Determinants of the prevalence of diarrhoea in adolescents attending school: a case study of an Indian village school

Working Paper Series

#2012-059

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UNU-MERIT Working Papers

ISSN 1871-9872

Maastricht Economic and social Research Institute on Innovation and Technology, UNU-MERIT

Maastricht Graduate School of Governance MGSoG

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ABSTRACT

In developing countries, including India, diarrhoea is a leading killer throughout the age pyramid. However, most of the medical literature on the determinants of diarrhoea focuses only on young children or the elderly, with health policy mainly targeting the former. Thus, the present article attempts to contribute to a better understanding of the determinants of diarrhoea in adolescents – the understudied population. The paper develops a model using the medical literature, refines it to fit an Indian village context and tests the hypotheses identified through administering a questionnaire to 114 adolescents in an Indian village school. Results confirm the well known importance of household sanitation. In addition, the contribution of the present study is to assert that *access* to school toilets and *usage* of school toilets are also crucial. Furthermore, usage of toilets at school varies as a function of gender and the existence of a toilet in the student's household. Finally, the installation of toilets in schools is not enough, sustainable financial models must be found to maintain toilets and induce students to use them.

Key words: diarrhoea, adolescents, India, sanitation, school

JEL codes: I15, I25, O29

Acknowledgements: We would like to thank Mr. S. Paranjothi of Friend in Need and Ms. Aditi Kumar for their precious help in administering the questionnaire and all logistics. We remain responsible for all remaining errors. The first author gratefully acknowledges support from UNU-MERIT under the FINISH programme.

+ Timothée Frühauf is currently a Research Assistant. This work was carried out in India in 2010 while he was a student in the Johns Hopkins Post-Baccalaureate Premedical Program, and a research intern for Dr. Ramani with UNU-MERIT (The Netherlands) and Friend in Need (India).

Determinants of the prevalence of diarrhoea in adolescents attending school: A case study of an Indian village school

1. Introduction

Diarrhoeal diseases refer to a symptom or sign encompassing different types of diarrhoea. As a symptom it is characterized by "stools of decreased consistency and increased volume due to imbalance of secretion and absorption of water and salts in the intestine."[1] As a sign, diarrhoea is described as "an increase in stool water excretion to greater than 150 to 200 ml every 24 hours."[2] While the morbidity and mortality associated with diarrhoeal diseases make them a significant public health problem worldwide, the problem is most acute in developing nations. In India, diarrhoea is a major source of mortality in children under five and represents a heavy economic burden on health systems. About 33% of total paediatric admissions in India are due to diarrhoeal diseases and up to 17% of inpatient paediatric deaths are diarrhoea-related.[3] Finally, according to the World Bank, approximately 21% of communicable diseases in India are waterborne. Of these diseases, diarrhoea is the biggest killer and has been linked to as many as 1,600 deaths each day in India.[4] Perhaps because diarrhoeal diseases are most lethal for children under five years of age, national and international public health policy is mostly centred on them. However, repetitive diarrhoeal episodes during childhood and adolescence can eventually lead to lower fitness and decreased productivity as an adult.[5] Hence, there is a real need to understand the determinants of diarrhoea in adolescents as well. In the above context, to contribute to some insight to this understudied problem, the present paper examines in detail the determinants of diarrhoea among 114 adolescent students in the 9th and 10th grades of a village school in Southern India.

Kameshwaram is a typical[6] isolated rural village in the Nagapattinam district of Tamil Nadu, India. One of its notable features which lends it renown in the region is St. Sebastian School, a private secular school founded in 1954 by Mr. Rose Anthony, a school teacher with ancestral lands in Kameshwaram. At the request of his friends Mr. Anthony bequeathed the major financial contribution to start a school, as there were none of repute in the region. This was a prime example of citizens cooperating to advance a common cause and good. The school's claim to fame lies in its remarkable academic achievement. Over the last 7 years, all of its students in the 10th grade have successfully passed the State School Board Exams.

St. Sebastian is the only school in the village offering middle school and high school education. At the time of the study (2010), 492 boys and 365 girls were enrolled, taught by 28 teachers. The waitlist for students seeking admission to the high school is long and there is widespread demand from parents of the adjacent regions for the school's expansion. Given the elevated school attendance rate among the inhabitants of Kameshwaram and the fact that St. Sebastian is the only school offering education to adolescents in the village, interviewing

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[1] Black, Robert. Epidemiology of Diarrheal Diseases. Powerpoint lecture available through Open Course Ware of the Johns Hopkins Bloomberg School of Public Health, Baltimore MD, 2007 ; Binder, Henry. Pathophysiology of Acute Diarrhea. *The American Journal of Medicine* 1990; 88(Supl6A): 2S-4S.

[2] Binder (1990).

[3] B. Banerjee, S. Hazra and D. Bandyopadhyay, Diarrhea Management Among Under Fives, Indian Pediatrics 2004; 41:255-260.

[4] http://www.who.int/mediacentre/multimedia/2002/ind_sanitation/en/index.html

[5] Guerrant RL, Kosek M, Moore S, Lorntz B, Brantley R, Lima AA. "Magnitude and impact of diarrheal diseases".Archives of Med Research. 2002 Jul-Aug;33(4):351-5.

[6] Kameshwaram is a typical rural village in the sense that there are many other villages in India with similar geographical and socioeconomic features and which follow similar social norms and modes of governance.

the students attending the school guaranteed the most comprehensive access to data from adolescents.

A better understanding of the risk factors for diarrhoeal diseases among teens in developing countries is required, because recent estimates point out that these are leading killers throughout the age pyramid.[7] More specifically, narrowing in on the determinants of diarrhoea among adolescents is important, as a recent literature review has highlighted the significant incidence and mortality from diarrhoea among this segment of the population, despite the dearth of diarrhoeal studies specifically focused on adolescents. Using the latest available 2005 data, it estimated that infectious diseases were the biggest killer of adolescents in India, with diarrhoea being the most important of those diseases and accounting for 15% of all deaths in the 10 to 14 year category.[8] In addition to mortality, diarrhoeal diseases among adolescents are also an important source of morbidity and could potentially have an effect on the number of missed school days. Hence, focusing on school-attending adolescents would capture such previously omitted consequences of diarrhoea.

The present study is therefore very pertinent for public health strategy and policy for four reasons, the list being non-exhaustive. First, designing an effective public health policy to reduce the incidence of diarrhoea is a real challenge, because it has to take into account that diarrhoea can be caused by a wide variety of bacteria and viruses, which complicates timely and accurate diagnosis and treatment, especially for marginalized and low-income populations with little access to modern laboratory analyses and drugs. Diarrhoeal diseases can be addressed through investments in curative measures (focusing on the post-disease period) as well as investments in preventive measures (focusing on the pre-disease period). The former includes care and medication, while the latter refers to investments for improved water quality and quantity, sanitation measures and health awareness. For this reason, appropriate health policy designed to tackle diarrhoeal prevalence must recognize the equal importance of investing in both preventive and curative measures. And inferences from representative rural, village-level data can contribute to the discourse on improving this policy design.

Second, a more comprehensive understanding of adolescent-specific risk factors of diarrhoea is needed because diarrhoeal morbidity is not receding in many age groups including that of adolescents. The rapid decline in diarrhoeal mortality across the age pyramid which characterized the 1980s through 2000[9] has reached a slowing pace even though diarrhoeal diseases remain one of the most deadly preventable killers in developing nations.[10] Tailored information on the determinants contributing to diarrhoeal mortality and morbidity among adolescents should be used as guidance to define interventions that need to be implemented to reverse these trends.

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[7] Fischer Walker, CL and Black, RE. Diarrhoea Morbidity and Mortality in Older Children, Adolescents, and Adults. *Epidemiology and Infection*. Available on Cambridge Journal Online 2010.

[8] Morris et al. (2011)

[9] Bern, CJ et al. The Magnitude of the Problem of Diarrhoeal Disease: A Ten-Year Update. *Bulletin of the World Health Organization* 1992; 70:705-714 ; Kosek, M, Bern, C, and Guerrant, RL. The Global Burden of Diarrhoeal Disease, as Estimated from Studies Published Between 1992 and 2000. *Bulletin of the World Health Organization* 2003; 81: 197-204 ; Snyder, JD and Merson, MH. The Magnitude of the Global Problem of Acute Diarrhoeal Disease: A Review of Active Surveillance Data. *Bulletin of the World Health Organization* 1982; 60: 604-613.

[10] Keusch, Gerald T et al. "Diarrheal Diseases." *Disease Control Priorities in Developing Countries (2nd Edition)*. New York: Oxford University Press, 2006. 371-388.

Third, disease does not emerge in vacuum and often the complementarity between the different risk factors are not studied enough. For instance, in India the heath status of individuals is usually viewed as being a function of the socio-economic status (SES) of the households to which they belong, in addition to family-specific health history. As a result, it is assumed that by focusing on poverty alleviation, and therefore improving SES factors, the health status of the poor will subsequently improve by default. But, it is self-evident that the prevalence of diarrhoea also depends on household living conditions including access to water and a toilet as well as household behaviours especially with respect to food consumption, hygiene, and sanitation. Though this issue has been recognized in some articles, there has been no comprehensive study of diarrhoea's risk factors and their complementarities. Therefore, to study the complementarities of those factors and their effect on diarrhoeal prevalence, there is a need for a comprehensive study on the determinants of diarrhoea at the micro-level.

Fourth, the global spread of diarrhoeal diseases in low- and middle-income countries warrants the generation of data, which can be used to improve efforts to tackle this major killer. According to the UN Water Statistics organization: "Globally, diarrhoea is the leading cause of illness and death, and 88 per cent of diarrhoeal deaths are due to a lack of access to sanitation facilities, together with inadequate availability of water for hygiene and unsafe drinking water […] Today 2.5 billion people, including almost one billion children, live without even basic sanitation. Every 20 seconds, a child dies as a result of poor sanitation. That's 1.5 million preventable deaths each year."[11] Developing countries with inadequate sanitation coverage are tackling this problem through State programmes and Public-Private Partnerships with international agencies (e.g. UNICEF, WATER AID, WASTE) and local NGOs. Thus, despite important village- and country-specific particularities of the data, the findings of the present study will also be useful to many low- and middle-income countries with similar problems, as diarrhoea is "the single largest cause of disease and death in the world – and they affect the poor disproportionately."[12]

The methodology comprised four steps. First, we formulated a model from a survey of the literature on determinants of diarrhoeal diseases in low- and middle-income countries and India. This model sought to link all previously identified risk factors in one comprehensive framework. We then refined this model into a conceptual framework integrating considerations that were lacking from the current literature adjusting it to be more consistent with the context of a rural Indian village.

Second, we designed a questionnaire from the model to collect data on the determinants of diarrhoea and other health associated behaviours. We validated the questionnaire by consulting with two Indian medical practitioners, a gastroenterologist and a paediatrician, familiar with the context of rural South Indian healthcare and status. As a result, the questionnaire was amended for cultural competency. It was then translated into Tamil and further modified after consulting with the staff of two local NGOs involved in sanitation projects during the course of 2010 to ensure pertinence of the questions. Prior to being administered, the questionnaire was revised after being tested among five local households and ten adolescents to ensure consistency in data collection.

[11] http://www.unwater.org/statistics_san.html

[12] Lane, J. (2006). Improving Water and Sanitation Services in Rural Areas: Lessons Learned from Ghana, Lesotho and South Africa, In L. Fox and R. Liebenthal (eds.), *Attacking Africa's Poverty: Experiences from the Ground.* (pp. 257-84) World Bank: Washington D.C.

Third, the final questionnaire was administered via face-to-face interviews with all the students in the 9th and 10th grades at St. Sebastian School. The questions were asked by one trained translator and recorded by a data collector simultaneously. Each interview lasted approximately 45 minutes.

Fourth, a statistical analysis was carried out to identify the main risk factors correlated with the occurrence of diarrhoeal diseases for the population interviewed. Additionally, the analysis identified the interactions between the different determinants and the correlation of these interactions with their health outcomes.

Finally, we recognize the two main limitations of our micro-level study. First, this case study takes a more narrow approach by concentrating on only one disease as opposed to the entire health status of the adolescents. The choice of diarrhoea is however motivated by both the importance of the disease as a major killer in India as well as the well-known association between sanitation and this disease. Second, the findings pertain to a single village. That said, our approach is very relevant for the Indian context. A significant majority of the population in India still resides in rural areas, with only 30% of the population living in urban areas.[13]

The remainder of this paper is organized as follows. Section 2 presents the literature review and develops a conceptual framework from its findings. Section 3 describes the questionnaire designed to fit the conceptual framework and the compilation of the data. Section 4 contains the statistical analysis. Section 5 discusses the main results. Finally, section 6 concludes.

2. Literature review and conceptual framework

2.1. A review of the medical literature

In order to gain a better understanding of the current knowledge on determinants of diarrhoeal diseases in developing nations a review of the medical and public health literature was undertaken between April and June 2010.[14] The objectives behind the literature review were as follows:

1. Identify studies focused on diarrhoeal diseases among adolescents to understand the current debate on that topic.
2. Obtain a comprehensive list of all risk factors that have been correlated to diarrhoeal diseases incidence and prevalence in developing nations.
3. Understand the established interactions between these different risk factors.
4. Build a comprehensive model to identify the currently known interactions between the factors and categorize the different levels at which the determinants and diarrhoea can be studied.

Identification of appropriate articles was performed through consultation of PubMed, the searchable database administrated by the National Institutes of Health's United States National Library of Medicine. PubMed principally accesses the MEDLINE database of

[13] CIA The World Factbook. « India » https://www.cia.gov/library/publications/the-world-factbook/geos/in.html
[14] Carried out by Timothée Frühauf

biomedical and life sciences articles, which includes medicine and public health. The search was performed between April and June 2010.

The following keywords were used to identify articles: diarrhoeal diseases, diarrhoea, determinants, risk factors, low and middle income countries, South-East Asia, India. Several combinations of the keywords were used.[15] All articles identified by PubMed were subsequently manually screened to ensure they were relevant to the objectives of the literature review. There were a total of 116 articles selected for further analysis and integration in the comprehensive conceptual framework.

All references for the articles included in the literature review can be found in Appendix 1.

To make sense of the wide variety in risk factors that had previously been identified in the literature as being correlated to diarrhoeal diseases in low- and middle-income countries, the risk factors were classified according to five categories that were defined based on the articles' findings. These were: (1) Physical environment; (2) Resources; (3) Built environment; (4) Behaviour; (5) Host characteristics. All risk factors identified in the literature were assigned to one of these categories.

Two principal observations were made from the literature review:

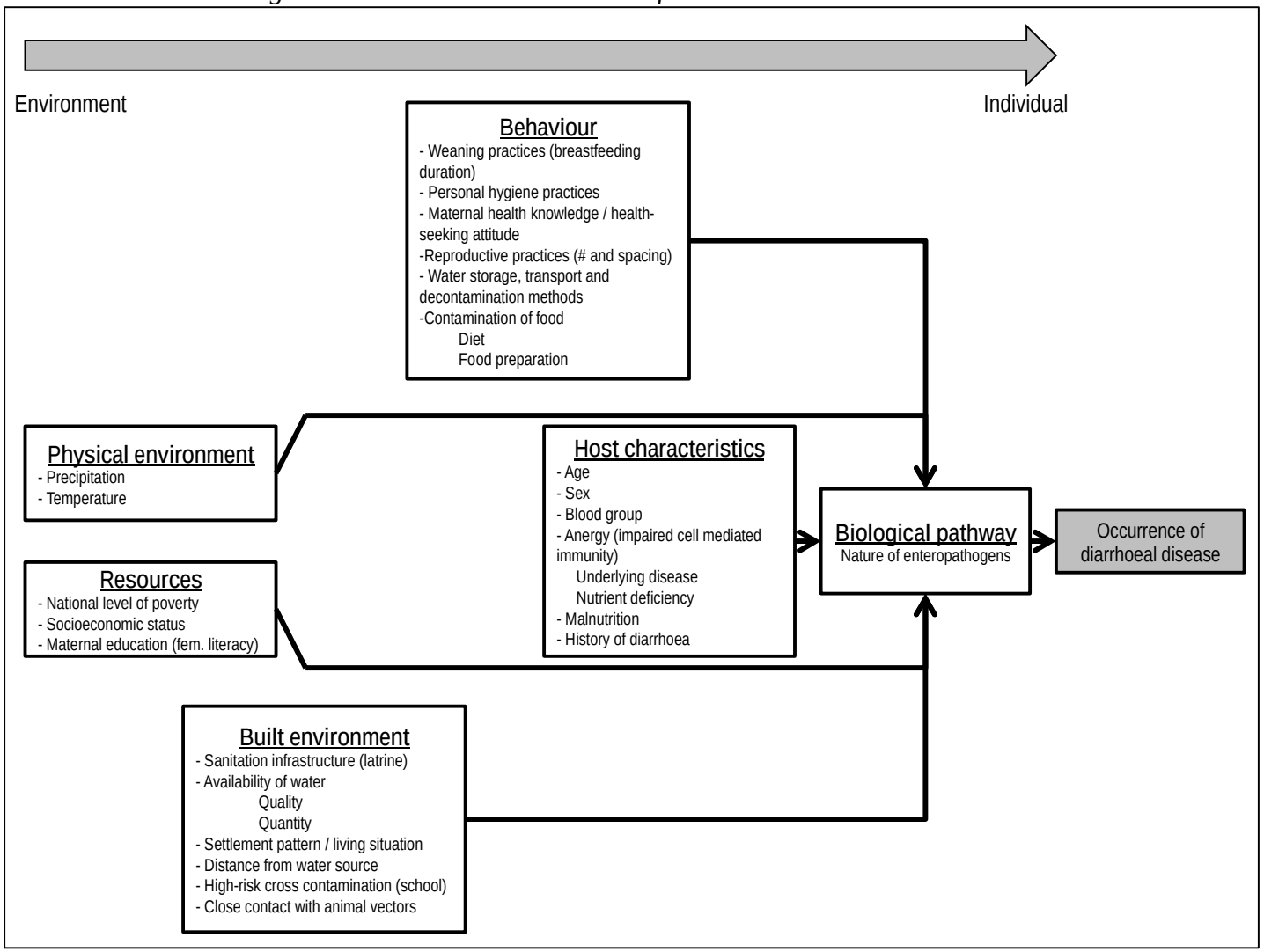
First, it revealed that while almost all people living in low- and middle-income countries are at high risk for diarrhoeal diseases, some have a higher individual risk. Therefore both environmental and individual-level risk factors should be identified and separated. However, the distinction is more nuanced and should be seen as more of a spectrum ranging from environmental to individual-level factors. It must also be noted that varying environments, which are more or less encompassing could also be defined (i.e. a country vs. a village vs. a neighborhood vs. a household) and therefore extend or restrict the spectrum at one end.

Second, it was noted that the risk factors were not only individually correlated with the occurrence of diarrhoea, but also engaged in interactions between risk factors, which had a compounding effect on the outcome of interest. Therefore interactions between factors were equally important in identifying the major determinants of diarrhoea as the factor's impact itself.

A model was developed to capture both these dynamics, the environmental to individual level spectrum and the interactions between risk factors. The model lays out the different risk factors that are associated with the occurrence of diarrhoeal diseases, taken as the outcome towards which the risk factors converge. It shows both the relationship between different risk factors as well as the environmental-individual dichotomy (Figure 1).

[15] Keyword combinations: diarrhoeal diseases AND determinants ; diarrhoeal diseases AND « risk factors » ; diarrhoeal diseases AND « low and middle income countries » ; diarrhoeal diseases AND « South-East Asia » ; diarrhoeal diseases AND India ; diarrhoeal diseases AND adolescents ; diarrhoea AND determinants ; diarrhoea AND « risk factors » ; diarrhoea AND « low and middle income countries » ; diarrhoea AND « South-East Asia » ; diarrhoea AND India ; diarrhoea AND adolescents.

Figure 1: Model: the determinants of diarrhoeal disease occurrence



The risk factors could be positioned on a spectrum ranging from the more distal environmental level (i.e. factors that affect all people in one environment) to the more proximal individual level (i.e. factors that affect an individual with certain characteristics). According to this model, all the risk factors influence the presence of enteropathogens in a host, which is directly linked to the occurrence of diarrhoeal diseases.

In the international economics literature, there were no articles exploring the determinants of diarrhoea in adolescents or adults in India. So, the next step was to use the above model based on the medical literature to develop a social sciences conceptual framework that could be tested with a questionnaire in a village.

2.2. Development of a conceptual framework based on the medical literature

Consider the formulation of a health policy to reduce the prevalence of diarrhoeal diseases. Disease prevalence can be considered as the occurrence of an event, which depends on factors some of which can be addressed in the short run and other which can be changed or rectified only in the long run, if at all. The former will be referred to, as in common economics parlance, as ‘variable factors’ and the latter as ‘fixed factors’. The clear distinction between fixed and variable risk factors is important because only variable factors can be modified relatively quickly in the short-term. As a result, these factors should be the initial focus of policy measures to reduce diarrhoeal disease occurrence. Behaviour, as defined in Figure 1, can be considered as being comprised of a set of variable factors, which can be varied to some extent through appropriate incentive systems. The built environment and resources can also be altered in the medium run to some extent through policy. However, host characteristics, physical environment and biological pathways have to be taken as fixed factors – which government policy has to accommodate and cannot change.

We then re-designed the model to make it appropriate for the study of school-attending adolescents. Four kinds of changes were introduced.

First, we took into account the fact that every student belongs to a household. Therefore, the socio-economic status of the household forms the environment under which the health status of a student is determined. Moreover, the behavioural routines that are defined at the level of the student’s household, (for example, food consumption practices), impinge as much as the individual adolescent’s behaviours on his or her vulnerability to disease. Thus, any case study on adolescents has to integrate information from different sub-levels, household and individual, making up the micro-level.

Second, many of the behaviours identified in the literature and the model are not relevant for the population of this study. For example weaning practises are not relevant for non-pregnant girls and or boys.

Third, new variables were introduced and some were combined on the basis of our discussions with local physicians and NGOs in order to take Kameshwaram’s specific context into consideration. For instance, several variables were added to broaden the category ‘resources’, which was re-labelled as ‘socioeconomic status’. The variables included under the categories ‘built environment’ and ‘physical environment’ were combined to constitute ‘living conditions’. The risk factor category labelled ‘behaviour’ was modified to include a variety of variables about hygiene, water storage, care-seeking practices, and food preparation

and consumption. The outcome of interest was also broadened beyond the occurrence of diarrhoea to include the general health status of the surveyed population.

As a result of these modifications, the implications of the model (Figure 1) for the risk factors affecting the prevalence of diarrhoea in school-attending adolescents, can be summarized as follows:

(i) Given a physical and socio-economic environment of a household, the probability of diarrhoea in a school-going adolescent belonging to this household, p, is a function of a set of both fixed and variable factors including:
   - A = The vector defining the physical characteristics of the student (fixed factors);
   - B = The vector defining the behaviours of the student (variable factors);
   - C = The vector defining the behaviours of the students' associated household (variable factors); and,
   - D = The vector defining the 'built' and 'interacting' environment of the household of the student (which may be either fixed or variable factors).

(ii) Complementarities exist between the above different factors and they jointly impact the probability of infection.

This gives rise to the following model to be estimated:

$$p = f(A, B(A, C, D), C(D), D) \quad (1)$$

Additional interviews with two medical practitioners in India led to a final choice of variables to be included in vectors *A, B, C* and *D* based on their relevance for Kameshwaram adolescents.

- A = physical characteristics = {age, gender, blood type }
- B = individual behaviours = {hygiene practices}
- C = household behaviours = {sanitation practices, food preparation and consumption practices, water storage, purification and consumption practices, care-seeking practices}
- D = {socioeconomic status, household asset portfolio including toilet ownership, living conditions as defined by the habitat, access to water, access to sanitation, and proximity with animals, access to markets for health care}

Two points are noteworthy. First, while the medical literature on diarrhoeal disease determinants is relatively silent on the role of markets for healthcare (diagnostics, drugs, health services), it is obvious that access to healthcare impacts the prevalence of infection. Second, the socioeconomic status of the households in India is usually measured by the Kuppuswamy index, an index based on the income of the household and the education and occupation of the head of the household.[16] Noting that the Kuppuswamy index was initially designed for urban households, we added the asset portfolio of the family including the ownership of a toilet to the above variables comprised in the index.
The final conceptual model contained 92 variables, which are presented in Appendix 2.

[16] Kuppuswamy, B. Manual of socioeconomic status (Urban) Delhi: Manasayan; 1981.

2.3. Final variables considered and database compiled

A questionnaire was designed to facilitate the collection of data on all variables included in the conceptual framework. Consultation with local NGOs and trial administration of the questionnaire highlighted some challenges, which led to further simplification of the questions. Only then were the interviews conducted in the school. Male and female students enrolled in the two highest grades, 9th and 10th grades, of St. Sebastian School were interviewed for this case study. There were a total of 116 students in these grades who were eligible for participation in the case study. However, only 114 students were present at school during the time period when the interviews were conducted.

A lack of knowledge, on the part of the adolescents, regarding household practices and behaviours was sometimes a limitation for the compilation of the database.

In order to have a guaranteed minimum impact on the targeted community who was sharing its time with us, we undertook two immediate actions. We undertook the repairing of the water taps and some of the toilets in the school.[17] In addition, Tamil-English dictionary were given to all students who participated in the project.

On the basis of a preliminary analysis of the completeness and consistency of the data, the variables included in the explanatory vectors to be correlated with the occurrence of diarrhoeal episodes were further reduced to 32 as shown in the Table 1. Sample distribution for these variables can found in Appendix 3.

Table 1: Subset of variables selected for an initial analysis

HEALTH STATUS (OUTCOME)	
Number of diarrhoeal episodes in the past 6 months	
DETERMINANTS	
A = Physical Characteristics	Separation of drinking water
Gender	Water bottle at school
B = Individual behaviours	Care-seeking decision maker
Frequency of bathing	Time before seeking care at last illness
Method for bathing	First response after diarrhoea
Frequency of hand washing	Consumption of de-worming tablets
Frequency of nail cutting	Consumption of Vitamin A & iron supplements
Frequency of clothes washing	**Db = Household built environment**
C = Household behaviours	Household income
Site for bio-degradable waste disposal	Maternal education level
Site for non bio-degradable waste disposal	Ownership of a toilet
Method to clean drinking water vessel	Family size
Frequency of toilet cleaning	Number of rooms
Frequency of house cleaning	Site for water collection
Use of a toilet at home	Availability of water for washing in the toilet
Use of a toilet at school	**Di = Household interacting environment**
Frequency of external food consumption	Time to reach health care facility
Source of food consumed at school	Possession of domestic pets
Number of vessels for water storage	

[17] The first author runs the NGO Friend in Need, which is active in Kameshwaram. The second author was an intern for Friend in Need and was the program manager for the research component of this action-research project.

However, for 11 of the above variables, the sample distributions were very narrow, with almost all of the adolescents interviewed reporting the same answer. This was especially the case for several behaviours (Table 2). Such results point in the direction of a village-wide "culture" with regards to hygiene, sanitation, and food and water consumption norms and therefore these variables were removed because of their uniformity.

Table 2: Variables for which 70% or more of the adolescents responded identically

Variables	% of sample
Possession of a domestic pet	71.93
Daily bathing frequency	75.44
Hand washing before eating	92.98
Daily clothes washing frequency	83.33
Use of water and soap to clean the drinking water vessels	74.11
Consumption of food from a tiffin box when at school	70.18
No separation of drinking water	94.74
Not treatment of drinking water	97.32
Bring a water bottle to school	70.18
No consumption of deworming tablets	77.88
No consumption of Vitamin A or iron supplements	71.93

Then various combinations of variables were tried out for logistic regressions and 13 more variables were removed because they were too insignificant and/or reduced goodness of fit. Thus, ultimately only 9 variables were retained and their distribution in the sample is reported below in Table 3.

Table 3: Distribution of the sample for the final variables considered

Maternal education level	**N=111**	**%**			
Graduate / postgraduate	3	2.70			
High school	14	12.61	**Use of toilet at home and/or school**	**N=114**	**%**
Middle school	29	26.13	Always open defecation	37	32.46
Primary school / literate	34	30.63	Mix of open defecation and latrine	40	35.09
Illiterate	31	27.93	Always latrine	37	32.46
Number of inhabitants per room	**N=114**	**%**	**Water bottle at school**	**N=114**	**%**
Less than 1 per room	1	0.88	No	34	29.82
1 to 1.99 per room	38	33.33	Yes	80	70.18
2 to 2.99 per room	36	31.58	**Care-seeking decision maker**	**N=108**	**%**
3 to 3.99 per room	15	13.16	Mother	42	38.89
4 to 4.99 per room	10	8.77	Father	47	43.52
5 or more per room	14	12.28	Other	19	17.59
Possession of a domestic pet	**N=114**	**%**	**Gender**	**N=114**	**%**
No	32	28.07	Male	68	59.65
Yes	82	71.93	Female	46	40.35
Site for bio-degradable waste disposal	**N=114**	**%**	**Time to reach health care facility**	**N=103**	**%**
Individual pit covered with dirt	14	12.28	Less than 5 min	1	0.97
Individual uncovered pit	45	39.47	5-10 min	16	15.53
Common disposal pit covered with dirt	4	3.51	11-15 min	20	19.42
Common uncovered disposal pit	4	3.51	16-20 min	2	1.94
Burned	3	2.63	21-25 min	2	1.94
Pile	24	21.05	26-30 min	41	39.81
No designed area (outside)	19	16.67	More than 30 min	21	20.39
Other	1	0.88			

All of these variables included in the best-fit model have a relatively widespread sample distribution. A new variable was also created to aggregate variables in the habitat category and define a measure of crowding: family size was divided by the 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. Most adolescents belonged to households with an average of one to two or two to three inhabitants per room (33.3% and 31.6%, respectively).

3. Results: Empirical model

Now, it is widely known that the efficient use of safe toilets with subsequent hand-washing using soap can significantly reduce the incidence of diarrhoea given that transmission of infectious diarrhoea occurs principally and almost exclusively through the faecal-oral route. Therefore, as a first step to understanding the dynamics of diarrhoea incidence, we first examined the impact of ownership or non-ownership of toilets on their usage at home and at school. Even such a simple descriptive analysis yields insight into adolescent behaviour and needs. Then we turn to the impact of sanitation on diarrhoea incidence

3.1. Results on the usage of toilets

We present our four main results on the usage of toilets at home and at school as a function of ownership of a toilet by the student's household and the gender of the student. Table 4 confirms national Indian statistics that there are more boys than girls attending higher grades in rural schools, possibly because female students drop out. It is also interesting that 41.30% of the households of female students own a toilet, while 60.29% of the households of male students own a toilet.

Table 4: Toilet ownership by gender

Ownership of a toilet / gender	Owns a toilet	Does not own toilet	TOTAL
Male	41	27	68
Female	19	27	46
TOTAL	60	54	

The rest of the results in this section are presented in the form of conditional probabilities derived from the raw data on usage of toilets by both male and female students summarized in Appendix 4.

Let us start with student behaviour at home. The following results are derived from data presented in Table 5.

<u>Result 1:</u> site of defecation of students while at home

- *If a household owns a toilet, the student is likely to use it while at home;*
- *If a household does not own a toilet then the student is likely to resort to open defecation.*

Table 5: Site of defecation when the student is at home, by ownership of a toilet

Defecation site / ownership of a toilet	Open defecation	Use of household toilet
Household owns a toilet	13.33%	86.67%
Household does not own a toilet	98.15%	1.85%

The results are different when looking at student behaviour at school. The following results are derived from data presented in Table 6.

Result 2: site of defecation of students while at school

- *Students whose households have a toilet are more likely to resort to open defecation while at school than students whose households do not own a toilet*
- *Students whose households do not own a toilet are more likely to use the school latrines than students whose households own a toilet.*
- *Students are more likely to withhold defecation if they are members of a household who owns a toilet, than students who are members of a household who does not own a toilet.*

Table 6: Site of defecation when the student is at school, by ownership of a toilet

Defecation site / ownership of a toilet	Open defecation	Use of school toilet	Withhold defecation
Household owns a toilet	33.33%	30.00%	36.67%
Household does not own a toilet	31.48%	44.44%	24.07%

We now disaggregate the data to examine if the above results differ according to gender. The following results were derived from Tables 7 and 8.

Result 3: gender differences in usage of toilets

- *The usage of toilets by students who are members of households who own or do not own toilets is similar among female and male students at home.*
  - *Students whose households own toilets use them more than they practice open defecation, regardless of gender.*
  - *Students whose households do not own toilets are more likely to practice open defecation than use a toilet, regardless of gender.*
- *The usage of toilets by students who are members of households who own or do not own toilets is not the same among female and male students at school.*

  Whether or not the students' household owns a toilet, female students are more likely not to withhold defection and to use the toilet at school.

Table 7: Site of defecation when the student is at home, by ownership of a toilet and gender

Defecation site / ownership of a toilet by gender	Defecate in bush	Use of household latrine
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%

Table 8: Site of defecation when the student is at school, by ownership of a toilet and gender

Defecation site / ownership of a toilet by gender	Defecate in bush	Use of school toilet	Withhold 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%

To study the impact of the ownership of a toilet from another angle, a new variable combining the site of defecation at school and at home for each adolescent was generated.

Three categories were created for that variable: 'use of only bush', 'use of only latrine' and 'mixed use of bush and latrine'. The following results were derived from data in Table 9.

Result 4: impact of toilet ownership for male and female students on site of defecation

- *Female students have a higher propensity to use latrines whenever possible.*
- *Inadequate access to toilets at school gives incentives for open defecation regardless of the sex of the student.*

Table 9: Site of defecation by different combinations of ownership of a toilet and gender

Defecation site / ownership of a toilet by gender OR gender OR ownership of a toilet	Always open defecation	Never open defecation	Mix of open defecation and toilet use
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%

While the percentages of males and females who never resort to open defecation, whether at school or at home, is similar (33.8% vs. 32.6%, respectively), the percentage of males who consistently practice open defecation (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 open defecation, never open defecation, mix of open defecation and latrine) is more uniform than that of the females among the same three groups. There is a significantly greater percentage of females who use a mix of both open defecation and latrines than of females who consistently chose either site of defecation.

It should be kept in mind that the difference between site of defecation between the genders is not the result of a difference in access to latrines between genders alone, but a choice that itself is dependent on a myriad of factors including preference for privacy, cleanliness of toilets, etc…whose impact may differ between genders, thereby pushing males and females to make a different choice.

3.2 Determinants of diarrhoea prevalence and the role of sanitation

Analysis of the data from adolescents attending St. Sebastian School in Kameshwaram reveals that 22.1% of adolescents had at least one episode of diarrhoea in the six months preceding the survey. Two logit regressions were carried out, both of which lead to the same conclusion.

Result 5: Usage of latrines lowers the probability of diarrhoea occurrence and is the main variable to focus on to reduce the prevalence of diarrhoea among adolescents.

A logit regression with the occurrence of diarrhoea in the past six months as the binary dependent variable (0 represents the absence of a diarrhoeal episode and 1 the occurrence of at least one episode) was used to identify the correlation between the newly defined variable

for site of defecation (combined school and home site of defecation) and diarrhoeal prevalence. The results are summarized in Table 10.

Table 10: Odds of having at least one episode of diarrhoea for adolescents using different sites of defecation, compared to adolescents always practicing open defecation.

	Odds Ratio	Standard Error	z	P>z
Mix of open defecation and latrine	0.2021978	0.127712	-2.53**	0.011
Always latrine	0.4880637	0.2582056	-1.36	0.175
** Significant at 5% level				

Using latrines is significantly correlated with lower odds of diarrhoea occurrence. The odds of having at least one episode of diarrhoea are 80% lower for adolescents who practice a mix of open defecation and latrine use compared to adolescents who always practice open defecation. The same trend is observed for adolescents who always use latrines compared to those who always defecate openly, but the result is not statistically significant. In conclusion, the use of latrines appears to be an important determinant of diarrhoeal prevalence among adolescents.

In a second round, all the final variables considered were included in the logit regression and the results are presented in Table 11. The odds of the occurrence of at least one episode of diarrhoea was tested for each of the variables, in reference to another category for categorical and binary variables (i.e. site of defecation, gender, time to reach healthcare facility, having a water bottle at school, care-seeking decision maker, maternal education level, possession of domestic pets, biodegradable waste disposal site) or in reference to a continuum for continuous variables (number of inhabitants per room).

Table 11: Logistic regression results – Odds having at least one episode of diarrhoea for adolescents for a combination of variables

Number of obs = 98					
LR $chi^2(11)$ = 24.37			Prob > chi^2 = 0.0113		
Log likelihood = -37.404535			Pseudo R^2 = 0.2457		
	Odds Ratio	**Std. Err.**	**z**	**P>z Conf.**	**[95% CI]**
Use a mix of open defecation and latrines	0.0663179	0.0738589	-2.44**	0.015	0.0074755 - 0.5883309
Always use latrines	0.4984177	0.3136715	-1.11	0.269	0.1451787 - 1.711134
Female	0.0839074	0.0812039	-2.56**	0.010	0.01259 - 0.559211
Time to reach healthcare facility	0.9204383	0.5681331	-0.13	0.893	0.2745348 - 3.085972
Carries a water bottle to school	1.630406	1.2307480	0.65	0.517	0.3713196 - 7.158859
Mother is care seeking decision maker	0.5933292	0.3661077	-0.85	0.398	0.1770396 - 1.988478
Mother has primary education	0.6006845	0.4282165	-0.71	0.475	0.1485392 - 2.429135
Number of inhabitants per room	1.423683	0.3154338	1.59*	0.101	0.9221878 - 2.197895
Possession of domestic pets	0.453558	0.3532117	-1.02	0.310	0.0985719 - 2.086952
Biodegradable waste disposal site is an uncovered pit	1.369473	1.1399080	0.38	0.706	0.2679409 - 6.999515
** significant at the 5% level * significant at the 10% level					

The odds of having at least one episode of diarrhoea for adolescents are significantly related to practicing a mix of open defecation and use of latrines, gender and the number of inhabitants per room for the household to which the adolescent belongs.

The odds of having at least one diarrhoeal episode decrease by 6% for adolescents who use both latrines and open defecation as compared to adolescents who always defecate in the open. Therefore the use of latrines can be considered to be an important determinant of diarrhoeal diseases among adolescents.

Female adolescents have 8% lower odds of having at least one episode of diarrhoea compared to male adolescents. Given the previously mentioned cross frequencies of latrine use by gender, this result can be explained by the fact that a smaller percentage of females chose to defecate in the open. Gender is therefore a significant determinant for diarrhoeal diseases among adolescents.

The number of inhabitants per room is significantly related to the odds of having at least one episode of diarrhoea at the 10% level. An increase in the number of people sharing a room increases the odds of having diarrhoea by 42%. Therefore the amount of space per household member can be considered a determinant of diarrhoea for adolescents.

On the other hand, always using latrines, the time to reach a healthcare facility, carrying a water bottle to school, the mother being the care-seeking decision maker, maternal education level or the site for biodegradable waste disposal were not found to be significantly correlated with the occurrence of diarrhoea.

Overall, the Pseudo R^2 is high meaning that the model can explain important degrees of variations. The log chi^2 value of 24.37 suggests that the model is a good fit. Furthermore, it can be inferred that all variables included in the subset analysed, which were not included in the regression model of best fit, are not determinants of diarrhoeal diseases among adolescents.

4. Discussion of results and recommendations

4.1 Discussion of results

The present study on the determinants of diarrhoea among adolescents attending school found that two variables were significantly influencing the occurrence of diarrhoeal episodes. These were: (i) having access to a latrine; and (ii) having adequate living space for the members of the household – both of which reduce the probability of prevalence. The former issue can be tackled in the short run, but the latter is a greater challenge as this is not only a result of a means for the households to alleviate their poverty but also of social norms, including living in joint or extensive families, rather than nuclear families.

The detailed case study of the student population confirmed an obvious result, but also revealed two counterintuitive correlations. First, for students whose households do not own a toilet at home, access to a toilet in school is a boon, and lowers their rate of open defecation. Second, while having access to a household latrine is an advantage for a student while at home, it has the unintended consequence of provoking the student to withhold defecation or resort to open defecation while at school. Third, while it could be expected that female students are more likely to resort to this behaviour, it was found that the boys are more likely

to exhibit this behaviour. Indeed, girls are more inclined to use toilets while at school, whether or not their household owns one.

These important findings could however be interpreted as the result of a very harsh reality that marks the majority of Indian schools - not only rural schools but also urban schools, including those catering to non-poor households. The toilets are poorly maintained, and unclean. These insalubrious conditions lead many students, including those who do not own a toilet at home, to selectively prefer to withhold defecation while at school and resort to open defecation of use the household toilet after school hours.

Why are the school toilets left in such conditions? Indeed, none of the schools in surrounding villages visited had a team in charge of cleaning the school toilets. This was not a transient situation as none of the school workers interviewed could identify a time when it was different. All these schools had toilets in various states of dilapidation both poorly maintained and unclean. Extensive discussions with the present Director of the St. Sebastian School, Mr. Das, yielded three main reasons, which were confirmed by three other interviews with school directors in adjacent villages.

The social challenge: In India, cleaning of any public toilets is associated with 'manual scavenging,' which refers to work involving direct physical contact with human waste (urine and faeces) without adequate protection. In India, deep feelings of shame are associated with the cleaning of any toilets because the labour market for these jobs was regimented by the caste system for centuries, being 'institutionally' closed so that only the lowest caste, scavengers, would participate in these activities. Today, there are programmes for the rehabilitation and retraining of this community undertaken by the Ministry of Social Justice, NGOs and civil society groups. Despite these advances and the official dismantling of the caste system, there remains a social stigma associated with the cleaning of public toilets. As a result, there is an extreme shortage or absence of labour to perform these tasks.

Lack of interest in toilets of all stakeholders (to the exception of students): Schools are judged solely on the basis of their students' academic performance by both parents and official authorities. Neither party takes the conditions of the school's toilets into consideration. In particular, access to computers and internet is a higher priority than access to clean toilets for many parents. Therefore, the upkeep of the school toilets is not the concern of the school authorities. There have been some attempts by school directors in Kameshwaram to involve students in toilet cleaning and maintenance. Often, these programs are often terminated as a result of parents' complaints who do not want their children involved in such activities. However, most parents are also either unwilling or unable to pay additional fees for toilet maintenance.

The financial challenge: Private schools often use the revenue from student fees to pay for the infrastructure and the staff of the school. This means that long term investments are usually assigned to expanding the school buildings, improving the equipment of the science laboratories, purchasing sports equipment, installing a computer centre, etc. …, but usually not to repairing or ensuring the cleanliness of school toilets. It is important to consider that in many schools faced with this problem, the majority of students come from households living below or slightly above the poverty line. As a result, schools enrol a large number of students in order to be economically sustainable; they are able to charge low fees but earn enough through the high volume. In government schools, funds are allocated to the provision of midday meals and the maintenance of school premises. The latter funds are usually used to

clean the classrooms and it is implicitly assumed that a portion will also be used to maintain the toilets. This situation is not the same in private schools.

Policy can be designed and implemented to overcome these barriers to sanitation and reduce the prevalence of diarrhoea among adolescents. This is the subject of the next section.

4.2 Policy recommendations

The Indian government launched the School Sanitation and Hygiene Education (SSHE) Campaign in 1992 as part of its Total Sanitation Campaign in rural India, where a majority of India's impoverished population still resides. The SSHE has a two-fold purpose: to erect toilets and hand washing facilities in schools and to change behaviour with regards to the use of toilets (i.e. to motivate a change from open defecation to use of toilets). According to its website,[18] "[s]chools are learning laboratories where habits of good sanitation practices, personal health and hygiene by children can go a long way in inculcating these habits when they become adults. Besides, presence of school toilets, safe drinking water, clean surroundings and basic information on hygiene improves the learning abilities of children, improves health, and improves attendance, especially of the girl child, with far reaching consequence on the health of the community. The combination of adequate facilities, correct behavioural practices and education is meant to have a positive impact on the health and hygiene conditions of the community as a whole, both now and in the future."

While this vision of schools and the campaigns objectives represent a step in the direction needed to remedy the situation, no comprehensive study has been made to evaluate the performance or impact of the SSHE Campaign, to the best of the knowledge of the present authors. However, in partnership with UNICEF, the SSHE Campaign's main efforts seem to be focused on raising awareness and building infrastructure. Given the present realities discussed in the previous section, it is clear that these measures are insufficient to solve the problem at hand.

Explore solutions to resolve the 'social problem': The biggest challenge in the way of increased toilet use and decreased diarrhoeal rates among adolescents is the aforementioned 'social challenge.' How can each school have a team of workers dedicated to cleaning the school toilets given the social dynamics at play? This dilemma remains unresolved because of an institutional vacuum, namely a lack of agencies dedicated to the maintenance and repair of public toilets. This is a result of the aforementioned social stigmas attached to such activities. At present, a variety of models ranging from municipalities being in charge to outsourcing to private agencies via public-private partnerships exist for the cleaning of cities. The extension or creation of similar programs for schools should be explored.

However, it must be noted that, often, the waste management staff of municipalities pertain to the original manual scavenging community. It would be socially regressive to allow or not prevent similar exclusion to occur when designing new programmes for the maintenance of toilets. Therefore, care must be taken that specific measures are implemented to ensure that the agencies responsible for the maintenance of school toilets have high community diversity and does not recruit most of its workers from the lowest caste.

Initiate regulations to ensure the allocation of funds for the building and maintenance of toilets: A number of schools, which have small student bodies and are private, avoid being

[18] http://ddws.gov.in/schoolsanitation#

part of the formal economy and therefore do not have enough funds to cover the maintenance of toilets. In order to enjoy returns to scale, schools have to be part of the formal economy. It is regarding this point that regulations can be created. These regulations should concern not only the number of toilets but also their level of cleanliness and accessibility. Indicators to measure performance in both these directions have to be developed as a function of the school population and resources.

Put in place databases and monitoring routines to ensure compliance: Many schools in India do have toilets for student use, but they are usually left abandoned and unclean. They are only cleaned prior to the visits of the school inspector. In order to tackle this problem regarding maintenance of toilets, the degree to which toilets are not taken care of must first be estimated. There is a dire need to have a comprehensive database on schools and sanitation facilities in schools, comprised of data on both access and upkeep of these facilities. At present, there seem to be no comprehensive and reliable information even regarding the number of public schools in India or the availability and usage of the toilets in them, despite the common recognition that there are many gaps in the field of school sanitation.

It is evident that state programmes have to move from a focus on awareness creation to identifying sustainable business models that can be applied in schools in order to successfully decrease the prevalence of diarrhoea among adolescents by instigating a change in behaviours. The first public program to focus exclusively on sanitation was the Central Rural Sanitation Program (CRSP) initiated in 1986 by the Ministry of Rural Development. Under this scheme, the Offices of the District Rural Development Agency (DRDA) financed the construction of toilets to meet set targets at the district level. The beneficiaries were partially or totally absolved from bearing the costs of construction, depending on their income levels. Officers were given a target number of toilets to build without consideration of the appropriateness of such an undertaking for each particular setting, neither in terms of technology nor the socio-economic context.

A former Secretary of the Planning Commission notes that there were causes other than cleanliness which resulted in the abandoning of the toilets: “lack of demand from people who did not see the need or feel the desire for sanitation; lack of adequate water sources; lack of space; absence of choice on cost or technology; total absence of people’s participation – construction of the latrines was done centrally; hygiene promotion and marketing of the products were lacking; and lack of supply chain – materials and skills were not locally available.” [19]

In the light of the above experience, the strategy of the Indian government was restructured in 1999 and the new Total Sanitation Campaign was launched. The State programme moved from a high subsidy to a low subsidy regime, with the investment of funds in building awareness and increasing sanitation coverage through public-private partnerships with NPOs. Under this programme, with respect to schools, the focus has been on building awareness and on building sanitation infrastructure.

While increasing awareness is necessary both in the school and household contexts to convey the importance of owning a toilet and the impact that this ownership can have on health, this should not be seen as the final measure. Awareness will not guarantee a change in behaviour and therefore the impact on health runs the risk of being null. Such a result was, in fact, observed with regards to the impact of awareness building in schools. While raising awareness may have led to the construction of toilets in schools, it did not lead to an uptake in toilet use. Building school toilets without ensuring that a concurrent mechanism for the

[19] N.C. Saxena, Bridging Research and Policy in India, Journal of International Development, 17 (2005) 737-746.

presence of financial and human resources to maintain these toilets is in place, will not increase their use and will have no impact of diarrhoeal rates. Instead, these new toilets will progressively deteriorate, the conditions becoming so deplorable that students will continue to withhold defecation while in school or resort to open defecation. Such results were in fact observed in Kameshwaram.

5. Conclusion

Most of the medical literature on the determinants of diarrhoea focuses on children under 5 years of age or the elderly. This leaves the adolescent population relatively understudied. The purpose of the present article is to contribute to filling this dearth of information through a detailed examination of a small population of adolescents attending school in an Indian coastal village. A model organizing the risk factors for diarrhoeal diseases was built using the medical literature. Through several rounds of discussions with local medical practitioners and NGOs, it was honed into a conceptual framework tailored to the rural Indian context. A questionnaire was then designed to incorporate all variables in the framework and administered to 114 adolescents in an Indian village school. The data was analysed to understand the dynamics of toilet usage and identify the determinants of diarrhoeal prevalence.

Among the many determinants of diarrhoeal prevalence noted in the medical literature, a crucial one was the use of safe sanitation at home. The present study confirmed this result and identified *access* to school toilets and *usage* of school toilets as additional determinants of diarrhoea for adolescents. Students spend long hours outside of the home and having access to a functioning toilet during that time can lower the prevalence of diarrhoea. This conclusion, however, leads to another set of issues because many schools do have toilets, but these are often not well maintained or functional. As a result, sanitation is not improved despite access to toilets as students resort to open defecation or other health-adverse behaviours.

St. Sebastian School in the village of Kameshwaram in India can be seen as a prototype of many similar schools scattered in rural areas all throughout the developing world. In such schools, the prevalence of diarrhoea is elevated among adolescents and is perhaps leading to increased absenteeism. This study suggests that such incidence can be decreased significantly if the schools offer clean, functioning toilets for their students to use. Furthermore, it also reveals that this problem cannot be solved simply through the installation of toilets. For instance, St. Sebastian School does have toilets. But like in millions of similar schools, these toilets are not maintained or cleaned, leaving them to be used by very few, if any, students. Therefore, the challenge is three fold for rural schools in developing countries: to install toilets, to have a sustainable financial model to maintain toilets and to induce students to use the toilets instead of resorting to open defecation. In India, this challenge is amplified because the cleaning of toilets is associated with the lowest caste and is seen as a shameful activity. As a result, there is a labour shortage for this type of work. This can possibly be overcome if workers are given proper equipment and the specialization of workers as toilet cleaners is avoided. If those who maintain toilets are also responsible for the general cleaning of the school, toilet maintenance would become a part of a job which promotes a salubrious environment for children and youth.

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Appendix 2: All variables considered

		CONTINUOUS VARIABLE	CATEGORICAL VARIABLE
	SOCIOECONOMIC STATUS (SES)		
	Socioeconomic status (standard SES indicators)		
1	Household income	X	
2	Father's occupation		X
3	Mother's occupation		X
4	Maternal education level		X
5	Paternal education level		X
	Asset portfolio (additional SES indicators)		
6	Ownership of a bicycle, car, truck, motor bike, TV, A/C, refrigerator, electricity or stove		X
7	Ownership of a toilet		X
	LIVING CONDITIONS		
8	Family size	X	
	Habitat		
9	Roof type		X
10	Number of houses	X	
11	Number of rooms	X	
12	Size of bedroom		X
13	Number of windows	X	
14	Separate kitchen		X
	Access to water		
15	Site for water collection		X
16	Consistency of water source		X
17	Time to reach water source		X
18	Distance to water source		X
19	Sufficiency of water quantity		X
	Access to sanitation		
20	Time to reach toilet		X
21	Number of families using the same toilet		X
22	Availability of water for washing in the toilet		X
	Proximity with animals		
23	Possession of domestic pets		X
24	Type of domestic pets owned		X
25	Type of animals commonly seen		X
	BEHAVIOURS		
	Hygiene practices		
26	Hand washing after waste disposal		X
27	Hand-washing prior to meal preparation		X
28	Family hand washing practice		X
29	Frequency of bathing		X
30	Method for bathing		X
31	Frequency of hand washing		X
32	Method for hand washing		X
33	Use of footwear outside		X
34	Use of footwear when using toilet		X
35	Type of footwear used		X
36	Frequency of nail cutting		X
37	Frequency of clothes washing		X
38	Method for clothes washing		X
	Sanitation practices		
39	Site for bio-degradable waste disposal		X
40	Site for non bio-degradable waste disposal		X
41	Person who cleans the toilet		X
42	Person who disposes of the garbage		X

43	Method to clean the toilet		X
44	Method to clean the house		X
45	Method to clean drinking water vessel		X
46	Disposal of infant diarrhoeal stools		X
47	Frequency of toilet cleaning		X
48	Frequency of house cleaning		X
49	Use of a toilet at home		X
51	Use of a toilet at school		X
	Food preparation and consumption practices		
52	Number of times food is prepared		X
53	Time when food is prepared		X
54	Existence of left-over food		X
55	Site for storage of left-over food		X
56	Duration of left-over food storage		X
57	Washing of vegetables prior to consumption		X
58	Number of meals per day	X	
59	Frequency of tea/coffee consumption		X
60	Frequency of fruit consumption		X
61	Frequency of meat and fish consumed		
62	Type of fruit consumed		X
63	Frequency of uncooked vegetables consumption		X
64	Type of uncooked vegetables consumed		X
65	Frequency of external food consumption		X
66	Frequency of street food purchase		X
67	Source of food consumed at school		X
	Water storage, purification and consumption practices		
68	Type of vessel for water collection		X
69	Number of vessels for water storage	X	
70	Separation of drinking water		X
71	Type of vessel for drinking water collection		X
72	Presence of lid on drinking water vessel		X
73	Width of mouth of drinking water vessel		X
74	Site for drinking water storage		X
75	Utensil used to pour drinking water		X
76	Method used for water purification		X
77	Existence of second uses for water		X
78	Water bottle at school		X
	Care-seeking practices		
79	Care-seeking decision maker		X
80	Time before seeking care at last illness		X
81	First response after diarrhoea		X
82	Consumption of de-worming tablets		X
83	Consumption of Vitamin A & iron supplements		X
	MARKETS FOR HEALTHCARE		
84	Time to reach health care facility		X
	INDIVIDUAL CHARACTERISTICS		
85	Age		X
86	Gender		X
87	Blood type		X
	HEALTH STATUS		
88	Number of illnesses in past 6 months	X	
89	Presence of skin problems in the past 6 months		X
90	Number of diarrhoeal episodes in the past 6 months	X	
91	Consistency of stools		X
92	Presence of blood in stools		X

Appendix 3: Distribution of the sample for the subset of selected variables

Household income	**N**	**%**	**Frequency of clothes washing**	**N**	**%**	**Source of food consumed at school**	**N**	**%**
0-2000	25	32.05	Once a week or less	9	7.89	Returns home	30	26.32
2001-4000	22	28.21	Twice in a week - once in 2 days	6	5.26	Tiffin	80	70.18
4001-6000	17	21.79	Daily	95	83.33	School canteen	4	3.51
6001-8000	5	6.41	Other	4	3.51	**Number of vessels for water storage**	**N**	**%**
8001-10000	5	6.41	**Site for bio-degradable waste disposal**	**N**	**%**	1	1	0.88
1000+	4	5.13	Individual pit covered with dirt	14	12.28	2	26	22.81
Maternal education level	**N**	**%**	Individual uncovered pit	45	39.47	3	10	8.77
Graduate / postgraduate	3	2.70	Common disposal pit covered with dirt	4	3.51	4	15	13.16
High school	14	12.61	Common uncovered disposal pit	4	3.51	5	23	20.18
Middle school	29	26.13	Burned	3	2.63	6	37	32.46
Primary school / literate	34	30.63	Pile	24	21.05	**Separation of drinking water**	**N**	**%**
Illiterate	31	27.93	No designed area (outside)	19	16.67	No	108	94.74
Inhabitants/ Room	**N**	**%**	Other	1	0.88	Yes	6	5.26
less than 1 per room	1	0.88	**Site for non bio-degradable waste disposal**	**N**	**%**	**Method used for water purification**	**N**	**%**
1 to 1.99 per room	38	33.33	Individual pit covered with dirt	6	5.26	Not treated	109	97.32
2 to 2.99 per room	36	31.58	Individual uncovered pit	30	26.32	Boiled	2	1.79
3 to 3.99 per room	15	13.16	Common disposal pit covered with dirt	1	0.88	Water purifier	1	0.89
4 to 4.99 per room	10	8.77	Common uncovered disposal pit	4	3.51	**Water bottle at school**	**N**	**%**
5 or more per room	14	12.28	Burned	15	13.16	No	34	29.82
Site for water collection	**N**	**%**	Pile	30	26.32	Yes	80	70.18
Individual hand pump	40	35.09	No designed area (outside)	25	21.93	**Care-seeking decision maker**	**N**	**%**
Common hand pump	14	12.28	Other	3	2.63	Mother	42	38.89
Individual tube-well/borehole (motor)	45	39.47	**Method to clean drinking water vessel**	**N**	**%**	Father	47	43.52
Others	15	13.16	Not cleaned	7	6.25	Other	19	17.59
Availability of water for washing in the toilet	**At home**	**At school**	Water	11	9.82	**Time before seeking care at last illness**	**N**	**%**
No	4	4.00	Water and soap	83	74.11	Did not visit the doctor	9	8.04
Yes	107	67.00	Ash	8	7.14	The same day	71	63.39
Possession of a domestic Pet	**N**	**%**	Other	3	2.68	1-3 days	29	25.89
No	32	28.07	**Method to clean house**	**N**	**%**	4-7 days	3	2.68
Yes	82	71.93	Only water	17	15.89	**First response after diarrhoea**	**N**	**%**
Frequency of bathing	**N**	**%**	Water and soap	9	8.41	Visit the doctor	12	48.00
Once in 3 days - once in 2 days	1	0.88	Broom	57	53.27	Took medication	5	20.00
Daily	86	75.44	Chemical	21	19.63	Took home remedy	8	32.00
More than once a day	27	23.68	Other	3	2.80			

Appendix 4:

Site of defecation while at home by ownership of a household latrine (number of adolescents)

	Open defecation	Use of household toilet
Male students whose household owns a toilet	5	36
Female student whose household owns a toilet	3	16
Male students whose household does not own a toilet	26	1
Female students whose household does not own a toilet	27	0

Site of defecation while at school by ownership of a household latrine (number of adolescents)

	Open defecation	Use of school toilet	Withhold defecation
Male students whose household owns a toilet	18	6	17
Female student whose household owns a toilet	2	12	5
Male students whose household does not own a toilet	12	5	10
Female students whose household does not own a toilet	5	19	3

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