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On Diarrhoea in Adolescents and School Toilets: Insights from an Indian Village School Study

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ABSTRACT *The economics literature on the determinants of diarrhoea focuses on infants; but what about school going adolescents? Our survey in an Indian village school affirms that sanitation, defecation practices at home and school, and the degree of crowding of living space at home are all significant determinants of diarrhoeal incidence for adolescents. Usage of toilets at school varies as a function of gender and existence of a toilet in student's home. Access to toilets is not sufficient to guarantee their usage. To eliminate open defecation: toilets installation, behavioural change, and sustainable mechanisms to maintain school toilets seem necessary.*

1. Introduction

Diarrhoea is a symptom for several different diarrhoeal diseases. As a sign, it is described as "an increase in stool water excretion to greater than 150–200 ml every 24 hours" (Binder, 1990). Most diarrhoea results from infection by bacterial, viral and parasitic organisms commonly spread through the fecal-oral route as a result of exposure to contaminated water or inadequate hygiene (WHO, 2013). The morbidity and mortality of diarrhoeal diseases is greatest in developing nations. According to the World Health Organisation (WHO), diarrhoeal diseases are the third highest cause of death in low-income countries and the fifth highest in lower middle-income countries (WHO, 2014). Importantly, both the scientific literature and public health policies tend to focus on children less than 5 years of age, who are most affected by diarrhoeal mortality, largely ignoring the rest of the population pyramid affected by diarrhoeal morbidity. To contribute to closing this gap, the present paper explores the determinants of diarrhoea among school going adolescents or children between 10 and 19 years of age as per the WHO definition.

Diarrhoeal mortality began to rapidly decline across the age pyramid in the 1980s, but slowed down after the start of the new millennium (Keusch et al., 2006; Kosek, Bern, & Guerrant, 2003; Snyder & Merson, 1982). Consequently, diarrhoeal diseases remain one of the most deadly preventable killers throughout the age pyramid (Walker, Sack, & Black, 2010). Their morbidity and economic costs are also still high: repetitive diarrhoeal episodes during childhood and adolescence lower fitness and decrease adult productivity (Guerrant et al., 2002).

Children older than 5 years, adolescents, and adults experience more than 2.8 billion episodes of diarrhoea per year, 200 million of which occur among 5–15 year olds (Walker et al., 2010). Among adolescents, 95 per cent, 4.95 per cent, and 0.05 per cent of diarrheal episodes are characterised as mild, moderate and severe, respectively, making morbidity, rather than mortality, the most common

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burden from diarrhoea (Lamberti, Walker, & Black, 2012). To date, no studies have identified the specific morbidity consequences of diarrhoea among adolescents, but it can be postulated based on other episodic chronic diseases, that school absenteeism, degree of achievement and eventually human capital are all negatively affected by diarrhoea in adolescence.

It is well known that diarrhoeal incidence can be decreased by blocking the infection route through the installation and use of toilets and improved hygienic practices (WHO, 2004). However, 2.5 billion people globally still lack access to an improved sanitation facility, a toilet connected to a sewer, tank or pit to prevent contamination (WHO /UNICEF, 2012). About one billion people still have to resort to open defecation (OD), 90 per cent of which occurs in rural areas (WHO /UNICEF, 2012).

Among developing countries, India is home to the largest population in the world lacking water and sanitation according to the Water Supply and Sanitation Collaborative Council (UNOPS, 2016). Moreover, India is one of 27 countries, where a quarter or more of the population practices OD (JMP, 2012). As of 2011, only 47 per cent of the 247 million households had their own toilet facility and only 3 per cent of the remaining 53 per cent had access to public toilets (Census of India, 2011). As a result, about half of the Indian households, 69 per cent of which live in rural areas, have no option other than OD (Census of India, 2011).

Though the sanitation challenge has been partially addressed by the Indian government since 1986, it has not been enough (Ramani, Sadreghazi, & Gupta, in press). Given this inadequate performance, India renewed its efforts by launching a national flagship programme, the Clean India or Swachh Bharath Mission in 2014. Its central objective is to eliminate OD in India by 2019 by providing access to sanitation and promoting its usage. Every school in India is also to have a set of functional toilets, separate for girls and boys, along with well maintained water and hygiene facilities.

At the international level, sanitation targets are also included in the Sustainable Development Goals (SDGs). SDG 6 not only aims to ensure availability and sustainable management of water and sanitation for all by 2030, but also to eliminate OD, including by school going children. The reduction of OD depends, in part, on targeting adolescents, who are the natural change makers of the future. As they acquire a sense of their identity, adolescents become citizens with agent-specific psychosocial and behavioural routines (Sharma, 1996). These must be moulded towards the use of toilets and the rejection of OD as a norm. .

Behavioural change in adolescents requires an understanding of the current sanitation practices of school going adolescents in order to develop effective adolescent-tailored interventions that take into account the specificities of the problem. For instance, the lack of school toilets has a gender discriminatory impact on school retention during adolescence. Girls require toilets for more than defecation; they also have particular sanitation needs when menstruating and the ability of girls to attend school is restricted, when they lack access to an appropriate sanitation facility during menstruation (Bharadwaj & Patkar, 2004; UNHR, 2011). The increased enrolment of pubescent girls in schools has been linked to the construction of sex-specific school toilets (Adukia, 2013). Finally, the installation of toilets in schools is not enough; facilities also need to be safe, maintained and monitored (Abrahams, Mathews, & Ramela, 2006).

To sum up, access to adequate sanitation is an important determinant of diarrhoeal diseases with particular nuances for adolescents. Nonetheless, most existing studies focus on children under 5 years of age whose hygiene behaviour is overwhelmingly controlled by mothers or caregivers. Not much is known about the hygiene practices of adolescents, whose lives are split between home and school, who govern their own hygiene behaviour, and who suffer significantly from diarrhoea's morbidity. Furthermore, while gendered differences in sanitation needs have been reported, gender's effect on toilet usage and diarrhoeal incidence, which becomes encrusted during adolescence, remains unknown. For these reasons, this study focuses on adolescents in the school environment and addresses two central questions: Is access to sanitation a determinant of diarrhoeal incidence among adolescents? Is the effect of access to sanitation gender discriminatory among adolescents? To answer these questions in the context of rural India, the study develops a conceptual framework based on the literature and uses it to guide the collection and analysis of primary data on a sample of school going adolescents in an Indian coastal village.

The present study contributes to two streams of literature: the public health literature on determinants of diarrhoeal incidence, and the health policy literature on investment in school sanitation. With respect to the former, it confirms that access to sanitation is an important determinant of diarrheal incidence among adolescents specifically. Furthermore, the paper identifies two novel determinants of diarrhoea not hitherto included in the literature: the "degree of crowding" at the household level and the "choice of defecation practice" at the individual level. Finally, it indicates that the effect of sanitation on diarrheal incidence is gendered among adolescents. With respect to the health policy literature, the survey results validate the interconnectedness of home and school hygiene practices and their importance as determinants of diarrheal incidence among adolescents. This suggests that an improved public investment strategy should target both home and school hygiene practices to obtain behaviour change.

The paper proceeds as follows: Section 2 presents the study design and includes a brief review of the literature on determinants of diarrhoeal incidence in Indian children. Section 3 describes the results. Section 4 discusses the findings in light of the present public investment programme in school sanitation. Section 5 concludes and highlights contributions to the literature.

2. Study Design and Data Collection

Primary data was collected from adolescents attending St. Sebastian School, the only school providing 9th and 10th grade education in Kameshwaram, an Indian coastal village in the Nagapattinam district of Tamil Nadu. The choice of the village was guided by our participation in an ongoing sanitation coverage project there.

A five-step methodology was used. First, a conceptual framework was formulated from a review of the economics and public health literature on the determinants of diarrhoeal diseases in India and validated through discussions with local medical providers and NGOs. Second, a questionnaire was designed from the framework to collect data on the determinants of diarrhoea. Third, the questionnaire was administered through face-to-face interviews with all the students enrolled in the 9th and 10th grades at St. Sebastian School. Fourth, data obtained were analysed to model diarrhoeal incidence as a function of explanatory variables through logistic regressions. Results were reported as odds of the occurrence of at least one episode of diarrhoea. Finally, the results were disseminated to the staff of St. Sebastian School and three schools in nearby villages through focus group discussions which provided further validation.

2.1. A Brief Review of the Literature

From a comprehensive survey of the medical literature with respect to low- and middle-income countries, Ramani, Fruhauf, Dutta, and Meijers (2012) classify the main correlates of diarrhoeal diseases into five categories: (1) physical environment (for example weather, water table, drainage and so forth); (2) socio-economic development; (3) knowledge, resource and asset portfolio of the household (for example level of education of the mother, access to water and sanitation); (4) hygiene behaviours of the household (for example child care practices and open defecation) and (5) individual host characteristics (age, gender). All these risk factors influence the presence of enteropathogens in a host, which is directly linked to the occurrence of diarrhoeal diseases and include environmental, household and individual level determinants of diarrhoea.

From this classification, three principal observations informed the conceptual framework for this study. First, while almost all people living in low- and middle-income countries are at high risk for diarrhoeal diseases, some have a higher individual risk. Therefore both environmental and individual-level risk factors should be identified and separated. Second, the relationships between environmental and individual level factors depend on the scope of the environment considered. Environments can be more or less encompassing (that is a country vs. a village vs. a neighbourhood vs. a household) and correspondingly extend or restrict the spectrum of possible relationships. Third, the risk factors are not

only individually correlated with the occurrence of diarrhoea, but also engaged in interactions between themselves, which in turn may have a compounding effect on the outcome of interest. Therefore, interactions between factors are equally important in identifying the major determinants of diarrhoea as the factor's impact itself.

The above classification is confirmed by studies on the Indian population that further explore the correlates of diarrheal incidence. A study by Dutta, Hajra, and Ramani (2016) covering all Indian states demonstrates that access to sanitation and drinking water, and hygiene behaviours of a household are the three main complementary determinants of child diarrhoea. The higher the level of socio-economic development in a state, the higher is the complementarity between the three focal variables in terms of quantity and quality.

The link between access to safe water and sanitation facilities and diarrhoeal incidence is highlighted by several studies. Kumar and Vollmer (2013) find that the mean incidence of diarrhoea for boys under 5 years of age in households with access to improved sanitation is 2.0 per cent lower than for the boys in households without a toilet; the corresponding figure is 0.7 per cent for girls. Similarly, Panda (1997), shows that households with toilet facilities are two-fifths as likely as households that have no such facility, to have experienced episodes of diarrhoea. Households that utilise public tube wells or bore wells as sources for drinking water are three-fifths as likely to have experienced an episode of childhood diarrhoea compared to those that utilise unsafe drinking water. Additionally, Borooah (2004) demonstrates that while inadequate toilet facilities increase the likelihood of diarrhoea by 5 per cent, safe water supply reduces the incidence of diarrhoea by 5 per cent. Jalan and Ravallion (2003) reiterate that the prevalence and duration of diarrhoea among children under five in rural India are significantly lower on average for families with piped water than for households without it.

Host resources also affect diarrhoeal cases: the prevalence of recurrent diarrhoea is significantly more common among children belonging to a lower socioeconomic class (Avachat, Phalke, Phalke, Aarif, & Kalakoti, 2011). While inadequate sanitation is associated with a 24 per cent higher odds of diarrhoea among children of low-income households, it is only associated with a 2.5 per cent higher odds for children of high-income households (Kumar and Vollmer, 2013). Similarly, children from high-income households are half as likely as those from low-income households to have experienced an episode of diarrhoea (Panda, 1997). These differences reflect the association between resources and the aforementioned determinants of diarrhoea such as access to sanitation, higher education level, greater awareness and a cleaner living environment.

Host characteristics such as the mother's health and behaviour, both of which are dependent on the mother's education, are also important determinants of diarrhoeal episodes. If mothers are aware of the causes of diarrhoea, then their children are less likely to experience it (Khanna, 2008). If the mother is literate, rather than illiterate, then the probability of her child having diarrhoea decreases by 3 per cent (Borooah, 2004). Borooah also finds that if the mother is healthy, the child has a 7 per cent lower likelihood of having diarrhoea compared to a child with an anaemic mother. Further, if a mother washes her hands with soap before feeding the child (compared to not washing her hands before feeding the child), the likelihood of diarrhoeal incidence is reduced by 8 per cent. A mother's literacy status influences not only her hygiene routines, but also feeding practices and recurrent diarrhoea is significantly more common among children receiving top-up feeds before 4 to 6 months as compared to children who are exclusively breastfed (Avachat et al., 2011). Regular hand washing consistently lowers diarrhoea (Fan & Mahal, 2011).

The current literature also emphasises negative externalities of OD in terms of physical and biological contamination as determinants of diarrhoeal incidence. For instance, Spears (2012a) indicates that the amount of OD per square kilometre can explain cross-country variation in child height as lack of sanitation leads to under-nutrition (Chambers & Medeazza, 2013). When harmful bacteria and parasites damage the small intestine, its absorptive capacity decreases and makes the child more vulnerable to a gamut of additional infections, such that their nutritional energy is diverted to fighting infection instead of growth. The negative externalities from OD are reflected by the fact that OD affects both wealthier urban children who use toilets and poorer ones whose homes have none. Finally,

stunting in part due to a lack of sanitation is significant in explaining differences in cognitive development among Indian children (Spears, 2012b).

Table 1 summarises these main findings on India, along with the policy recommendations that can be derived from these findings. In addition to providing the basis for this study's conceptual framework, the above analysis highlights that adolescents have been left out from the examination of the determinants of diarrhoeal diseases.

2.2. Conceptual Framework and Questionnaire Design

The literature on diarrhoeal diseases, focusing on children under five, identifies four determinants of diarrhoeal incidence (Figure 1). We assume that these determinants are the same among school-going adolescents. The first vector includes the physical characteristics of the host or the student characteristics, such as age and gender. The second vector is the hygiene practices of the host or student. The third vector is the "built" and "interacting" environment of the student's household, which includes socioeconomic status, asset portfolio and living conditions, as defined by access to water and sanitation. The fourth vector comprises the behaviours of the student's household, including sanitation practices and water storage, purification and consumption routines. Assuming that the variables forming these vectors are independent of one another, the above empirical model can be estimated through logistic regressions.

Extensive discussion of the above conceptual framework with medical practitioners and local NGOs led to a first version of a questionnaire containing queries on 91 variables corresponding to the four vectors in addition to diarrhoeal incidence. Questions on menstrual hygiene were discouraged. Diarrhoeal incidence was measured by asking the student: "How many episodes of diarrhoea lasting more than 2 days did you have in the last 6 months?" Prior to being administered, the questionnaire was pre-tested among five local households and ten adolescents to ensure consistency in data collection and was revised.

2.3. School Survey

At the time of the study, 492 boys and 365 girls were enrolled in St. Sebastian School. Given the elevated school attendance rate of over 90 per cent of boys and approximately 70 per cent of girls in Kameshwaram as well as the fact that St. Sebastian is the only school for adolescents in the village, interviewing students attending the school guaranteed the most comprehensive access to adolescent data. The questionnaire was administered through face-to-face interviews. A total of 116 students in 9th and 10th grades were eligible for participation. However, only 114 students were present at the time when interviews were conducted. The questions were asked by one trained translator and recorded by a data collector simultaneously. Each interview lasted approximately 45 minutes. The adolescents' lack of knowledge about household practices and behaviours was a limitation for some interviews.

2.4. Final Choice of Variables

On the basis of a preliminary analysis of the data, 60 variables were excluded because a significant number of adolescents had either been unwilling and/or unable to give information consistent with their other answers (see Appendix 1).

Logistic regressions were then performed on systematic combinations of variables and 18 variables were kept as control variables rather than the explanatory variables because they were too insignificant and/or reduced goodness of fit (Appendix 1). This was especially the case for several behaviours whose sample distributions were very narrow, pointing in the direction of a village-wide "culture" with regards to hygiene, sanitation, and food and water consumption norms. These trials also led to the introduction of a new variable: "crowding." Crowding was defined as family size divided by the

Table 1. Main findings on the sanitation-health nexus in India

Authors	Age group studied/ source of data	Impact of sanitation on incidence of diarrhoea/other health problems	Other complementary factors that lower the incidence of diarrhoea	Policy recommendations
Panda (1997)	Children under 4	Lowers incidence of childhood diarrhoea by 40 per cent	Safe drinking water, household income, mother's education	Link health and education policy to water and sanitation.
Jalan and Ravallion (2003)	Children under 5		Piped water	Combine public intervention in sanitation with education, income generation and poverty reduction.
Borooah (2004)	Children under 3	Without toilets likelihood of diarrhoea increases by 5 per cent	Education of mother; Health of mother; Not being Hindu or Muslim	Initiate partnership with soap manufacturers; Promote hand-washing, education and women's health.
Khanna (2008)	Children under 3	Lowers incidence of childhood diarrhoea by 10 per cent to 18 per cent	Piped in water within the household	Educate households on purification of piped in water
Avachat et al. (2011)	Children under 5	Likelihood of diarrhoeal incidence decreases	Breast feeding, education of mother, household income.	Create awareness through education
Fan and Mahal (2011)	Children under 5	Likelihood of diarrhoeal incidence decreases	Hand washing after defecation or handling stools has greater impact than access to sanitation	Create awareness and trigger change in hygiene behaviour
Spears (2012a, 2012b)	Children under 5	Lowers infant mortality by 4 deaths per 1000.		Study effects of faecal pathogens on health at large rather than just on diarrhoea to motivate government bureaucrats.
Chambers and Medeazza (2013)	No age focus	Without toilets likelihood of stunting increases		Recognise OD and lack of sanitation and hygiene as causes of under nutrition.
Kumar and Vollmer (2013)	Children under 5	(i) lowers likelihood of getting diarrhoea by 24 per cent in lower income groups; (ii) lowers likelihood of getting diarrhoea by 2.5 per cent in higher income groups; (iii) Decrease greater for boys than for girls.	Water treatment Household income Being a girl	Link public policy on sanitation with poverty alleviation, education and gender equality.
Dutta et al. (2016)	Children under 5	Impact of sanitation depends on quality and quantity of water and level of hygiene behaviour in the living zone	Access to water and hygiene behaviour	Take into account the complementary rather than individual presence of sanitation, water and hygiene behaviour

Source: Conceptualised by authors

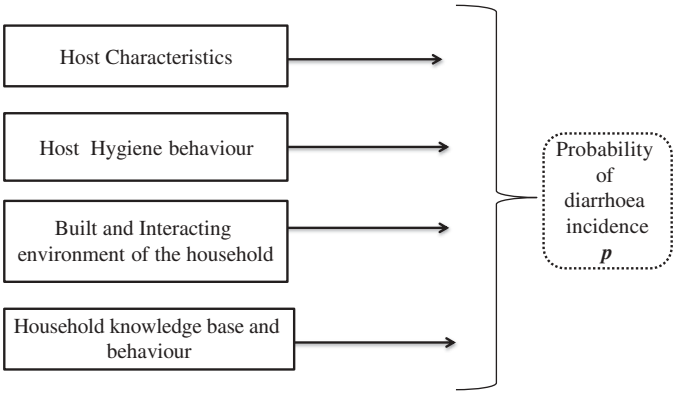

Figure 1. Model of the determinants of diarrhoeal incidence.

number of rooms to measure the average number of inhabitants per room for one household, which has been linked to adverse health outcomes in the literature.

Finally, 4 vectors including 12 variables with a relatively wide sample distribution were retained as explanatory variables for the incidence of diarrhoea. First, the gender of the adolescent was included as an indicator of host characteristics (vector one). Second, the host hygiene behaviour vector included carrying a water bottle to school and choice of site for defecation at home and school (vector two). Third, the built and interacting environment of the adolescent's household (vector three) were measured by monthly per capita household expenditures, the extent of crowding, the availability of toilets inside the house, the ownership of domestic pets, and the time needed to reach the nearest health facilities. Fourth, the household's knowledge base and behaviours (vector four) were represented by the mother's education, the care-seeking decision maker for the household, the frequency of regular house cleaning, and usage of a covered site for biodegradable waste.

3. Results

3.1. Sample Characteristics

Of the 114 students, there were 68 boys and 46 girls which translates to a school female to male ratio of 67.64, which is much lower than the 2011 national Indian average of 94 girls for every 100 boys enrolled in schools at the secondary level (World Bank, 2011). This hints that in some rural areas the female to male ratio is much lower than the national average. Salient characteristics of the sample households are summarised in Table 2.

According to the official poverty line for rural India for 2009–10 (Rs 672 per capita per month), 52.17 per cent of households in the study are living below the poverty line (Planning Commission, 2012). The median monthly per capita expenditure of the sample is Rs 645.83.

A greater percentage of the adolescents' mothers, 41.44 per cent, had completed secondary school (standard X) than the female national average (12.5%, Census of India, 2011). However, the decision maker about the household's care seeking behaviour included the mother in 52.78 per cent of households, while in 47.22 per cent of households the mother was excluded. This brings forth a dichotomy: despite the higher level of education of the mothers of the interviewed adolescents, their status as decision makers is not similarly elevated.

The living conditions of the households in this village are clearly illustrated. Water for toilet use or OD is more readily available (100%) than a toilet (56.14%). Waste is littered (81.60%) rather than being treated. While only 28.07 per cent of the households have domestic pets, in these households, the animals live with the household members. Most households (94.74%) do not have separate vessels

Table 2. Sample household characteristics: socio-economic status and behaviours

Variable	Category – %		
Number of diarrhoeal episodes in the past 6 months	None	One	More than one
	71.68	22.12	6.19
Monthly income per capita	Below Poverty Line	Above Poverty Line	
	52.17	47.83	
Degree of crowding	Less than 2 persons per room	2 to less than 4 persons per room	4 or more persons per room
	34.21	44.74	21.05
Availability of toilet	Yes	No	
	52.63	47.37	
Availability of water	Yes	No	
	96.40	3.60	
Ownership of pet	Yes	No	
	28.07	71.93	
Site for biodegradable waste	Covered	Uncovered	
	18.42	81.58	
Mother's education	Illiterate	Primary (I^{st} -V^{th} standard)	Secondary (X^{th} standard or above)
	27.93	30.63	41.44
Care seeking decision maker	Family including mother	Family excluding mother	
	52.78	47.22	
Frequency of house cleaning	Daily	Less than daily	
	62.50	37.50	
Water storage	No Separation	Drinking water is kept separately	
	94.74	5.26	
Water treatment	No treatment	Some form of purification	
	97.32	2.68	
Time to reach nearest health facility	Less than 25 min	More than 25 min	
	33.91	66.09	

Source: Analysis of primary data

to store water for drinking and water for other purposes and drink without purifying the water (97.32%). Healthcare is not available nearby for 66.09 per cent of households.

A little less than the majority (41.30%) of households of female students own a toilet, while 60.29 per cent of households of male students own a toilet. A majority of the students (71.05%) carry water bottles to school primarily because they have doubts about the quality of drinking water available there. Only 28.07 per cent of the students had received iron and vitamin A supplements and even less, namely 21.93 per cent, had consumed de-worming tablets in 6 months preceding the survey. With regards to their personal hygiene habits, 92.98 per cent claimed to wash their hands before eating and 92.98 per cent to wash their clothes every day. However, 22.1 per cent of the adolescents attending St. Sebastian School had at least one episode of diarrhoea in the 6 months preceding the survey. This figure is significantly higher than the national average of 9.98 per cent reported in the National Family Health Survey of India on diarrhoea incidence among children below the age of 5 years.

3.2. Gender Differentiated Defecation Practices

To answer our question about whether sanitation had a gender discriminatory effect on diarrhoeal incidence, we analysed data on usage of toilets stratified by gender using conditional probabilities

(Tables 3 and 4). It should be noted that the school has a separate toilet complex for girls and boys, each with a set of urinals and full toilets.

Three crucial observations can be made on the use of toilets and sanitation practices across genders. First, if the household owns a toilet then the practice of OD is lower (12.20% for males and 15.79% for females). However, OD is not inexistent even in toilet-owning households suggesting the need for additional interventions to improve acceptability and usage of home toilets by adolescents (Table 3).

Second, adolescents with a toilet at home are less likely to use the school toilet than students without a toilet at home, regardless of gender. Female adolescents are less likely to withhold defection and less likely to practice OD at school regardless of household toilet ownership status (Table 3).

Third, female adolescents have a higher propensity to use toilets than males as shown in Table 4 (54.35% practice a mix of OD and toilet use compared to 42.65% of males). While the percentages of males and females who never resort to OD, whether at school or at home, is similar (33.82% and 32.61%, respectively), the percentage of adolescent males who consistently practice OD (23.53%) is greater than the percentage of adolescent females who do so (13.04%). Furthermore, the distribution of male adolescents among the three groups (always OD, never OD, mix of OD and toilet use) is more

Table 3. Defecation practices and toilet usage by gender and toilet ownership status at home and school (%)

Defecation site at home by gender and toilet ownership status	OD	Household toilet
Male student whose household owns a toilet	12.20	87.80
Female student whose household owns a toilet	15.79	84.21
Male student whose household does not own a toilet	96.30	3.70
Female student whose household does not own a toilet	100.00	0.00

Defecation site at school by gender and toilet ownership status	OD	School toilet	Withholding defecation
Male student whose household owns a toilet	43.90	14.63	41.46
Female student whose household owns a toilet	10.53	63.16	26.32
Male student whose household does not own a toilet	44.44	18.52	37.04
Female student whose household does not own a toilet	18.52	70.37	11.11

Source: Analysis of primary data

Table 4. Combined school/home defecation practices and toilet usage by gender and toilet ownership (%)

Defecation site by gender and toilet ownership status	Always OD in home and school	Never OD in either home or school	Mix of OD and toilet use in either home or school
Male student whose household owns a toilet	12.20	56.10	31.71
Female student whose household owns a toilet	5.26	78.95	15.79
Male student whose household does not own a toilet	40.74	0.00	59.26
Female student whose household does not own a toilet	18.52	0.00	81.48
Male student	23.53	33.82	42.65
Female student	13.04	32.61	54.35
Student whose household owns a toilet	10.00	63.33	26.67
Student whose household does not own a toilet	29.63	0.00	70.37

Source: Analysis of primary data

uniform than that of females among the same three groups. Adolescent females prefer to practice a mix of both OD and toilet use rather than only OD or only toilet use.

3.3. Determinants of Diarrhoeal Episodes: Regression Results

Logistic regressions were used to quantify the conceptual framework for determinants of diarrhoea. The occurrence of diarrhoea in the past 6 months was taken as the binary dependent variable (0 represents the absence of a diarrhoeal episode and 1 the occurrence of at least one episode). The results are presented in Table 5.

The model affirms that toilet usage is a determinant of diarrhoeal incidence among adolescents: usage of toilets is associated with lower probability of diarrhoea. The probability of having diarrhoea is lowest for adolescents who practice a mix of OD and toilet usage rather than always either "OD" or "use of toilet". The marginal effect of "always toilet use" is 0.13 and that of "mixed use" is 0.20. This means that for every 100 toilet practices that are diverted from "always open" to even "mixed use" of toilets, 20 episodes of diarrhoea can be eliminated. Diarrhoea occurrence decreases significantly when the adolescent uses only toilets, but with lower levels of statistical significance.

Diarrhoea occurrence also depends on adolescent behaviour and household living conditions. Indeed, crowding is significantly related to the odds of having at least one episode of diarrhoea at the 10 per cent level. An increase in the number of people sharing a room increases the odds of having diarrhoea by 42 per cent.

Gender is also a significant determinant of diarrhoea among adolescents. The odds of having at least one episode of diarrhoea is 8 per cent lower for female as compared to male adolescents. This result is consistent with the conditional probability analysis performed above (Tables 3 and 4):

Table 5. Odds ratios of correlates for the occurrence of diarrhoea

Correlates	Odds ratio	P > z
Log Income	0.89	0.77
Crowding	1.42*	0.09
Ownership of domestic pet (reference = no)		
Yes	0.97	0.96
Frequency of house cleaning (reference = daily)		
Less than daily	2.19	0.18
Site for biodegradable waste disposal (reference = not covered)		
Covered	0.72	0.65
Time to reach health facility (reference = less than 25 min)		
More than 25 min	0.86	0.80
Mother's education level (reference = illiterate)		
Primary	0.85	0.80
Secondary & above	0.65	0.51
Care-seeking decision maker (reference = mother)		
Other than mother	0.66	0.45
Sex of the adolescent (reference = male)		
Female	0.28*	0.06
Carry water bottle to school (reference = no)		
Yes	1.16	0.81
Site of defecation (reference = Always open)		
Mixed	0.21**	0.02
Always Latrine	0.38*	0.10
Number of observations	113	
LR chi2(13) =	16.81***	
Pseudo R2 =	0.1408	

Notes: ***significant at the 1 per cent level, ** significant at the 5 per cent level * significant at the 10 per cent level

female adolescents are more likely to use toilets and toilet use is a significant determinant of diarrhoea.

Household income, ownership of a domestic pet, frequency of household cleaning, the site for biodegradable waste disposal, the time to reach a healthcare facility, the mother's education level, the mother's role as a decision maker for care-seeking, and carrying a water bottle to school, were not found to be significantly correlated with the occurrence of diarrhoea among adolescents.

4. Discussion

The statistical analysis of the survey data yields four main results. First, the defecation practice adopted by adolescents is a significant determinant of diarrhoeal incidence among adolescents. Second, among sanitation practices, a mixed one involving both use of toilets and OD is more effective in lowering diarrhoeal incidence than either only OD or only use of toilets. Contrary to intuition, students who always use toilets experience more diarrheal episodes, possibly because those using toilets exclusively often avoid defecation in school and hold back urine leading to adverse health effects. Third, female adolescents are less likely to withhold defecation or practice OD at school, more likely to practice an overall mix of OD and toilet use, and are consistently found to experience significantly less episodes of diarrhoea. Fourth, crowding in the adolescent's household is a significant determinant of diarrhoeal incidence among adolescents, with likelihood of diarrhoea increasing with greater crowding, possibly through its impact on household cleanliness and hygiene.

The above results suggest that access to toilets may not be enough to eliminate OD, and therefore, policy should target additional complementary factors as well. That said, while this study shed light on processes and potential causes and effects, it is not able to establish causality given its design. The findings were hence discussed with the staff of St. Sebastian school and three other similar schools in nearby villages to contextualise the results.

4.1. Contextualising the Results Through Focus Group Discussions

The focus groups yielded further insights on common challenges faced by school authorities. Participants explained that a harsh reality marks many Indian schools regardless of school fees or the economic status of the student households. Barring exceptions, toilets when they exist at all, are often poorly maintained and only cleaned prior to inspections. This leads many students, including those who do not own a toilet at home, to withhold defecation at school and resort to OD or use the household toilet after school.

The inability of school authorities to maintain school toilets is not only due to the lack of adequate resources. There is an institutional vacuum, namely a lack of agencies or individuals willing to maintain public toilets, because of the negative social stigmas attached to such activities. The cleaning staffs of the schools are willing to clean up the classrooms but not the toilets to prevent being associated with the manual scavenging caste. Many school authorities mentioned that the number of toilets to be cleaned is now much greater than the number of older members of the traditional manual scavenger caste; furthermore, since the government is actively engaged in their rehabilitation, younger members of the manual scavenging caste prefer to take advantage of the same and switch to other professions.

Interestingly, many school staff mentioned that OD is practised, because it offers opportunities for same-sex social interactions. Girls and women in many regions are not allowed to gather in public places and debate issues, exchange ideas or simply relax together. Adolescents face even greater restrictions as older women often sanction free discussion and exchange between them. Thus, OD offers a good opportunity to talk and spend time together free from other constraints and the watchful eyes of adults.

In summary, the focus groups offered possible explanations for this study's findings that mixed defecation practices are more common among females and significantly more effective in reducing

adolescent diarrheal incidence. The co-existence of OD with access to sanitation may be due to the insalubrious state of school toilets on the one hand and positive social externalities offered by OD in terms of gendered social interactions on the other hand. Furthermore, the main difficulty in maintaining school toilets lies in the lack of organisations or individuals willing to clean public toilets.

4.2. Implications for Ongoing Government School Sanitation Programmes

In 1999, a School Sanitation and Hygiene Education (SSHE) campaign was initiated by the government of India in partnership with UNICEF with a two-fold purpose: to erect toilets and hand washing facilities in schools and to promote behavioural change from OD to the use of toilets through hygiene education. State investment in school sanitation received another boost in 2014 with the launching of the national flagship programme, the Swachh Bharath Mission (SBM) or the Clean India Mission. The school sanitation component of the Clean India Mission accepts that WASH interventions must be more than installing toilets and water taps in order to ensure a healthy school environment and to develop or support hygiene behaviours (GOI, 2016).

As of 2014, 1 million girls and 23 million boys in India lacked access to gender segregated toilets; and while 85.8 per cent of the schools have toilets, only 27.4 per cent of these toilets have water available in them for flushing and cleaning (UNICEF, 2016). In response to these conditions, the ongoing Clean Schools Mission of the Indian government recognises that elimination of OD by school children is a systemic problem that must be addressed through capacity enhancement of students, teachers, community members, village councils, non-governmental organisations, community based organisations and education administrators keeping in mind gendered needs (GOI, 2016). The program emphasises that an impact on the health and hygiene of children can also trigger behavioural change in their families and the larger community. Finally it notes: "poor operation and maintenance of these facilities are undermining sustained coverage, resulting in loss of investments. For example, lack of dedicated funds for operation and maintenance, weak management and poor water availability inside toilets, all contribute to dysfunctional, unusable toilets" (GOI, 2016).

The findings of this paper confirm that the systemic and multidimensional approach promoted by campaigns such as Clean India Mission is a move in the right direction and offer three main inferences for policy design.

First, the provision of usable and clean toilets is the central key to the containment of diarrhoeal diseases. Simply installing toilets in schools would be a myopic strategy. Installation must be preceded by a reflection on maintenance, an obvious principle that is often overlooked in national programs (Zawahri, Sowers, & Weinthal, 2011).

Second, triggering behavioural change is also important. There is currently a heavy investment in programmes to raise awareness about sanitation in India. While awareness is necessary both in schools and households, it does not guarantee a change in behaviour. Unless investments in awareness creation translate into hygiene behaviour changes, it runs the risk of having no impact on health. Participatory techniques such as those used by the Community Led Total Sanitation methodology may be useful in translating awareness into behaviour change (Biekart & Gasper, 2013).

Regardless of the approach taken, behavioural change initiatives must be compatible with the beliefs and aspirations of adolescents and take into account gender differences. Differences between genders on defecation mode are not the sole result of a difference in access to latrines. Rather they are choices that depend on a myriad of factors including the need for safe areas to exchange information outside the home, the need for privacy and the cleanliness of toilets. The importance of these factors differs between genders and pushes males and females to make different choices. That said, OD has emerged as an endogenous social norm partially as a response to a lack of spaces outside of the home that allow for the free exchange of ideas and permit social interaction. Therefore, any initiatives for triggering behaviour must seek to provide safe alternatives for socialisation outside of the home especially for women. Techniques such as *shaming* those who do not use toilets are likely to have negative consequences when applied to adolescents (Engel & Susilo, 2014).

In addition to behaviour change, sustainable financial models for toilet maintenance must be developed. In India, this challenge is amplified because the association of cleaning of toilets with the lowest caste makes it a shameful activity for which there is a labour shortage. This can possibly be overcome if those who clean toilets are given proper equipment and other responsibilities, besides toilet maintenance, related to the promotion of a salubrious environment for children and youth.

It is thus evident that rural school sanitation programmes in India have to move beyond a focus on toilet and water installations and awareness creation. The challenge that must be addressed is three fold: to install toilets, to incentivise adolescents to use the toilets instead of resorting to OD and to identify financially sustainable models for the maintenance of school toilets.

5. Conclusions

Diarrheal diseases pose a very heavy health burden in low and middle income countries where access to sanitation is incomplete. While the determinants of diarrheal diseases among children less than 5 years of age and mothers have been extensively examined, school going adolescents remain an understudied group despite bearing a significant portion of diarrhoea's morbidity. This study aimed to overcome the dearth of research on this population by examining the literature to formulate and subsequently validate a conceptual framework on the determinants of diarrhoea through a survey of school going adolescents in an Indian village.

The study indicates that among school going adolescents, toilet usage and the degree of crowding in the adolescent's household are significantly associated with diarrhoeal episodes. Having access to toilets at home and school as well as adequate living space at home reduces diarrhoeal incidence. Furthermore, for students whose households do not own a toilet at home, access to a toilet in school lowers their rate of OD, but is not enough to improve health status, as measured by diarrhoeal incidence. Indeed, usage of school toilets is a crucial determinant of diarrhoea for adolescents. School going adolescents, who mix toilet use with OD experience less diarrhoea than students who withhold themselves from defecating at school, or those who systematically defecate in the open.

Some counterintuitive behaviours also came to light. First, students who have a toilet at home are less likely to use toilets at school compared to those without toilets at home. While having access to a household toilet is an advantage, it seems to be associated with withholding defecation or OD at school, particularly among boys. Girls are more inclined to use school toilets, whether or not their household owns one. These findings also point to the importance of factors other than access to toilets in determining toilet use. Since students do not unanimously use school toilets, school sanitation programs cannot focus solely on access to toilets.

The Indian government is investing in both household and school sanitation to eliminate open defecation by 2019. However, as this study shows, access to school toilets does not guarantee their use: OD and withholding defecation can co-exist with access to sanitation. This duality may be explained by the positive social externalities offered by OD and the inadequate maintenance of school toilets. The success of programs aiming to improve school sanitation will therefore depend on a holistic view of eliminating OD. Policies to improve sanitation must include three components: the installation of toilets in schools, a focus on behaviour change, and the development of sustainable mechanisms to maintain school toilets.

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Appendix 1. Excluded variables and control variables

Excluded variables		Control variables
Father's occupation	Time to reach toilet	Site for water collection
Mother's occupation	Number of families using the same toilet	Availability of water for washing in the toilet
Paternal education level	Person who cleans the toilet	Frequency of bathing
Roof type	Person who disposes of the garbage	Method for bathing
Number of houses	Method to clean the toilet	Frequency of hand washing
Size of bedroom	Method to clean the house	Frequency of clothes washing
Number of windows	Disposal of infant diarrhoeal stools	Site for bio-degradable waste disposal
Separate kitchen	Hand washing after waste disposal	Site for non bio-degradable waste disposal
Number of times food is prepared	Hand-washing prior to meal preparation	Method to clean drinking water vessel
Time when food is prepared	Family hand washing practice (after defecation, before meals)	Frequency of toilet cleaning
Existence of left-over food	Method for hand washing	Frequency of house cleaning
Site for storage of left-over food	Use of footwear outside	Frequency of external food consumption
Duration of left-over food storage	Use of footwear when using toilet	Source of food consumed at school
Washing vegetables	Type of footwear used	Number of vessels for water storage
Number of meals per day	Method for clothes washing	Separation of drinking water
Frequency of tea/coffee consumption	Frequency of nail cutting	Time before seeking care at last illness
Frequency of fruit consumption	Number of illnesses in past 6 mo	Consumption of de-worming tablets
Frequency of meat and fish consumed	Presence of skin problems in the past 6 mo	Consumption of Vitamin A & iron supplements
Type of fruit consumed	Consistency of stools	
Frequency of uncooked vegetables consumption	Presence of blood in stools	
Type of uncooked vegetables consumed	Age	
Frequency of street food purchase	Blood type	
Consistency of water source	Existence of second uses for water	
Time to reach water source	Type of domestic pets owned	
Distance to water source	Type of animals commonly seen	
Sufficiency of water quantity	Ownership of a bicycle, car, truck, motor bike, TV, A/C, refrigerator, electricity or stove	
Type of vessel for water collection	First response after diarrhoea	
Type of vessel for drinking water collection	Site for drinking water collection	
Presence of lid on drinking water vessel	Utensil used to pour drinking water	
Width of mouth of drinking water vessel	Method used for water purification	