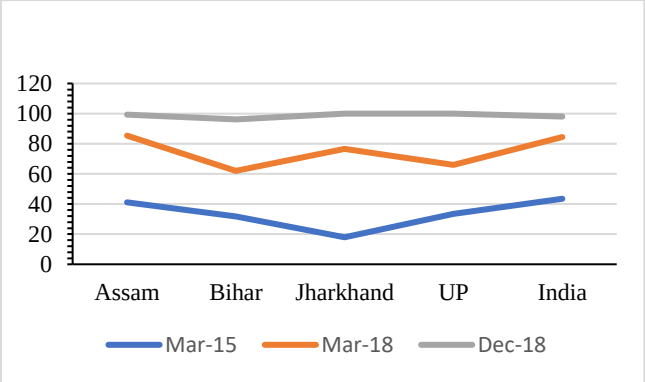


Figure 2: IHHL coverage across 4 states over time

Sanitation scenario in four states with high incidence of stunting:

According to UNICEF and WHO (2012) estimates of 2010, 15 percent of people in the world, and 19 percent of people in developing countries, defecate in the open. Of this 19 percent, nearly 60 percent lived in India. These alarming figures correspond with the findings during the census 2011 that 53.1% Indian households and 69.3% of those living in rural areas “usually" do not use any kind of toilet or latrine. However, the access to Individual Household Latrines (IHHL) in rural India increased very fast after launching of the SBM-Gramin or the SBM(G). As per the IMIS of the MDWS, the IHHL (Individual Household Latrine) coverage in the rural areas of the country as on the 27th December 2018 was 98.2% compared to that of 38.7% coverage on the 2nd October 2014, when the SBM (G) was launched. Under this programme 90.96 million IHHLs were constructed during the said period and 26 states were declared ODF as on the 27th December 2018 (www.sbm.gov.in data downloaded on the 27th December 2018). The growth of IHHL coverage in the said 4 states along with the country average is shown in the Figure 2. The Figure shows very steep increase in IHHL coverage through very fast pace of construction. However, a few studies conducted by SIGMA Foundation show that there has remained substantial gap in utilization of toilets (studies conducted by SIGMA Foundation in a few districts of India during 2018 shows that actual access to toilet in ODF districts was between 70.5% to 93.2%). There are many HHs without toilet in districts declared as ODF and many of the toilets are defunct. These result in gap in actual access and

the gap is higher for the weaker section. The weaker sections have also been found to have poorer quality of infrastructure which may affect sustainable use of the toilets. Field studies have further found that there is inequity in use of toilets and the weaker sections who generally have higher incidence of malnutrition also have lower rate of utilization of their toilets. The study also found high incidence of unhygienic practices like lack of hand washing with soap and water at critical occasions at the household as well as at institutions like schools and AWCs, which reflect inadequate and ineffective behaviour change communication. The perceived risk in continuation of unhygienic practices is low and the people are not motivated to use toilet and maintain hygiene for lowering the risk of exposure to pathogens causing diseases. Further, there is unhygienic disposal of child faeces even in districts declared as ODF, indicating that the faecal-oral route of contamination was still quite open. The septage management has been also unhygienic. As a result, effectiveness of protecting children from being a victim of Environmental Enteropathy continues to be high even in districts declared as ODF. However, what has been achieved is phenomenal and provides necessary conditions to move further for maintaining proper hygiene and environmental cleanliness for every child in the country. Apart from bridging the gap in WASH infrastructures, particularly in schools, AWCs and public places and proper management of solid and liquid waste, there is need to put in place a second-generation behaviour change communication to cut the oral-faecal route of contamination. These states where attainment of ODF status has been faster are likely to have more gaps in practice and require a much stronger campaign to adopt hygienic practice.

Access to drinking water scenario in the four-high stunting-burden states:

Safe drinking water is vital for reducing the global burden of disease and improving health. In India, improvement of drinking water supply has been attempted through implementing national flagship programme for many years. In 2009 the NRDWP was launched by modifying the Accelerated Rural Water Supply Programme with major emphasis on ensuring sustainability of water availability in terms of portability, adequacy, convenience, affordability and equity. The MDWS, in its 'Strategic Plan 2011-22 for rural drinking water in India', had set the goal to 'Ensure that at least 55% of rural households are provided with piped water supply; at least 35% of rural households have piped water supply with a household connection; less than 20% use public taps and less than 45% use hand pumps or other safe and adequate private water sources by 2017'. The goal set for the year 2022 in the said strategic plan was that every rural person in the country will have access to 70 LPCD (litre per capita per day) water, against the current norm of 40 LPCD, within their household premises or at a horizontal or vertical distance of not more than 50 meters from their household without barriers of social or financial discrimination. The coverage of piped water in the rural areas of India as per the Census 2011 was 30.8%. Compared to that, the coverage in the selected states were 2.6% in Bihar, 3.7% in Jharkhand, 6.8% in Assam and 20.2% in Uttar Pradesh. However, all piped water supply schemes did not have provision for treatment and even where it was there studies have shown that the quality of water was not always of acceptable standard.

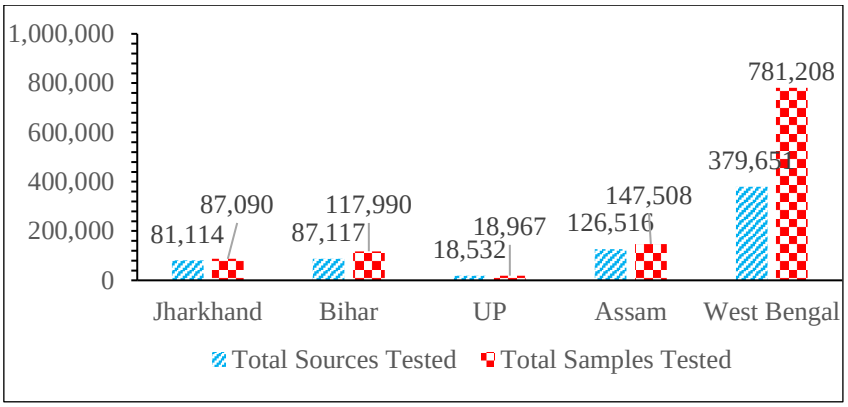


Figure 3: Status of water samples tested in labs

Water quality monitoring and surveillance:

Water quality being a serious public health concern in India, the NRDWP Guidelines and the Jal Jeevan Mission (JJM) have given due priority on Water Quality Monitoring & Surveillance (WQMS) towards ensuring that drinking water used by everyone is safe. A Revised Guideline for water quality monitoring and surveillance has been issued under the Water Quality Sub Mission in July 2017 considering the criticality and urgency of the matter. As per 'National Rural Drinking Water Quality Monitoring and Surveillance Programme'(NRDWQMSP), a community-based water quality monitoring and surveillance system through training and equipping people at the Gram Panchayat (GP) level to test water quality parameters in the laboratory is a prioritized activity. There is a clear mandate about the water quality testing for physico-chemical parameters once in a year and for knowing the bacteriological parameters four times a year (once in every season and at least twice pre-monsoon and post monsoon) (% calculation done on the basis of 5,00,000 samples as per GOI standard).

The said guideline requires testing of 4,00,000 to 5,00,000 samples per state per year. As per report uploaded in the IMIS, actual tests conducted in the year of 2017-18 were total 81,114 drinking water sources and 87,090 samples (17%) in Jharkhand, total 87,117 drinking water sources and 1,17,990 water samples in Bihar (24%), total 18,532 drinking water sources and 18,967 water samples (3%) in Uttar Pradesh, total 1,26,516 drinking water sources and total 1,47,508 water samples (29%) in Assam (as per IMIS data of 2017-18 in the Format E-1 of the MDWS, GOI). Comparatively, total 3,79,651 drinking water sources and 7,81,208 water samples (100%) were tested in West Bengal, located in the same region. Thus, there has not been adequate monitoring of the water quality and these states were much lagging in terms of testing of required number of drinking water samples in the laboratories. The status across these states are shown in the Figure 3. It clearly shows that there was huge gap in water quality surveillance in the said four states, reflecting inadequate focus on drinking water quality.

A study conducted by SIGMA Foundation on drinking water quality surveillance in Assam found that poor governance, inadequate laboratory infrastructure including lack of human resources and professional competence of the laboratory staffs, following outdated testing methodology for testing certain important water quality parameters were responsible for poor water quality monitoring and surveillance. The study by SIGMA Foundation found further that mere establishment of laboratories and putting in place the human resources is not enough to achieve a sound system of water quality testing as per acceptable standard (IS 10500:2012).

Inadequate water testing laboratory infrastructures:

The total number of laboratories in these four states are inadequate as per GOI norms (every block of a state should have a lab with all the testing facilities). Table 1 shows the actual percentage coverage of lab in these states:

Table 1: Coverage of lab in states

State	No. of Districts	No. of Blocks	No. of Labs	% of Lab coverage
Jharkhand	24	260	40	41%
Bihar	38	534	53	10%
UP	75	822	83	5%
Assam	33	219	107	38%

Source: IMIS, MDWS, 2017-18

There is need to develop laboratory infrastructure for testing water quality as well as putting in place a proper system of water quality monitoring and surveillance. There is also need to follow the right specifications for laboratory space, equipment, quality of the reagents and glassware's and the most important is to put in place all the protocols for ensuring quality of the test results.

Protection of drinking water sources:

As per Uniform Drinking Water Quality Protocol, Sanitary Survey of drinking water sources to assess the risk of contamination is recommended once in a year for all public water sources (GOI 2013). However, performance of the said four states in this respect, as shown in the Figure 4, has been rather poor as per IMIS 2017-18 records.

No sanitary survey of the drinking water sources was conducted in Assam, Bihar and Jharkhand. In Uttar Pradesh only 0.31% of drinking water sources had sanitary surveillance.

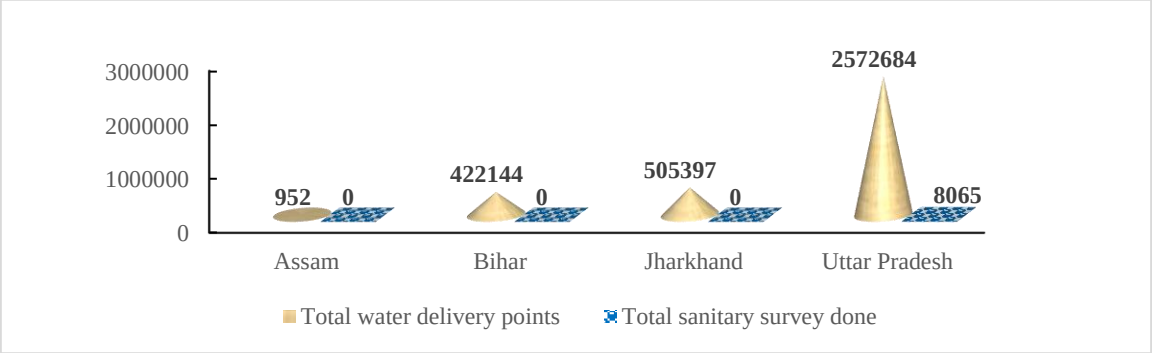


Figure 4: Drinking water source protection status

High incidence of flood and adverse impact of sanitary practices:

It is noted that geographically stunting is mostly prevalent in the alluvial deltaic region where the amount of rainfall is moderate to high and flood is a recurring threat. The risk of faecal-oral contamination in these states due to poor WASH is accentuated during flood. Overflowing of main rivers of Uttar Pradesh like Ganga, Yamuna, Ramganga, Gomti etc. is a known hazard and causes huge loses (approximately ₹4.32 billion annually) (floods play havoc in Bihar and Uttar Pradesh, Samachar Today, 28 August, 2010).

Secondly, Bihar is India's most flood-prone State, with 76% of the population in the north Bihar living under the serious threat of flood devastation (flood management information system-History of Flood in Bihar, Archived 2010-4-19 at the way back Machine). Thirdly, every season a hyper active south-west monsoon brings very heavy rains in parts of Jharkhand state and create flood-like situation. Importantly, Subarnarekha and Kharkai Rivers of Jharkhand flows above the danger mark during the rains. While Subarnarekha flows at around 2.5 metres above the danger mark and Kharkai too flows at around 4.5 metres above the danger mark in almost every season and wash out the basic amenities like drinking water sources and sanitation facilities (The Indian Express, Friday March 22, 2019). The water levels of the rivers rise because of rainfall resulting in the rivers overflowing their banks and engulfing nearby areas and affecting basic facilities (Flood situation in Assam, Hindustan Times, 23rd August, 2018). While there has been recent increase in access to toilets to near universal level in many districts but there has been little resilience to sustain safe sanitation arrangement and practices during disaster like floods, which is so common in these states. Exposure to faecal pathogens during flood is a major threat in these areas, which is likely to contribute in higher incidence of Environmental Enteropathy and stunting in these states.

Discussions:

Addressing Environmental Enteropathy and stunting through improving WASH:

Environmental Enteropathy is asymptotic and it is difficult to know which child is having that condition before the same is manifested as stunting in the child. When a child is found stunted the damage is already done and that is irreversible. In such situation the only solution is to develop a strong defence mechanism covering all the children by providing them clean environment and safe water (apart from adequate food intake) so that there is little scope of pathogens finding any route to go into the intestine of the children. As have been discussed before, although toilet coverage has reached closed to 100% as per the IMIS, there are households with no access to toilets or there are several factors which will make the usage of toilet unsustainable. Further, the unhygienic practices like defecating in the open, unhygienic disposal of septage evacuated from the toilet pits and septic tanks, lack of handwashing with soap and water, unhygienic handling of child faeces etc. need to be eradicated completely. It is very difficult to make rapid progress in providing access to piped water supply due to huge investment that will be required. Providing universal access to safe water to be piped in every dwelling unit, one of the goals of the SDG to be achieved by the year 2030, will take many years. Further, operation and maintenance (O&M) of the existing water supply schemes have been found to have several problems with adverse effect on the quality of service delivery (World Bank 2008). The immediate option is protection of the drinking water sources and monitoring of water quality as per protocol and covering every habitation.

Issues of equity and disaster risk mitigation:

The water and sanitary services fail to reach the poorer sections and there is also problem of uptake of the available services by the poorer section in many areas. In respect of behaviour change communication related to sanitation and hygiene also, field experiences show substantial information asymmetry, which leads to lack of knowledge, attitude and practice (KAP) related to WASH by the poorer sections. In addition to those the poorer sections are less equipped to meet the possible service disruption during natural calamity like flood. During the rainy season many areas of the said states are often flooded and the children become highly vulnerable to water borne diseases. The presence of bacteriological contaminant like Total Coliform/Faecal Coliform or E. Coli makes water unfit for human consumption during such

situation and ingestion of pathogen in the gut of the children has potential to cause Environmental Enteropathy. The poorer sections being ill-equipped to cope with the problem have higher chance of suffering from stunting. Therefore, ensuring equity and mitigation of risk due to disaster like flood is of critical importance in tackling Environmental Enteropathy.

Strengthening local governance:

Both access to sanitation and drinking water should be the responsibilities of the local government, i.e., the GPs. All the selected states have weak GPs, which need to be strengthened. More devolution of functions and funds on the GPs have been the mandate of the 73rd Amendment of the Constitution. However, the devolution on the GPs and related empowerment have been highly inadequate in most states and potential of the GPs in improving delivery of various services more effectively by leveraging its local presence and community connect have been less appreciated. The states have to appreciate the urgency of strengthening the GPs for many reasons including more child responsiveness of which preventing stunting is an important one. Also, the GPs are at present involved in developmental activities which are mostly tangible in nature like construction of roads, irrigation facilities etc. There has been inadequate attention in human development of which child growth and nutrition is critical. They need to be sensitized and capacitated for developing human capital and paying due attention to proper growth and nutrition of the children and ensuring health environment for every child.

Community engagement for convergent actions in improving child's environment:

As explained before, prevalence of Environmental Enteropathy and resultant stunting requires convergent actions at the local level along with favourable state policy to support local actions. The delivery of services from the AWCs on providing supplementary nutrition, sustaining ODF status in true sense for cutting the faecal-oral route, protecting the drinking water sources and monitoring water quality as per GOI protocol are to be ensured. The GP is the ideal institution to ensure proper delivery of all these services with equity and local measures for reducing risk of disaster related failures of services. The GPs at present hardly have the capacity to do so. They need to be sensitized about the issues and the need to mobilize the people for improving environment of the children through better WASH services and intake of food with appropriate feeding practices to the children. The GPs need to be enabled and empowered in ensuring adoption of sanitary and hygienic practices by all the residents and protecting the drinking water sources by mobilizing the people, which will be critical in preventing children from falling victims of Environmental Enteropathy and stunting.

Conclusion:

The research findings showed that lack of poor water, sanitation and hygiene practices are the factors which helped to increase the prevalence of Environmental Enteropathy in many states in India. Based on the findings of this research, we proposed WASH (Water, Sanitation and Hygiene) interventions as per GOI norms including supply of safe drinking water through Functional Household Tap Connection (FHTC), availability of improved twin pit toilet facility, improved hand washing facility at the household level, and manage the solid & liquid waste as per Govt. protocol. To do so a 360^0 channels of communication and strategic awareness campaign will be mandatory to create awareness for the community people. A further research is needed for future action oriented plan.

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