Health impact evaluation of improved water supplies and hygiene practices in Sri Lanka: background and methodology

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Abstract

Between January 1987 and March 1988 a Health Impact Evaluation (HIE) of the Rural Water Supply and Sanitation Project (RWSSP) was conducted in Kurunegala District. Four related activities were undertaken: 6598 children were recruited into a case-control study of diarrhoea morbidity conducted in five hospitals; an additional 1649 children from the catchment areas of three of the five hospitals were recruited as a community comparison group; environmental microbiology was performed on water samples collected during 3092 visits to the homes of children recruited into the study; diagnostic stool microbiology was performed for 371 children with diarrhoea and 121 controls. In this paper the seasonality of reported diarrhoea and the socio-demographic characteristics and health-related behaviours of each study group are examined. Cases, clinic controls and the community comparison group were all drawn from the essentially rural settlements typical of the southern part of the dry zone of Sri Lanka. The majority of households in these settlements are Sinhalese buddhist, and the main economic activity is subsistence farming. There was some evidence of differences between the three groups, community recruits tending to come from larger and wealthier households than the children recruited at the hospitals. Issues arising in the design and analysis of this Health Impact Evaluation are discussed. In particular, potential sources of bias are examined and the question of validity investigated.

Introduction

Diarrhoeal diseases are a major cause of morbidity and mortality among young children in the developing world. It has been estimated that about one billion episodes of diarrhoea occur annually among children aged less than 5 years, and that these episodes are responsible for some 5 million child deaths (Snyder and Merson, 1982). In 1978, the Diarrhoeal Diseases Control Programme (CDD) of the World Health Organisation (WHO) was launched with the twin objectives of reducing diarrhoeal morbidity and mortality. Initially, the CDD programme placed a great deal of emphasis on the promotion of oral rehydration therapy (ORT). While ORT is effective in reducing mortality from dehydration in episodes of acute, watery diarrhoea, its effectiveness in preventing death from chronic or dysenteric diarrhoea is less certain, and ORT can be expected to have little or no impact on diarrhoea morbidity (Feachem, 1986). In 1982 the CDD programme initiated, therefore, a review of potential alternative non-clinical interventions (Feachem et al., 1983). These were grouped into three categories; interventions for which the evidence for high effectiveness and feasibility was reasonably strong; those which were of uncertain effectiveness or feasibility and required further research; those which were found to be ineffective, not feasible, or too costly (Feachem, 1986). Improvements in water supply and sanitation facilities, and promotion of domestic hygiene were among the interventions considered to belong to the first category.

In 1978, the year in which the CDD programme was launched, the period 1981–1990 was declared the International Water Supply and Sanitation Decade. Its aim was the provision of a potable water supply and adequate excreta disposal facilities to all. As well as direct benefits such as time savings in water collection activities, it was hoped that the provision of such facilities would lead to an improvement in the health of those people previously denied access to them. An important means by which, it was anticipated, this improvement in health would occur was through a reduction in the incidence of diarrhoea. It was in this light that in 1983 the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) launched a programme for the improvement of rural water supplies and sanitation facilities in the district of Vavuniya-Mullaitivu, Sri Lanka. In 1986, this was extended to the district of Kurunegala, Sri Lanka. In the same year, GTZ approached the London School of Hygiene and Tropical Medicine to carry out a study of the health impact of the water supply and sanitation facilities existing in the district of Kurunegala.

Detecting the health impact of water supply and sanitation programmes is problematic. In 1976, before the declaration of the Decade, an expert panel convened by the World Bank concluded that longitudinal studies were probably the only way of detecting the health benefits arising from such projects (International Bank of Reconstruction and Development, 1976). The panel also concluded that the costs of such studies were likely to outweigh any benefits and recommended that they should not be undertaken. Furthermore, in

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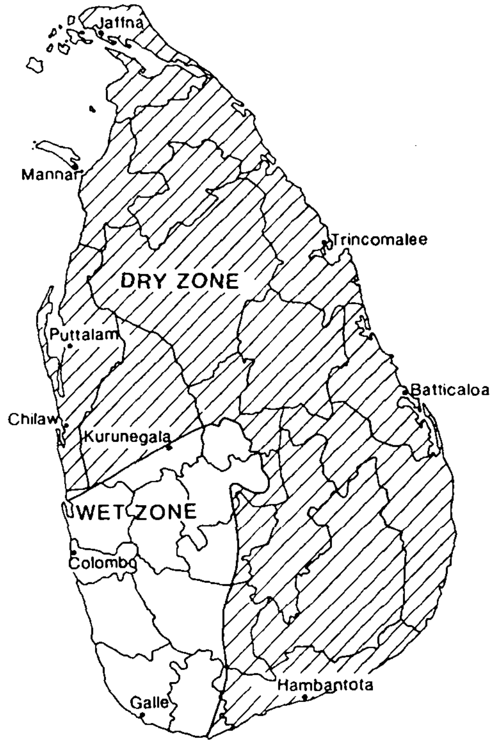

Fig. 1a Sri Lanka: climatic zones

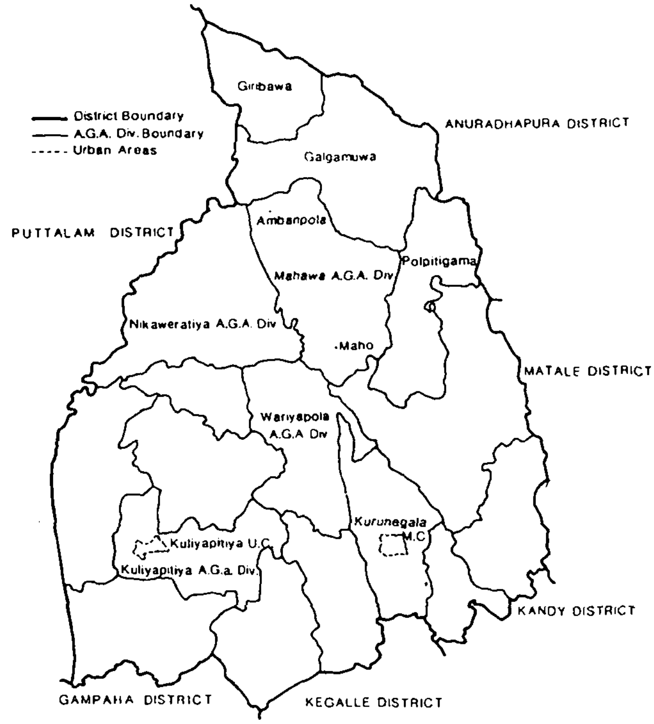

Fig. 1b Kurunegala district: Assistant Government Agent Divisions (AGAs) and urban areas

1983, a review of studies of the health impact of water and sanitation projects pinpointed a number of serious methodological problems (Blum and Feachem, 1983). The realisation of the methodological problems facing health impact evaluations of water and sanitation interventions led to a workshop held in Cox's Bazaar, Bangladesh in 1983, to review the information and experience accumulated to date and to define a way forward (Briscoe et al., 1986). One of the products of this workshop was a document which proposed the use of the case-control method for evaluating the impact on diarrhoea of such interventions (Briscoe et al., 1985). A second outcome of the workshop was the recognition that measures of child growth represented alternative indicators of health impact, which were potentially of great importance, and which merited further investigation (Briscoe et al., 1986).

This paper is the first in a series which reports the results of a case-control study and cross-sectional surveys conducted between October 1986 and March 1988 in the district of Kurunegala, Sri Lanka. The overall aim of these investigations was to assess the impact of the GTZ water and sanitation programme and to identify those elements which may be important in maximising health benefits when implementing a new water and sanitation project. This paper presents the background to, and methodology of the various components of the study, together with a socio-demographic and economic profile of the study population.

Background

Study site

The district of Kurunegala is situated in the North-Western province of Sri Lanka and covers an area of 4773 km^2 (Fig. 1a). The town of Kurunegala itself is located 80 km north-east of Colombo and lies at the foot of the central hill region. The district runs north from the town into a large plain throughout which are scattered numerous reservoirs of water ("tanks").

The area's climate is determined by its proximity to the equator, its low altitude and the north-east monsoon (December to February). The temperature is high (28 °C to 38 °) throughout the year. The southern-most part of the district belongs to the intermediate dry-wet zone while the remainder is essentially dry (Fig. 1a). The mean annual rainfall varies from 650 mm to 1800 mm (Domros, 1976) and the main dry season occurs between April and October. However, for a large period of the fieldwork drought conditions prevailed throughout the district: the monthly rainfall was consistently below the mean monthly rainfall over the thirty year period 1931–1960 (Domros, 1976), and "tanks" which, in other years, would have provided the population with water dried up.

Study population

The economy of the district is almost entirely rural and largely based on the cultivation of coconut and rice. At the 1981 Census the total population of the district was 1,212,755 of whom 3.6% were classified as living in urban areas, 95.5% as living in rural areas and 0.9% as living in the estate sector (Ministry of Plan Implementation (MPI) 1985). The average population growth rate for the whole island was estimated to be 1.7%. The projected, mid-year population for the district in 1986 was 1,332,817, corresponding to a population density of 279.2 inhabitants per km^2 (MPI, 1985). The percentage of infants in the district was 2.5% and the percentage of preschool children (1–4 years) 9.5%. The infant mortality rate in Kurunegala district was 32.4 per thousand live births in 1984 (Department of Health, Sri Lanka, 1987). At the 1981 population census the national literacy rate was 95.5% for males and 82.4% for females (MPI, 1985).

Although Sri Lanka has a pluri-ethnic population who follow a variety of religions, the district of Kurunegala consists mainly of Sinhalese (approximately 95%). Other ethnic groups in the district are Tamils, Moors and Burghers, together with a small number of Chinese and Eurasians. The main religion is Buddhism (practised by the Sinhalese). Other religions include Islam (Moors and Tamils), Hinduism (Tamils) and Christianity (Sinhalese, Burghers and Tamils).

The GTZ Rural Water Supply and Sanitation Project (RWSSP)

In 1986, GTZ launched a programme for the improvement of rural water supplies and sanitation facilities in the district of Kurunegala. The programme had three components. First, new tube wells were constructed and traditional wells rehabilitated; caretakers and hand pump maintenance units were trained in order to ensure the long-term sustainability of the intervention. Second, latrine construction was supported through the provision of materials, and financial and technical assistance. Third, a health education programme aimed at improving hygiene practices in the community was carried out in collaboration with the Ministry of Health. Personnel involved in teaching activities, including school teachers and village health workers, were trained to deliver messages concerning the importance of using clean water and safe excreta disposal methods. Attention was also paid to messages relating to personal hygiene.

The involvement of the community in project activities was a major focus of attention. Decisions on where to locate tube wells depended as much on the identification of the needs and motivation of communities as on geological surveys and water divining. Areas for latrine construction programmes were also selected on the basis of community motivation. The health education component of the programme preceded the construction of tubewells, the rehabilitation of shallow wells and the provision of materials and expertise for the construction of latrines. Thus information on the importance of clean drinking water and good hygiene practices, and on the modes of transmission of diarrhoeal diseases was readily available to a large section of the community in the intervention areas.

The GTZ RWSSP initially covered a geographical area of five Assistant Government Agent Divisions (AGAs); Giribawa, Galgamuwa, Maho, Polpitigama, and Nikaweritiya (Fig. 1b). Wariyapola AGA was added in 1987. The health impact study was conducted in four of these divisions: Maho, Nikaweritiya, Wariyapola and Kurunegala.

Health services

Private and government health services in the study area may be divided into two major streams, allopathic ("Western") and ayurvedic medicine. Ayurvedic medicine is of ancient Indian origin and is based on the study of bodily humours and their balance. It specializes in treating a broad spectrum of conditions including eye and skin diseases, fractures and dislocations, hypertension, paralysis and snake bites. Thus, while Ayurveda has limited resources for the treatment of diarrhoeal diseases and some other acute infectious diseases, the ailments of the clientele of ayurvedic doctors do not differ a lot from the ailments of the patients of western practitioners (Perera, 1985). The two systems coexist and patients are readily transferred from ayurvedic hospitals to allopathic hospitals. It is difficult, therefore, to separate clearly the patterns of usage of each stream. Treatments used in Sri Lanka are often a blend of home remedies, long-term ayurvedic cures, and efficiency-oriented allopathic medications. In rural areas, ayurvedic practitioners are more numerous than allopathic practitioners by a ratio of up to 6:1 (Central Bank Reports, 1983). Organised ayurvedic services are, however, very limited with only one ayurvedic government hospital in the whole district. In contrast, there are more than ten allopathic government institutions. Thus, more severe diseases tend to be reported to allopathic institutions where care can be provided for several days.

Government hospitals are subsidised and the cost involved in the treatment of an episode of childhood infectious disease includes the cost of transport, of purchasing medication and of staying at the hospital if the condition requires it. The cost of treating the same episode at a private institution or, if the episode is not severe, at a private allopathic or ayurvedic practice is estimated to be at least double this, even if the distance travelled to the private practice is shorter.

Home-based treatments are widely used in Sri Lanka and include recipes of ayurvedic origin or domestic tradition, pharmaceuticals among which analgesics are the most common, or a combination of any of these products (Caldwell et al., 1989). A large proportion of families grow medicinal plants in their gardens or can buy them from specialised shops. Western medications as well as ayurvedic preparations are readily available over the counter, although in the urban areas it is increasingly necessary to present a prescription.

Preventive medicine and health education is provided through government services such as antenatal clinics, the expanded programme of immunization (EPI) for preschool children, and specialised campaigns against endemic tropical diseases such as the Anti-Malaria, the Anti-Filariasis and the Rabies Control Programmes. A health education programme has been active for several decades and has encouraged the use of uncontaminated water, the safe disposal of waste, the construction of sanitary excreta disposal facilities and, more recently, widespread immunization. These initiatives are organized either in the clinics by the local medical officer of health (MOH) or through health education and vaccination campaigns in the villages and services are delivered by the family health workers (FHW) and the public health inspectors (PHI).

The study design

The health impact study consisted of four related activities (Fig. 2). First, a concurrent case-control study of childhood diarrhoea, was conducted in five health facilities,

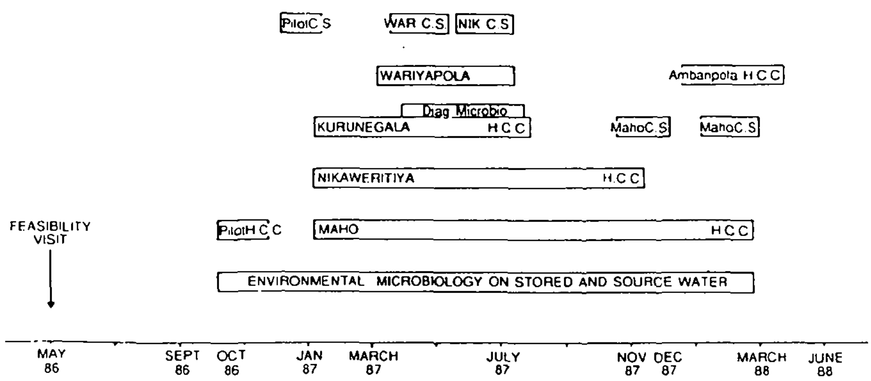

Fig. 2 Schedule and location of the surveys, health impact evaluation, Kurunegala district, Sri Lanka.
HCC: Hospital-based case-control study; CS: Cross sectional survey; Diag. microb: Diagnostic sool microbiology; WAR: Wariyapola; NIK: Nikaweritya

and is referred to hereafter as the hospital-based case-control study or HCC. All five hospitals were allopathic institutions since it was believed that the majority of the more severe episodes of diarrhoea are reported to such institutions. Together they serve a population which was estimated at 360,000, of whom less than 30,000 (8.3 %) live in urban areas (MPI, 1985). Second, cross-sectional community surveys were carried out in three rural areas within the catchment areas of three of the HCC hospitals. Third, environmental microbiology was performed on samples of stored and source water used for drinking purposes in a selection of the households of children recruited in the hospital-based case-control study and the community surveys. Fourth, diagnostic microbiology was performed on stool samples collected from a subsample of children recruited into the case-control study.

All questionnaires were designed so that most of the coding was done during the completion of the questionnaire. The questionnaires were conceived in the light of key informant and focus group discussions, and were extensively piloted. The translation of the questionnaires from English to Sinhala was performed by two independent persons. A third person translated (blind) both versions back into English and results were compared.

Hospital-based case-control study (HCC)

The detailed methodology is given by Mertens et al. (1990b). In brief, cases were children under five years of age reporting to the clinics for diarrhoea. Controls were children less than five years old reporting to the same clinics as the cases for other acute conditions unrelated to water supply and sanitation facilities and without diarrhoea. Control diseases included lower respiratory tract infections, malaria, fever of unknown origin, otitis, tonsilitis and chickenpox. A ratio of approximately 1:2 was maintained between cases and controls in each age group, except in Ambanpola and Kurunegala where the ratio of cases to controls was approximately 1:1. A large sample size (more than 6500 children were enrolled) was chosen in order to investigate potential associations between relatively rare exposures (e.g. use of handpumps) and reported diarrhoea rates, and to explore potential interaction effects (Smith and Day, 1984). During the hospital interviews, medical professionals selected and examined the cases and controls and entered their clinical observations onto a structured coded questionnaire in English. The mother of the enrolled child was then interviewed by a female volunteer, using another structured questionnaire in Sinhala. The data collected included information on the socio-cultural characteristics of the mother and child, the sex, weight and height of the child, type of water source and use of sanitation facilities. The age of the child was determined from the date of birth.

A home visit was carried out for a subsample of cases and controls (56 %) with the purpose of gathering data on the socio-economic and environmental circumstances of the household. This took place shortly after the child had been discharged from the hospital. No appointment for the household visit was made as it became apparent during the pilot study that some families changed their behaviour and made preparations for the visit. The household interviewers were unaware of the disease status of the child. The data collected included information on water collection and use during the dry and wet seasons, hygiene, sanitation and breastfeeding practices, socio-economic and educational indicators, and preference for different types of health care when reporting childhood illnesses.

The HCC started after a pilot study of two months in January 1987 in two district hospitals (Maho, Nikaweritiya) and the general hospital in Kurunegala. Wariyapola district hospital and Ambampola peripheral unit were included later during the course of the hospital based case-control study. The centres were chosen in consultation with the Ministry of Health on the grounds that they were situated in GTZ intervention areas, that they were accessible, that they saw a large number of outpatients each day and that they were reasonably well-staffed (Mertens, 1986).

Community-based surveys (CS)

1649 children below five years of age, referred to hereafter as community children, were selected at random from the community in order to provide information on nutritional indicators (see Cousens et al., 1990) and the prevalence of diarrhoea in the general population living in the same communities from which children were recruited into the hospital based case-control study, plus a description of socio-economic and environmental circumstances of their households. The recruitment of children from the community group enables a comparison of the characteristics of children recruited in the community with the characteristics of children recruited at the clinics. Such a comparison is important before attempting to generalize the results of the HCC study (Fletcher et al., 1982). Community-based cross-sectional surveys (CS) were conducted in Maho AGA (892 children), Nikaweritiya

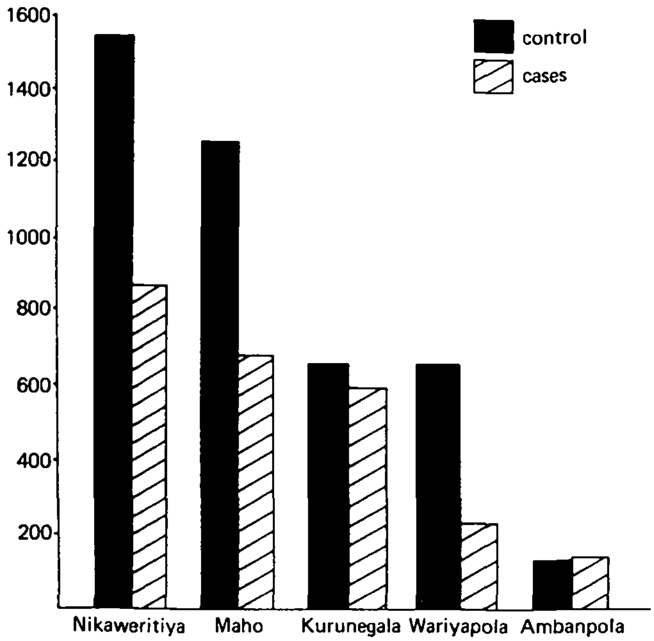

Fig. 3 Hospital-based case-control study. Statistics of recruitment per hospital up to 31 March 1988, Sri Lanka

AGA (377 children) and Wariyapola AGA (380 children). These were the three main areas of the hospital – based case – control study and where the GTZ programme was involved. Each survey was performed over a period of eight to ten weeks (Fig. 2). Children were selected using the following multistage sampling scheme. Half of the Grama Sevaka (GS) Divisions (smaller administrative sections within the AGA division) were selected at random and a census of households performed. From the census, a list of households with one or more children below five years was drawn up. Computer-generated random numbers were used to select the households to be visited. In each household where more than one child below five years of age had been located the youngest child was selected and the same exclusion criteria as those for the hospital based case-control study were applied (Mertens et al., 1990b). The same questionnaire, measurement and observation schemes were used for the community surveys as for the household visits performed for the hospital-based case-control study.

Environmental microbiology

In addition, households from a second subsample of children recruited in the HCC were visited (37 %) in order to collect samples of source water and of water stored in the home. Faecal contamination of the water was assessed by the membrane filtration technique (Cheesbrough, 1984). During the water sampling visit, the time needed to reach the water source from the household was measured. 56 % of houses in the community surveys had also their drinking water sampled. Patterns of water use and water quality in the study population are presented and discussed in the second paper of this series (Mertens et al., 1990a).

Diagnostic microbiology

Between March and July 1987 stool samples were collected from a subsample (500) of cases and controls recruited at four of the hospitals. The methods are described in detail by Mertens et al. (1990c). The following microorganisms were sought: *Shigella* spp., *Salmonella* spp., *Campylobacter jejuni*, enterotoxigenic (LT) and enteropathogenic *Escherichia coli*, rotavirus, *Giardia lamblia*, *Entamoeba histolytica*, *Cryptosporidium* spp. and helminths.

Characteristics of the study groups

Hospital-based cases and controls

Between January 1987 and March 1988 a total of 6651 children aged less than five years were recruited at the five hospitals participating in the study. Of these children, 53 (0.8 %) were excluded from the study because they failed to fulfill all the criteria for inclusion (see Mertens et al., 1990b). The following analyses and results are based on 2458 cases and 4140 clinic controls satisfying all inclusion criteria. Fig. 3 shows the distribution of cases and controls between the five hospitals. A total of 3694 (56 %) follow-up home visits were completed. Of these, 1415 were to the households of cases and 2279 to the households of controls. Data were occasionally missing (less than 5 % of the sample) for certain exposures or socio-economic variables. Numbers therefore vary slightly, depending on the variable under consideration.

Slightly more cases than controls had a duration of symptoms of less than seven days (Table 1) ($p = 0.05$).

Table 1 Distribution of selected variables amongst clinic cases and clinic controls

Variable	Clinic cases, numbers (%)	Clinic controls, numbers (%)	Test	P value
Child's age				
0– 5 months	302 (12.3)	401 (9.8)	$X^2 = 80.9$	$p < 0.01$
6–11 months	554 (22.6)	687 (16.8)	(3 df)	
12–23 months	761 (31.1)	1176 (28.8)		
24–59 months	831 (33.9)	1817 (44.5)		
Mean in months (standard deviation)	20.8 (14.5) n = 2438	24.1 (16.1) n = 4081	T-test	$p < 0.001$
Child's sex				
Female	1118 (46.9)	1961 (47.8)	$X^2 = 0.6$	$p = 0.44$
Male	1268 (53.1)	2137 (52.2)	(1 df)	
Onset of disease				
< = 7 days	2222 (91.7)	3689 (90.3)	$X^2 = 3.99$	$p = 0.05$
> 7 days	200 (8.3)	398 (9.7)	(1 df)	

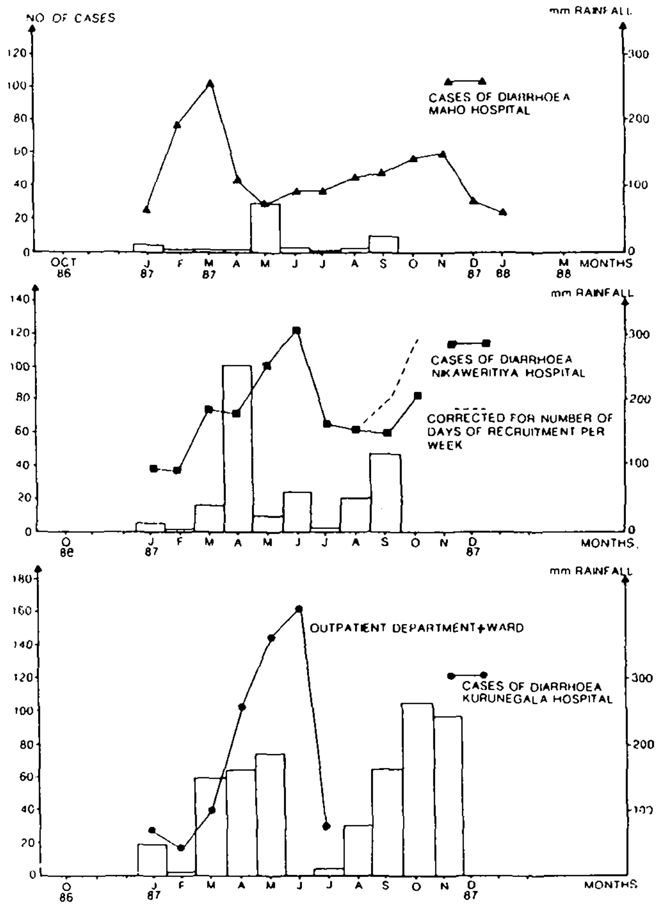

Fig. 4 Rainfall and reported diarrhoea in three hospitals, Sri Lanka 1987–1988

Among the 4140 controls, three children (0.1%) reported for chickenpox, 901 (21.8%) for malaria, 185 (4.5%) for otitis, 48 (1.2%) for tonsilitis, 2012 (48.6%) for respiratory infections and 991 (23.9%) for fever of unknown origin. Sixty children were diagnosed as suffering from both diarrhoea and bronchitis and 58 had fever of unknown origin associated with the diarrhoea. Diarrhoea was associated with malaria in 13 children, and with otitis in six children. Only once was a diagnosis of pneumonia associated with diarrhoea.

The distribution of cases and controls with regard to age, sex and duration of illness is presented in Table 1. Although a considerable effort was made to frequency match cases and controls for age, there are some 8% more cases than controls aged less than one year and an excess of controls aged between two and five years. Both cases and controls include an excess of males over females. 4.5% of mothers of diarrhoeal children were below 20 years of age compared with 3.6% of mothers of controls ($X^2 = 5.5$, df $= 2$, $p = 0.06$). Overall both groups were very similar with regard to socio-economic variables. Mean monthly income was 375 Rupees (approximately 15 US$) among both cases and controls (standard deviation 407 and 372 respectively). This average income represents a middle to low monetary income in the essentially selfsufficient economy of the households.

The number of diarrhoea cases recruited at the three clinics where recruitment lasted for more than six months shows two peaks (Fig. 4). In Maho, the first peak occurred between the middle of February and early April 1987, a period of drought in the area. In Nikaweratiya and Kurunegala the peak occurred later, between April and June 1987 towards the end of the intermonsoon rain. A second peak occurred in both Maho and Nikaweratiya, beginning at the end of September at the time of the North-East monsoon.

Community-based comparison group

Four community surveys (CS) were conducted in three areas (Fig. 2). During the interview, mothers were asked if the child had suffered from diarrhoea, defined as four or more loose or watery stools in a period of 24 hours, in the past two weeks. One hundred and thirty one mothers reported such an episode, giving a two week period prevalence of 7.9%. The age distribution of these prevalent cases of diarrhoea was very similar to the age distribution of the clinic cases. The majority of children from the community, who had not suffered from diarrhoea in the previous two weeks were, like clinic controls, on average older than the diarrhoea cases recruited in the hospitals. Over 66% of the cases were under two years of age, while only 50% of the community controls and 45% of the clinic controls were in that age range.

Socio-demographic profile of the three study groups

Household visits pertaining to the hospital-based case-control study were performed for 1027 cases of diarrhoea and 2290 controls in the three district hospitals of Wariyapola, Nikaweritiya and Maho, where children from the community had been recruited.

Table 2 presents a comparison of the distribution of socio-economic and demographic indicators for which major differences were observed between clinic cases, clinic-controls and community children. No significant differences between the three groups were observed in the sex distribution of the children or the civil status of their mothers. Mothers of cases did, however, tend to be younger than mothers of both clinic controls and children from the community. There was an excess of non-buddhists among the cases when compared with both control groups. Although statistically significant, the difference in the mean time of mothers schooling between the case group and the community comparison group was small (0.4 years). It is interesting to note that the estimate of maternal education among cases in Table 2 was drawn from the sub-sample visited at home. From data collected at the clinic for all cases, however, average mothers' education among the case group (7.2 years) did not differ from maternal education among the children from the community.

Not surprisingly, children from the community came from households situated further away from the district hospitals than clinic cases and clinic controls. Socio-economic indicators showed some differences between the clinic children and those recruited in the community. Children from the community had slightly better educated fathers who, when they were not cultivators, were more likely to be shopkeepers or craftsman and were less likely to be unemployed. Twenty percent of cases had a cement floor in their houses as compared with 28% of community children and 23% of clinic-

Table 2 Socio-demographic profile of three study groups, Sri Lanka 1987–1988

Variable	Levels	Clinic cases	Clinic controls	Community controls	Significance test	cases vs. clinic controls	cases vs. community controls	clinic controls vs. community controls
Child's age	Mean in months (s.d.)	20.8 (14.5) n = 1027	23.4 (14.8) n = 1913	26 (16.1) n = 1649	t-test	***	***	***
Religion	Buddhist Other	964 (94.8%) 53 (5.2%)	1856 (97.4%) 50 (2.6%)	1605 (97.5%) 42 (2.5%)	X^2 df = 3	***	***	NS
Mother's age	Mean in years (s.d.)	26.4 (5.1) n = 1010	26.9 (5.2) n = 1898	28.6 (5.6) n = 1635	t-test	*	***	***
Mother's schooling	Mean in years (s.d.)	6.9 (4.5) n = 1003	6.8 (4.1) n = 1891	7.3 (4.7) n = 1638	t-test	NS	**	***
Distance from home to clinic	Mean in miles (s.d.)	4.4 (3.0) n = 1014	4.2 (2.8) n = 1906	5.7 (3.4) n = 1641	t-test	NS	***	***
Size of household	Mean number of persons (s.d.)	4.8 (1.8) n = 1020	4.8 (1.7) n = 1880	5 (1.7) n = 1641	t-test	NS	*	***
Father's occupation	White collar shopkeeper/ craftsman cultivator unemployed	28 (2.8%) 188 (18.6%) 756 (74.6%) 41 (4.0%)	38 (2.0%) 362 19.2%) 1436 (76.0%) 53 (2.8%)	56 (3.4%) 399 (24.5%) 1149 (70.6%) 24 (1.5%)	X^2 df = 3	***	***	***
Father's schooling	Mean in years (s.d.)	6.3 (3.3) n = 994	6.4 (3.2) n = 1867	7.6 (4.5) n = 1607	t-test	NS	***	***
Type of walls of house	Brick or stone palm tree leave (cadjan) or mud	252 (24.7%) 769 (75.3%)	486 (25.5%) 1417 (74.5%)	500 (30.3%) 1149 (69.7%)	X^2 df = 3	NS	**	**
Type of floor	Cement mud or other	203 (19.8%) 820 (80.2%)	384 (20.1%) 1523 (79.9%)	463 (28.1%) 1186 (71.9%)	X^2 df = 3	NS	***	***

NS = not significant at 5% level; * = $p < 0.05$; ** = $p < 0.001$; *** = $p < 0.0001$

controls. Community children came from slightly larger households.

Health related behaviours

Among mothers taking children with diarrhoea to government hospitals 29.7% had used home remedies before presentation compared to 10% of mothers taking children with malaria or acute respiratory infections. Around 50% of all cases and controls had been seen in a dispensary before the hospital visit and 1% of them had been taken to an ayurvedic practitioner. 10.5% of children suffering from diarrhoea were seen by a private allopathic practitioner compared to only 5.5% of the clinic controls. Less than 1% had gone to a pharmacist. Finally around 5% of diarrhoeal children had received oral rehydration salts (ORS, "Jeewani") and another 8% home-based oral rehydration therapy (which includes king coconut water and rice water) before reaching the hospital.

In the community comparison group, mothers were asked what they had done first the last time they realised that their child had diarrhoea. 11.6% reported having gone to a pharmacist, 35% reported having given home remedies and 35% had reported to a government institution. Less than 1% said they had reported to an ayurvedic practitioner compared with 3.7% who had gone to a private allopathic doctor. Only 1% of mothers claimed to have given ORS while 15% had given home based rehydration therapy to their diarrhoeal child.

Validity of data collected at the clinic

Data on disease status

Misclassification of disease status is a cause of concern in health impact evaluations of water and sanitation programmes because it is likely to be an important source of bias, especially if the specificity of the disease measure, in the present situation diarrhoea, is poor (Briscoe et al., 1985). Furthermore, if the misclassification is non-differential with regard to exposure status and in situations where the magnitude of the association between the outcome disease and the risk factor is small, as in many studies of diarrhoea and water supply, a poor specificity of the disease measure may lead us to miss an existing association (Cousens et al., 1988).

As all cases and controls were examined by medical professionals with at least six years of formal training we believe that such misclassification is unlikely to have occurred to any great extent. In only 2% of the total sample was diarrhoea associated with a control disease and it is improbable that their inclusion as cases led to substantial bias even if the majority of these diarrhoeas were not caused by an enteric pathogen. Diagnostic microbiology performed on the stools of a subsample of cases and controls revealed that, out of 10 enteropathogens which were sought, at least one could be detected in more than 50% of the cases of diarrhoea. This was significantly higher than the overall detection rate among controls (Mertens et al., 1990c). This should also be viewed as further evidence that the majority of cases were genuine enteric infections.

Table 3 Comparison of answers given for maternal education at the clinic and at home for cases of diarrhoea (A) and for controls (B)

(A) Diarrhoea		Home interview			
		0–5 years schooling	6 years to higher education	Total	% agreement
Clinic interview	0–5 years schooling	458	76	534	85.8
	6 years to higher education	80	753	83	90.4
	Total	538	829	1357	
	% agreement	85.1	90.8		
(B) Controls		**Home interview**			
		0–5 years schooling	6 years to higher education	Total	% agreement
Clinic interview	0–5 years schooling	791	114	905	87.4
	6 years to higher education	119	1244	1363	91.3
	Total	910	1358	2268	
	% agreememt	86.9	91.6		

Socio-demographic and exposure data

In the HCC identical questions were asked about socio-demographic variables and use of water sources during the clinic and the home interviews. Before being entered onto microcomputers in Kurunegala all questionnaires were reviewed. Consistency checks were carried out on each questionnaire (clinic and household interviews). The most common problem encountered was that of missing data due either to the reluctance of some mothers to answer certain questions or to the interviewer rushing through the questionnaire. All questionnaires with problems were referred to the researchers, and follow-up interviews were conducted by four different interviewers who checked 15 specific questions or in some cases the entire questionnaire. It was thus possible, during the analysis of the data, to investigate the degree to which differences in classification arose between the two interviews with regard to socio-demographic variables, or to exposure to improved or unimproved water supplies. Such differences will occur if either mothers responded incorrectly at one of the interviews or if families change their water source over the course of time.

We examined responses to two questions in particular; level of maternal education and use of water source. There was some degree of disagreement between data collected at the clinics and that collected at home for both these variables. For maternal education a difference of 0.4 years in the mean time of maternal schooling between the clinic interview and the home interview was observed and this led to a statistically significant difference when comparing cases with children from the community (Table 2). Table 3 compares the answers given at the clinic with those given at home for maternal education according to whether a child reported for diarrhoea or for a control disease. Misclassification rates of 9% and 14% were observed for the higher schooling and lower schooling categories, respectively. This misclassification was non-differential with regard to disease status; i.e. the misclassification rates were independent of whether a child reported diarrhoea or was a control.

For the type of water source used by the household, a high rate of up to 23% of "misclassification" was observed through mothers who claimed to be using an unimproved source at the clinic, but who then reported using an improved supply during the household visit. 22% who reported using an improved water supply at the clinic claimed using an unimproved supply during the household visit. In order to investigate whether this "misclassification" was occurring at the clinic or at home further analyses were performed. These were conducted for four areas because it was observed that the association between diarrhoea rates and type of water source varied greatly between Wariyapola and the four other areas (Mertens et al., 1990b). Due to the above mentioned "misclassification" of exposure status the relative rate of diarrhoea computed from data obtained during the household interview differed by approximately 10% from the relative rate derived from the data collected at the clinic (relative rates = 0.92 and 0.84 respectively). We divided children into two categories. Those for whom there was an agreement between the exposure data collected during the clinic interview and that collected during the home interview, and those for whom there was disagreement. Separate relative rates were calculated for these two groups, using for both exposure data from the clinic interview. The relative rate thus obtained was 0.82 for those agreeing and 0.86 for those disagreeing, both of which were very close to that found from the clinic data for the four areas (relative rate = 0.84). This suggests that data on water source from the clinic interviews were more appropriate and that the differences obtained using the home data were most likely due to a real change in water sources between the two interviews. Indeed, the sources used by households varied over short periods of time, as some traditional sources dryed up but still provided water intermittently after brief periods of occasional rain. Water source choice appeared to depend essentially on the proximity of traditional sources, which in turn was affected by convectional rainfall (Mertens et al., 1990a).

Conclusion

The population studied in the health impact evaluation of existing water supplies, sanitation facilities and hygiene practices in Kurunegala district is typical of the rural settlements of the southern part of the dry zone of Sri Lanka. It is characterized by a large majority of Sinhalese buddhist subsistence farmers living in traditional housing conditions (MPI, 1985). Cases of diarrhoea, clinic controls and children from the community shared similar demographic characteristics, except for their age structures. Cases of diarrhoea were, on average, younger by three to six months than clinic-controls and community children respectively. Demographic data for the district of Kurunegala indicate an age-specific sex ratio of 1.03 with a slight excess of males in the 0 to 4 age group (MPI, 1985). The larger excess of males recruited as clinic cases in this study probably reflects increased reporting of diarrhoea for male children rather than increased morbidity, although in Nigeria, a cross-sectional study in the community has also reported a higher proportion of diarrhoea in males than females among children aged less than five years old (Huttly et al., 1987). The sex ratio among children recruited in the community was 1.10, slightly lower than the sex ratio for the cases (1.13).

Community controls were more likely to come from better-off and larger households than clinic cases or clinic controls, and this may be due to the fact that government health facilities tend to attract the poorest section of the community.

The two-week period prevalence of 7.9% of diarrhoea in the community is similar to the prevalence of 8% found during the nationwide Demographic Health Survey (DHS) in 1987 (MPI, 1988). Assuming an average duration of three days per episode of diarrhoea in the community, it is possible to estimate the incidence of diarrhoea to be of the order of two episodes per child per year, a figure higher than the country median of 1.0 reported in 1986 (WHO).

For the hospital-based case-control study an analysis of misclassification occurring between clinic and home interviews provides an insight into the validity of the clinic interviews. For the variable "maternal education" there was agreement of 85% to 91% between data obtained at clinics and at home for two levels of schooling. Bearing in mind that the measurement of maternal education by questioning relies on recall of several years, such a degree of misclassification suggests a good consistency of mother's answers between the two interviews. For the exposure to different water supplies much higher misclassification rates were observed between the two interviews. However, it appeared that data collected at the clinic on exposure to different water supplies were probably a good reflection of water source choice at the time of interview and, therefore, shortly after the challenge experienced by children.

Our data suggest that non-differential misclassification of exposure with regard to disease status occurred in the direction of clinic data to household data. This was true for all the variables which were repeated in both questionnaire and confirms, indirectly, the effectiveness of blinding the home interviewers to the disease status of the child. Such non-differential misclassification will result in the underestimation of any association between diarrhoea and putative risk factors from household data.

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