Assessment of the impact of a hygiene intervention on environmental sanitation, childhood diarrhoea, and the growth of children in rural Bangladesh

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Abstract

A community-based hygiene intervention was developed and implemented in five villages of lowland Bangladesh with the active participation of members of the target group, with the objective of reducing childhood diarrhoea by altering ground sanitation and personal and food hygiene practices such as the washing of hands with ash before handling food and after defecation-related activities, cutting fingernails, removing faeces from the child's body and from the yard, using tube-well water for preparing baby food, and reducing supplementary feeding contamination by proper cleaning of bottles or avoiding bottle-feeding.

The project area, typical of Bangladesh, was selected because of its poor hygiene and sanitation conditions and its high rates of diarrhoea and malnutrition. Households with children 0–18 months old in five contiguous villages were targeted for the intervention. Households with children in the same age range in a comparison (control) site selected for observational study without intervention were exposed to about the same amount of contact with the researchers.

Baseline surveys of the subset of households with children 9–18 months old were conducted at the control site in July 1985 and at the intervention site in September. The intervention activities were carried out from January to July 1986. A final survey was conducted at both sites in August 1986, using the same questionnaire as for the baseline survey and the children who were then in the same age range, 9–18 months.

Both sites had higher cleanliness scores, lower diarrhoeal morbidity, and better growth status at the end of the study period, but the improvement was greater at the intervention site. The effect at the control site may be attributed to the intensive observation exposures, mothers' education, and socio-economic conditions of the households, whereas the intervention site effects were most likely due to the intervention activities.

For evaluation of the effect of interventions, the repeat cross-sectional survey may be adequate for measuring relatively stable outcomes such as knowledge and practices, as well as cumulative growth status, but inadequate for fluctuating morbidity.

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Introduction

One of the deadliest childhood diseases in the world is diarrhoea [1]. Scrimshaw [2] and others established that it has a synergistic relationship with malnutrition. This vicious cycle results in an adverse effect on growth [3–6]. In Bangladesh, 90% of preschool children suffer from some degree of malnutrition [7], and, as in many other countries, diarrhoea is one of the most important causes of malnutrition [8] and child mortality [9]. Poor hygiene and sanitation are major contributors to the diarrhoea [10].

Many hygiene interventions that attempted to reduce childhood diarrhoea failed to demonstrate any effect, mainly because they were culturally unsuitable and often developed without understanding the problem in the target community [11–13]. In this project, a positive-deviance research approach [14] was used to develop a community-based intervention. The researchers sought to identify local adaptive behaviours that could be modified by a trial process [15] and implemented as culturally acceptable and low-cost interventions in five villages in rural Bangladesh. Five similar villages were used as a control site for evaluating the intervention.

The purpose of the study was to assess the impact of this intervention on mothers' knowledge and behaviour, and on the diarrhoeal morbidity and nutrition status of children 9–18 months old as measured by rapid cross-sectional surveys carried out before and after the intervention. A six-month longitudinal study was conducted, and its analyses are presented in a separate report [16]. The repeat cross-sectional evaluation permitted an investigation as to whether this relatively inexpensive technique measured the impact of interventions adequately, compared with more costly longitudinal methods.

Methods

Sites

The project was carried out at two rural sites, each consisting of five contiguous villages in Harirampur subdistrict, Manikgonj district, about 100 km northwest of Dhaka on the northern bank of the Padma River. This area, typical of rural Bangladesh [17], was chosen because of its poor sanitary conditions and high diarrhoeal and malnutrition rates [18].

A census was conducted in five villages in October 1985 to recruit all available households with children under 19 months of age for an intervention, and 185 households (98%) were targeted. In the same month, a similar census targeted 200 households (97%) for structured observational studies at the control site. The intervention site was five kilometres away from the control site and was accessible by a two-hour boat ride most of the year, and by foot over a narrow path in about one and a half hours during the driest winter months.

More than half the households in these villages did not own cultivable land, since much farm land had been submerged by the river. Household heads (almost exclusively men) were primarily engaged in farming, small-scale trading, salaried jobs, fishing, and day labour. Most of the farmers had small landholdings, growing mainly deep-water rice, jute, and seasonal vegetables. The traders sold grocery items and agricultural produce such as rice, wheat, vegetables, fruits, and date-palm molasses. Mothers spent their days processing food, cooking, cleaning, and caring for children.

The traditional homestead consisted of one or more thatch, jute straw, or tin houses surrounding an earthen courtyard. Huts made of thatch or straw generally served as living quarters but sometimes also as kitchens, animal sheds, or grain-storage areas. The more desirable and expensive tin-roofed and tin-walled houses were mainly owned by the richest households.

Children were cared for in and around the courtyard by the mother, grandmother, and siblings. The earth surfaces of the house and yard were used for domestic work, for raising chickens, ducks, goats, and cattle, and for child care, including child toileting. Ground sanitation, personal cleanliness, and food hygiene were difficult year-round, with the additional problems of insufficient water in the hot dry season (April–May) and too much water in the flood season (July–September).

The intervention

A community-based trial model, described in detail elsewhere [15], was used to develop interventions. Briefly, specific hygiene practices and sanitary conditions associated with diarrhoea were identified through baseline surveys, field observations, in-home problem diagnosis, and focus-group discussions and other methods recommended by Scrimshaw and Hurtado [19]. These assessments showed that villagers believed supplementary feeding of infants, teething, evil eye, bad air, and spirits caused diarrhoea [15]. Only 4% of the mothers at the intervention site had heard about germs. The connection between faecal contamination and diarrhoea was not recognized by most of the villagers. To develop an understanding of the occurrence of diarrhoea, the germ of theory of disease was taught to the participants.

One Tufts University doctoral candidate and two master's-level field supervisors worked with local project workers and the community to develop and test informational messages and teaching aids. A core of ten project workers were chosen from the community on the basis of at least ten years of education, ability, willingness to work in the field, and trustworthiness in the community.

Hygiene practices were proposed during working-group sessions and tested and revised through trial and practice at three levels, the first of which was in the homes of the ten project workers.

For the next level, the community was divided into five geographical blocks, each supervised by a project worker. From each block, five volunteers, who were themselves mothers targeted for the intervention, were selected using the following criteria: ability to articulate messages, willingness and family support for volunteering, and a friendly relationship with neighbours; it was prestigious to be a volunteer. Five workers taught the practices and supervised the trials at the second level in the homes of these 2[illegible] community volunteers.

After the volunteers' trials, the messages wer modified again, and the volunteers taught the rest of the community. The teaching was interactive, by demonstration, emphasizing question-and-answer and discussion sessions. Volunteer training and community-level teaching were done at least twice a week in groups of up to five. For the sessions, the mothers chose their less busy hours, late morning and late afternoon.

For the third level, the working-group members visited five of the poorest households in each block to assess their ability to use the messages. The final messages were established on the basis of this assessment.

The three trial levels thus addressed the needs and understanding of the different groups in the community, including the poorest. Successful behavioural advice was composed into simple, feasible, direct, and motivating verbal messages created to resemble locally popular proverbs, poems, and folk songs. The intervention themes and messages, after final testing and revisions during the education campaign in the community as a whole, were as follows, presented in the order in which they were developed and integrated into community practice.

» *Ground sanitation theme*—keeping babies from touching and eating disease-causing matter on the dirt surface of the compound:
  1. Sweep the baby's play area four times a day.
  2. Use a dirt thrower (similar to a flat garden trowel) to remove the baby's or animal faeces from the yard immediately so that the baby will not be contaminated.
  3. Use a pit to dispose of faeces and other filthy matter from the yard. (The pit was about 60 cm deep, with a narrow neck at the top that could be covered with a piece of broken pottery.)
  4. Wash the baby at a designated place after defecation so that contaminated water will not be spread everywhere.
  5. Keep crawling babies in a playpen rather than letting them crawl in the dirt.

» *Personal hygiene theme*—reducing the transmission of germs from defecation and other related activities:
  1. Wash both hands with ashes or soap after defecation, as well as before and after feeding or eating.
  2. Handle the *bodna* (water pitcher used for cleaning after defecation) with the right hand only so that the germs from the left hand (used for cleaning after defecation) do not contaminate the bodna for the next user.
  3. Clean the baby immediately after defecation to prevent faecal contamination.
  4. Use a razor blade to cut the nails of all family members, including the baby, at least once a week. (Since it is the custom in Bangladesh to eat with the hands, long nails can regularly transport germs to the mouth.)
  5. Use a hand rag to dry the mother's hands after defecation instead of her own sari.
  6. Clean the baby's rug or mat immediately whenever it gets soiled so that the baby will not come into contact with dirty matter.

» *Food hygiene theme*—reducing the transmission of germs during bottle-feeding and supplementary feeding:
  1. Do not use any feeding bottle if possible.
  2. If using a bottle (usually a small brown medicine bottle), soak it in salt water and/or wash it in hot water and boil the nipple before feeding.
  3. Prepare only the quantity of mixture that the baby can drink at one time. (The mothers were taught that germs would contaminate any leftover mixture.)
  4. Use only tube-well water for drinking and for mixing food for the baby.
  5. Wash both hands and eating plates with tube-well water before eating; wash both hands and utensils before food preparation.
  6. Do not feed leftover food that might be contaminated.
  7. Keep all food covered from flies, dirt, chickens, and dogs.
  8. Store clean plates and pots and pans upside down or cover them to keep animals off.
  9. Cover water pitchers so that animals or flies will not contaminate the drinking water.

Evaluation of the intervention

While the intervention targeted all available households with children 0–18 months old, the age range 9–18 months was chosen for the repeat cross-sectional evaluation. The crawling and toddler stages of development were considered crucial in terms of hygiene and sanitation practices, diarrhoeal morbidity, and malnutrition; and, at the crawling stage, infants' exploratory behaviours lead them to touch and taste faecal matter on contaminated surfaces [20].

The same 9–18-month age range was used in both the baseline survey in July and September 1985 and the final survey in August 1986. The 11 to 13 months between the two therefore meant that the children in the first sample were excluded from the final sample; four completely independent groups were thus obtained. The mothers of almost all the children in this age range participated in the surveys. There were 111 households at the intervention site in the 1985 survey and 90 in the 1986 survey; at the control site the sample sizes were 96 in 1985 and 78 in 1986.

The field workers who took part in the longitudinal research or intervention at the two sites switched locations to administer the final survey. In addition, personnel who had implemented the intervention were not involved in monitoring the outcomes of the intervention.

The same questionnaire was used for both surveys. Information was recorded on the socio-economic and demographic characteristics of the households as well as on basic practices and beliefs with regard to hygiene, sanitation, and infant feeding. The interviewers asked each mother to indicate the two locations where she most commonly placed the infant on the ground to play while she worked. The interviewers inspected the sanitary conditions of these areas and recorded the presence of faecal matter, spoiled food, garbage, other dirty things, dust, and wetness.

Information was also collected on diarrhoea among the children on the day of the interview and over the preceding two weeks. The children were weighed by trained anthropometry workers, using a beam-balance scale, and the weights recorded to the nearest 0.1 kg. The measurements were standardized by the Zerfas method [21].

Measures

Socio-economic characteristics

The socio-economic scale used in the analyses was adapted from a previous scale developed by researchers at the Institute of Nutrition and Food Science, University of Dhaka [22]. The scores for the components of the scale were as follows: housing materials and structures—all tin = 8, four-sided tin roof and bamboo walls = 6, two-sided tin roof and bamboo walls = 4, one-sided tin roof and bamboo walls = 2, all thatch-straw = 1; radio ownership = 3; tube-well ownership = 8; and mother's meals per day—three meals = 5, less than three meals = 0.

The sum of the mother's and father's years of schooling was used to measure education. The amount of land owned by the family was used as a measure of economic conditions.

Knowledge

Each mother was asked whether or not the following might cause disease if eaten by a baby: animal faeces, garbage, flies, baby faeces, adult faeces, spoiled food, and fresh food fallen onto the ground. The mother's knowledge of hygiene and sanitation was measured by the sum of her responses (incorrect = 0, correct = 1).

Hygiene practices and sanitary conditions

A sanitation scale was formed from the sum of the responses and observations of the following variables, with response categories ranked from low to high on the basis of their likelihood of preventing faecal contamination:

—how often the mother puts a mat or sack under the baby to prevent contact with the earth when it is placed on the ground to play (never = 0, rarely = 1, usually = 3, always = 4);

—how frequently the mother checks on the baby in the play area (rarely within a half hour = 0, once or twice within a half hour = 2, very frequently or always = 3);

—how clean the play area is observed to be (very dusty and dirty = 0, some dust and dirt = 1, all clean = 2);

—how quickly the mother cleans the baby of its faeces and cleans her hands after the baby's defecation (usually not until her job at hand is done = 0, sometimes not until her job at hand is done = 1, immediately upon seeing the baby defecating = 3);

—how the mother cleans the baby and removes its faeces from the ground (rubbing with her feet or cleaning with straw and leaves = 0, scraping completely with a hoe = 3);

—how the mother washes her hands after cleaning up from the baby's defecation (with water only = 0, with water and earth = 2, with water and ash = 3, with water and soap = 4);

—what is done with food that the baby drops on the ground (just picked up and given back to the baby = 0, washed and given back = 2, thrown away = 3).

Two other variables to address hygiene and sanitary conditions were the baby's contact with faeces within the previous two weeks, based on the mother's recall (no contact = 0, physical contact = 1, physical and oral contact = 2), and the dryness of the play area as observed on the day of survey (all mud = 0, moist earth and some mud = 1, some moist earth and some mud = 2, all moist earth = 3, some dry and some moist earth = 4, all dry earth = 5).

The dryness of the baby's play areas was one of the indicators of the ground-sanitation condition of a household because muddy areas trap contaminants and are not easily swept clean. Micro-organisms thrive in a moist environment, and moist or muddy soil is likely to adhere to crawling infants. Accumulated faeces, urine, and moist kitchen garbage also can make an area wet and muddy. The baseline survey results showed a negative association between the dryness of play areas and the prevalence of diarrhoea in the children. In the intervention campaign, the cleanliness and dryness of the play area were emphasized.

Morbidity

The point prevalence of diarrhoea and its prevalence over the preceding two weeks were measured by the mother's recall, as recommended in the WHO rapid assessment manual. A composite variable representing the diarrhoeal history of the child was also con-

TABLE 1. Demographic and socio-economic variables of the sample households

	Sample group							
	Control 1985 ($N = 96$)		Intervention 1985 ($N = 111$)		Control 1986 ($N = 78$)		Intervention 1986 ($N = 90$)	
	Mean (SD)	%	Mean (SD)	%	Mean (SD)	%	Mean (SD)	%
Child's age (months)	13.4 (3.2)^b		13.0 (2.0)^b		14.0 (2.5)^b		13.7 (2.7)^b	
Male child		55		49		51		50
Hindu family*		45		23		51		13
Father's education (years)†	2.6 (3.8)^c		2.3 (3.7)^c		3.8 (3.5)^d		2.5 (3.4)^c	
0		58		62		44		53
1–4		12		14		12		19
5–9		21		17		27		21
10+		9		7		18		7
Mother's education (years)‡	1.1 (2.2)^e		0.8 (2.0)^e		1.8 (2.7)^f		0.5 (1.4)^e	
0		77		83		73		83
1–4		7		8		5		10
5–9		16		7		12		7
10+		0		2		10		0
Landholding (acres)§	0.3 (0.8)^g		2.4 (4.0)^h		1.4 (3.5)^h		1.4 (2.5)^h	
0		81		55		65		38
0.01–0.99		7		7		8		27
1.00+		12		38		27		36
Major source of income								
service		10		13		21		18
business		45		42		15		33
farming		11		24		26		26
sharecropping		4		0		10		13
fishing and day labour		30		21		28		10
Housing material								
all tin		7		6		20		14
tin roof		51		64		64		57
thatch-straw		42		30		16		29
Radio ownership		28		28		37		28

Pairwise comparisons: CI85 = 1985 control vs. 1985 intervention. CI86 = 1986 control vs. 1986 intervention. C85-86 = 1985 control vs. 1986 control. I85-86 = 1985 intervention vs. 1986 intervention.
No significant differences between values in the same horizontal row with the same superior letter.
*CI85, $p = .001$. CI86, $p = .000001$.
†CI86, $p = .05$.
‡C85-86, $p = .01$. CI86, $p = .007$.
§CI85, $p = .0001$. C85-86, $p = .01$. I85-86, $p = .07$.

families. The 1985 control and intervention samples and the 1986 intervention sample were similar in mean age of children, sex ratio, means of the fathers' and mothers' education, and socio-economic scores.

The percentage of Hindus among the 1985 control families was twice as high (45%) as in the 1985 intervention group (23%) (chi-square test, $p < .0001$). In 1985 the intervention families owned a larger mean amount of land than the controls, but in 1986 the difference in land ownership was not significant. Overall, 19% of the mothers and 45% of the fathers had attended school. However, the 1986 control parents had more education than the others: 18% of the fathers and 10% of the mothers had ten or more years of school, whereas the corresponding figures were 7%–9% for the fathers and 0%–2% for the mothers in the other groups. The 1986 control group also had the highest socio-economic scores and radio ownership.

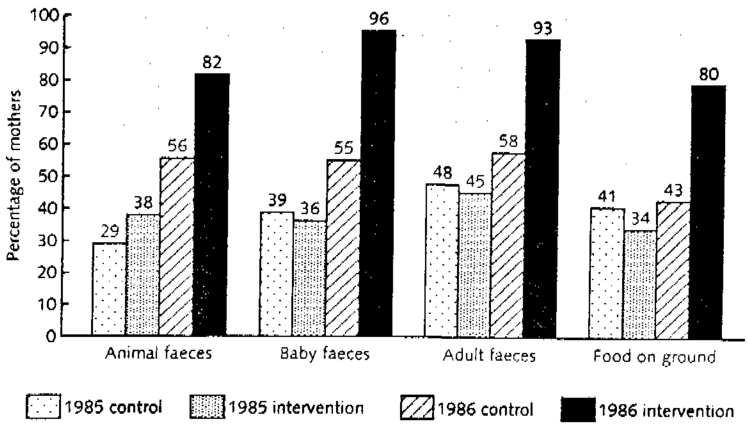

FIG. 1. Mothers' hygiene knowledge: percentages identifying substances as disease-causing

TABLE 2. Standardized regression coefficients of socio-economic and other variables on mothers' knowledge of germs, sanitation practices, children's contact with faeces, and dryness of play areas

Independent variable	Knowledge of germs	Sanitation practices	Faecal contact	Dryness of play area
Socio-economic status	0.004 (0.01)	0.07 (0.11)*	−0.02 (−0.06)	0.02 (0.13)**
Amount of land held	NE	−0.0005 (−0.04)	−0.007 (−0.03)	0.005 (0.13)**
Mothers' knowledge of germs	NE	0.32 (0.17)*****	−0.04 (−0.14)**	0.05 (0.09)
Parents' education	0.07 (0.01)	0.14 (0.10)*	−0.05 (−0.15)**	NE
Control 1986	0.76 (0.15)**	0.56 (0.06)	−0.29 (−0.14)***	0.13 (0.04)
Intervention 1986	2.52 (0.55)*****	5.21 (5.57)****	−0.43 (−0.22)****	0.84 (0.30)***
Intercept	8.38	7.19	1.44	3.34
Adjusted R^2	.28	.48	.14	.13
Significant F (p)	.0001	.0001	.0001	.0001

NE = not in equation.

*p = .03. **p = .01. ***p = .001. ****p = .0001. *****p = .00001.

Hygiene and sanitation knowledge and conditions

Mothers' knowledge

The percentage of mothers who correctly identified dirty and disease-causing items was significantly higher in the 1986 intervention sample than in either the baseline samples or the 1986 control sample (fig. 1).

Regression analysis (table 2) indicates that mothers' knowledge of germs and disease-causing substances was determined by the intervention, mothers' and fathers' education, and membership in the 1986 control group. The structured behavioural observations of sanitation and hygiene practices had been conducted among the members of the 1986 control sample.

Behaviours and conditions

No significant differences were found between the baseline samples with respect to the hygiene and sanitation variables shown in table 3. The 1986 intervention sample was higher than the 1986 control and the baseline samples in the percentages of mothers who were most attentive to their babies, checking on them continuously, and who either threw away food that fell on the gound or washed it before giving it back to the baby, and was much higher in the percentages who cleaned their hands with ash after defecating and who removed the babies' faeces from the ground completely with a scraper. It was also somewhat higher than the 1986 control sample and much higher than the baseline

TABLE 3. Sanitation and hygiene variables of households (percentages)

	Control 1985 ($N = 96$)	Intervention 1985 ($N = 111$)	Control 1986 ($N = 78$)	Intervention 1986 ($N = 90$)
Cleaning hands after defecation*				
water and soap	1	2	14	0
water and ash	0	1	0	83
water and earth	99	97	86	17
Removal of faeces from ground†				
scraping with hoe/dirt thrower	43	35	23	96
wiping with straw/leaves	79	87	76	6
covering with ash/sand	8	11	0	0
rubbing with foot	14	7	21	0
Cleaning of baby after defecation‡				
as soon as mother sees it	50	43	91	97
sometimes not until job at hand is done	46	55	8	3
usually not until job is done	4	2	1	0
Treatment of food dropped on ground§				
thrown away	12	12	14	37
cleaned and given back to baby	21	24	31	51
given back to baby	67	64	55	12
Mother's checking on baby‖				
continuous	34	46	57	71
more than once per half hour	44	39	23	23
less than once per half hour	22	15	20	6

Pairwise comparisons as for table 1.
*C85-86, $p = .0007$. I85-86, $p = .000001$. CI86, $p = .000001$.
†C85-86, $p = .007$. I85-86, $p = .000001$. CI86, $p = .000001$.
‡C85-86, $p = .000001$. I85-86, $p = .000001$.
§I85-86, $p = .000001$. CI86, $p = .000001$.
‖C85-86, $p = .00009$. I85-86, $p = .001$.

samples in the percentage who cleaned the baby immediately when it defecated.

The percentage of the babies' outdoor play areas that were clean was also highest in the 1986 intervention group (fig. 2). Similarly, a smaller percentage of that sample was reported to have been in contact with faeces than in the other groups, though the control group had a lower contact rate than the intervention group at baseline; there was a 35% change in the children's oral contact with faeces at the intervention site after about a year, compared with 7% at the control site (fig. 3).

The second regression in table 2 indicates that hygiene and sanitation practices were determined by the mothers' knowledge about disease-causing matter, the mothers' and fathers' level of education, socio-economic status, and the intervention.

The third regression indicates that the mothers' germ knowledge, the mothers' and fathers' education, and participation in either the 1986 control or the 1986 intervention group had significant effects on reducing babies' reported contact with faecal matter. In addition, the intervention, the family's socio-economic status, and the amount of land had a significant association with the dryness of babies' play areas.

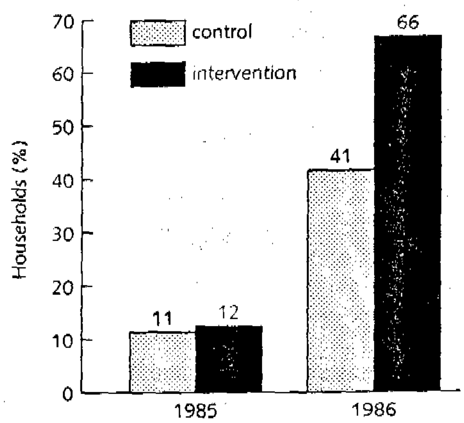

FIG. 2. Households in which the child's play area was rated clean (chi-square test: difference between 1986 control and intervention samples significant at $p < .001$)

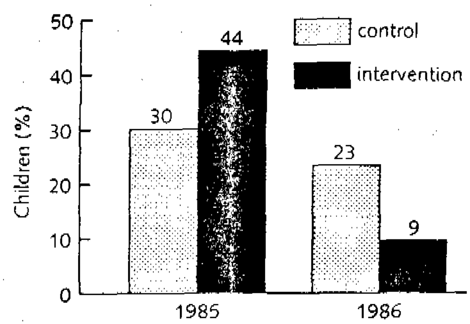

FIG. 3. Children's reported oral contact with faeces during the two weeks preceding the survey (chi-square test: differences between control and intervention samples significant at $p = .05$ in 1985 and $p = .0001$ in 1986)

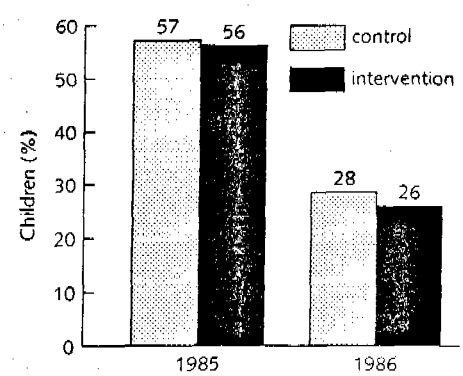

FIG. 4. Prevalence of diarrhoea in children 9–18 months old. The data for the control site in 1985 and for both sites in 1986 represent mothers' reports for the two weeks preceding the survey; the 1985 survey at the intervention site was conducted about two months after that at the control site, towards the end of the diarrhoea season, and the value represents the mothers' recall for the time of the survey at the control site, two months previously.

Children's morbidity and growth

Diarrhoeal morbidity

The baseline surveys were administered at different time—in July at the control site, which recorded a very high rate of diarrhoea (57% past two-week prevalence), and in September at the intervention site, with a rate of 20%. An attempt was made to arrive at a rough estimate of diarrhoeal prevalence in July for the intervention site, based on mothers' recall of whether the baby had diarrhoea two months previously. The recall yielded a rate of 56%, suggesting no significant difference between the control and the intervention samples in July (fig. 4). The final survey (1986) was administered at the same time in both sites. The children's past two-week prevalence of diarrhoea decreased at the end of the intervention period in both sites, but the difference between sites was not significant.

TABLE 4. Standardized regression coefficients of variables on children's diarrhoeal morbidity

Independent variable	Coefficient
Sanitation practices	−0.21 (−0.11)*
Dryness of play area	−0.90 (−0.17)**
Control 1986	−0.45 (−0.03)
Intervention 1986	−0.77 (−0.05)
Intercept	13.67

Adjusted $R^2 = .09$. Significant F, $p = .0001$.
*$p = .01$. **$p = .001$.

Table 4 shows that dryness of the child's play area, and hygiene and sanitation practices were significantly associated with lower diarrhoeal morbidity. The intervention did not show a direct effect on diarrhoeal morbidity as measured.

Growth

Figure 5 illustrates the mean WAZ scores of the children in the baseline and final surveys. In the 1986 samples, the intervention children had a significantly higher mean WAZ ($p < .05$) than the control children, while the difference between the 1985 samples was not significant. Multiple regression analysis indicates that diarrhoeal morbidity, socio-economic status, and the intervention significantly influenced the growth status of the sample children (table 5).

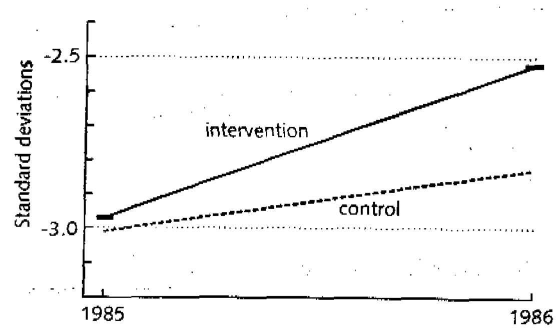

FIG. 5. Mean weight-for-age Z scores of children 9–18 months old, based on the WHO standard (1986 intervention sample significantly higher than all other samples at $p < .05$). Children below −3.5 SD: 1985 control 29%, intervention 28%; 1986 control 21%, intervention, 18%

TABLE 5. Standardized regression coefficients of variables on children's growth status (weight-for-age Z scores)

Independent variable	Coefficient
Age of child	−0.18 (−0.09)*
Socio-economic status	0.03 (0.15)**
Diarrhoea morbidity scale	−0.02 (−0.13)**
Respiratory infection	−0.002 (−0.05)
Control 1986	0.06 (0.04)
Intervention 1986	0.34 (0.11)*
Intercept	−2.98

Adjusted $R^2 = .07$. Significant F, $p = .002$.

$^*p = .03$. $^{**}p = .001$.

Discussion

Observation (placebo) effects

Improved hygiene knowledge and practices and lower diarrhoeal morbidity compared with the baseline samples were observed in the 1986 control group as well as in the intervention group, although they were substantially less pronounced. This may be due in part to the high level of education and socio-economic status of the 1986 control sample. Our finding that the parents' education was significantly associated with hygiene knowledge and practices is consistent with other studies [29–39]. It is probably more attributable, however, to the effects of intensive observation, which functioned as a placebo effect at the control site.

The behavioural observation team visited each family in the control-site sample every other day for six months and recorded routine eating or feeding events, food preparation, other child-care practices, and personal (face, hands, legs, between fingers, clothes), ground, and latrine cleanliness and defecation events [38]. To observe how mothers cleaned their babies after defecation, simulations were constructed using wheat-flour paste as faeces placed on the baby's posterior and on the ground. The mother was requested to clean up this paste as if she were cleaning faeces after defecation. The presence of paste remaining on the child and mother and on the ground was physically checked and recorded. Mothers also answered many queries about their hygiene and cleanliness practices.

A visit to these rural areas by city people or government officials usually is rare and considered special. The regular visits and continuous presence of an energetic and well-educated research team may have had a positive effect on the behaviours of those being observed. Although the field team was carefully trained not to give hygiene education, explain the purpose of the study, or express approval or disapproval of the behaviours they observed, the very nature of the questions they asked and the types of observations they made, as well as their unintended expressions or body language, could have provided villagers with feedback regarding the observers' values and intentions.

The compounded effects of all these factors may have resulted in behaviour change in the desired direction. In fact, we considered observational research to be an appropriate placebo intervention, since even the most ineffective of interventions would probably have exerted an influence through social approval of cleanliness.

Intervention effects and measuring problems

While the scores for the mothers' hygiene knowledge and practices were significantly higher and the children's growth status was better for the 1986 intervention sample than for the baseline samples or the 1986 control sample, this relatively low-cost cross-sectional study design did not detect significant differences in diarrhoeal morbidity. Significant differences that could not be measured by this evaluation, however, were documented in a study using longitudinal methods reported elsewhere [16]. From March through June the intervention site had significantly lower diarrhoeal prevalence than the control site, with the highest differences in one of the peak seasons (April–May). In general, we suspect that seasonal variability in diarrhoeal disease is too large to permit cross-sectional evaluation of rate changes. Even if repeat measurements are made at exactly the same time each year, seasonal trends may peak at different times in different years.

Two other factors possibly further obscuring the intervention effect were a two-month delay in administering the baseline survey at the intervention site, yielding a diarrhoeal rate not strictly comparable at the starting point, and the effect of faeces-pit flooding at the intervention site during the final survey.

In Bangladesh, the climate affects morbidity greatly [40, 41]. In 1985, when the baseline survey was carried out at the control site, a major outbreak of diarrhoea appeared to have occurred during the last two weeks in July when rising water levels contaminated water supplies. About two months later, the baseline survey at the intervention site was administered during a time of relatively dry weather when diarrhoeal prevalence among the sample children was low. The contrast in diarrhoeal rates between the control and intervention baseline samples (about 3:1) probably reflects seasonal conditions. A longitudinal study in Bangladesh documented that the diarrhoeal rate in August was three times higher than in September [40]. Therefore, the baseline survey results are not comparable between the intervention and control sites.

Although we attempted to estimate the diarrhoeal rate at the intervention site at the time of baseline at the control site, it has often been reported that estimates based on recalls longer than two weeks are inaccurate. In fact, long-term recall underestimates actual rates by as much as 44% [42]. We believe that our estimate of the diarrhoeal rate two months prior to the interview was probably much less than the actual rate. If our estimate of the baseline diarrhoeal rate (56%) was similar to the rate at the control site but lower than the actual rate, it supports our conclusion. Moreover, the longitudinal study of the same intervention [16] suggests the same conclusion.

A major failure to overcome problems of flooding diminished the real effect of the intervention at its end. One of the messages recommended depositing children's and animal faeces in a pit at the edge of the courtyard. During floods, this collection of faeces contaminated the source of bathing, washing, and cooking water at the intervention site and may have caused an increase in diarrhoea. A longitudinal study at the intervention site [43] found very high rates of diarrhoea in children whose families had flooded faeces pits. In contrast, at the control site faeces were usually thrown into the fields and dried up in the sun (N.U. Ahmed, personal observation, 1986), and so that site had lower levels of contamination than the intervention site.

Moreover, analysis of the baseline survey data reported elsewhere [44] showed that households with no latrine facilities used the field for defecation, and their children had fewer episodes of diarrhoea than children of households with latrines. This led us to believe that this specific intervention was detrimental in flood conditions. In future, it could be recommended that the faeces in the pit should be covered with dust or soil in layers every few days and then, when a given level is reached, that the pit should be filled with enough soil to seal it and a new pit made for further use [16].

Growth effects

There is commonly a positive association between the socio-economic condition of the family and weight for age [34–37]. In this study, however, despite the intervention families having lower socio-economic conditions, their children displayed higher growth status.

In addition to protecting growth through less diarrhoea, the intervention taught mothers to practise better food hygiene, which may have reduced the level of contamination and hence led to better absorption of nutrients by the children. Food hygiene intervention, however, may have had a negative effect on height for age caused by the successful campaign to reduce bottle-feeding [16], which inadvertently also reduced milk consumption.

Conclusion

Unhygienic practices can be altered by a combination of mothers' proper understanding of germ theory, of the detrimental effect of unhygienic behaviours on health, and of ways and benefits of hygienic practices. Although this conclusion is consistent with another study [45], it may be possible for community mothers to imitate the hygiene practices of project workers and volunteer teachers without understanding germ theory. Analysis of the same intervention data [16], however, found a highly significant positive correlation between the mothers' understanding scores and their rates of adoption of hygiene practices as well as their cleanliness scores, after controlling for mothers' education, mothers' age, children's sex and ages, household possessions, and agricultural wealth. We believe that if the hygiene-related messages are need-oriented, specific, simple, feasible, and suitable for the particular setting, the potential for their adoption among the target population tends to be very high.

Almost all the intervention recommendations were accepted by 90%–100% of the target-community mothers except for the use of tube-well water for cooking (25%), feeding no leftover food to the baby (75%), boiling the feeding bottle and nipple (50%), and replacing old, sticky bottle nipples (67%). These recommendations were less acceptable mainly for economic reasons. Food cooked with tube-well water was reported to taste of iron, discolour, and spoil faster. Many families could not afford to cook fresh food frequently or to avoid giving leftover food to the children. The failure of these aspects of the intervention suggests problems of poverty that may not be solved by education alone [16].

The findings of this study lead us to conclude that the higher levels of mothers' education, better socio-economic conditions, and intensive observations at the control site resulted in favourable outcomes there. Although these better conditions could have worked against our finding a large difference between the sites, nevertheless the intervention both compensated for the less favourable conditions and produced better outcomes.

Our conclusion regarding evaluation measures is that the repeat cross-sectional survey may be adequate for measuring relatively stable outcomes such as knowledge, practices, and cumulative growth status. It is not adequate for measuring morbidity, which fluctuates seasonally. It may be recommended that recall data collected at weekly or at least two-weekly intervals will provide adequate measures of morbidity.

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