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LACK OF IMPACT OF A WATER AND SANITATION INTERVENTION ON THE NUTRITIONAL STATUS OF CHILDREN IN RURAL BANGLADESH

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The nutritional impact of a water and sanitation intervention in a rural community of Bangladesh, comprising the provision of handpumps, construction of latrines and hygiene education was assessed. During 3 years, the quarterly anthropometric measures of about 200 children aged 12–35 months from the intervention community were compared with those of a similar number of children from a control area. The interventions reduced the incidence of diarrhoea by 25 per cent among the children less than 5 years of age. There was no significant difference in nutritional status, however, between the two groups of children. Moreover, within the intervention area, indicators of water and latrine use were not significantly related to the children's nutritional status. This suggests that either the obtained reduction of diarrhoea was not large enough to have an impact on nutritional status or that diarrhoea is not an important cause of malnutrition in this community.

Efforts to quantify the health improvements obtained from water and sanitation inverventions have often led to conflicting results. Differences may be partly attributable to the difficulty of defining the incidence, prevalence and severity of diarrhoea in the field. To overcome this difficulty, the use of nutritional anthropometry has been advocated to assess the health impact of water and sanitation inverventions (Chen, 1983; Esrey & Habicht, 1986; The Imo State Evaluation Team, 1989). Also, because anthropometric measures are well standardized and comparatively easy to obtain, they may be better indicators of the impact of hygiene interventions than information on diarrhoea.

In this study, nutritional data from a water and sanitation intervention from rural Bangladesh, which achieved a significant reduction in diarrhoea incidence, are analysed to assess the validity of this intergrated approach.

Materials and methods

A Handpump Project (Aziz *et al.*, 1989) took place in a rural area of Bangladesh, near the town of Mirzapur, about 60 km north of Dhaka. In this area, 77 per cent of the families were Muslim and 49 per cent of adult males and 78 per cent of adult females were illiterate. Most men were engaged in agricultural activity or daily waged labour, while women worked mainly in the home. Rainfall is seasonal, occurring mostly in the period of June to October. Maximum temperatures range between 25 °C and 35 °C.

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To evaluate the impact of this project, two areas separated by a distance of about 5 km were studied: an intervention area of two villages, with approximately 5000 inhabitants and a control area of three villages with a population of about 4600 inhabitants. The intervention and control areas were selected carefully keeping in view their similar socio-economic characteristics. Both the areas were at an almost equal distance from a hospital and no major epidemic of any disease occurred in either of these areas during the study period. Handpumps, latrines and hygiene education were provided only to the intervention area. Oral rehydration therapy for children suffering from diarrhoea and referral to a nearby hospital for critically ill children were offered in the two areas.

In December 1983, a census of the study area was conducted to collect baseline socio-demographic data and to compile a demographic data base. This data base was updated at monthly intervals with the recording of all births, deaths, marriages and migrations until the end of the study in December 1987. Children under 5 years of age represented 14 per cent of the study population.

The project started with the installation of simple robust handpumps during the last trimester of 1984, each serving groups of about 30 users. This was followed by installation of a double-pit water-sealed latrine in every household. A continuous hygiene education programme started in 1985 to motivate the members of this community to use these new installations and to improve knowledge, attitudes and practices related to health.

From March 1984, detailed data on diarrhoea were collected on children under 5 years of age using weekly recall by the child's mother or caretaker in interviews conducted by female community workers. An anthropometric survey was conducted in October 1984 using standard procedures (WHO, 1983), and was repeated at 3-monthly intervals. Measurements of height and weight were made on children less than 3 years of age by trained female Community Health Workers (CHWs) with at least 10 years of schooling. Three teams consisting of one CHW assisted by a porter conducted the surveys. Nude or lightly clothed children were weighed to the nearest 0.1 kg on a Salter Scale, which was regularly checked against standard weights. Recumbent length for children less than 2 years of age was measured to the nearest 1 mm on a locally made wooden length board with a sliding foot-board. Children over 2 years were measured with a height stick firmly secured to a solid wooden base and equipped with a flat movable arm.

Analysis of the impact of the project on nutritional status was restricted to children aged 12–35 months. This age group was chosen since the impact of diarrhoea on growth is pronounced among them (Rowland, Cole & Whitehead, 1977) and it was believed that their anthropometric indicators would be most sensitive to the effect of intervention. Anthropometric measures were referred to the NCHS standards (Hamill *et al.*, 1979). Nutritional indices for weight-for-age (W/A), height-for-age (H/A), and weight-for-height (W/H), were calculated in Z-scores, representing the difference of an anthropometric measure from the NCHS reference expressed in standard deviation units (WHO Working Group, 1986).

Nutritional differences between the intervention and control areas were measured by comparing mean Z-scores. Due to the heterogeneous user pattern of the improved facilities within the intervention area, comparisons of nutritional status were also made between subgroups in this area. For these latter comparisons, the average nutritional status for each child for 1986 and 1987 was computed. T-test or a one-way analysis of variance, whenever appropriate, were used to compare means (Armitage, 1971).

Results

On average, for each anthropometric survey, complete data were available for 213 and 192 children aged 12–35 months in the intervention and control areas respectively. The mean age of children studied in each area was 23 months.

The intervention had a considerable impact on diarrhoea in children under 5 (Aziz *et al.*, 1989). Baseline diarrhoea incidence rates (1984) were similar in the intervention and control area (3.85 and 3.75 episodes per year per child respectively). These steadily declined to 2.34 and 3.12, respectively in 1987 (incidence density ratio: 0.75, 95 per cent CI: 0.70–0.80). This impact was evident in all seasons and in all age groups, except those aged less than 6 months of age. The reduction in the age group (12–35 months) studied here was slightly more than 25 per cent (Aziz *et al.*, 1989).

The variations in nutritional indicators throughout the study period are presented in Figs 1 to 3 by area. The mean W/A Z-scores ranged between −2.4 and −3.0 and were similar in the two areas. Nutritional status as measured by this indicator was best around December/January, and worst in September and October, when food is in short supply and there is a low demand of labour. The effect of seasons on each of the nutritional measures was significant ($P < 0.01$). There was also a significant ($P < 0.01$) upward trend in the mean W/A and H/A of Z-scores over time in both areas.

Mean W/H Z-scores ranged between −1.1 and −1.6, and followed the same seasonal pattern as W/A. They were similar in the two areas and were also highest in December/January and lowest in September.

In both areas the mean H/A Z-scores were between −2.3 and −3.0, showing a high degree of stunting in this population. In the first two surveys, children in the intervention area had a lower H/A Z-score than those in the control area but these differences were not statistically significant. Thereafter the mean Z-scores were similar in the two areas and showed a steady increase over time until the last two surveys.

Within the study area, none of the nutritional indicators showed a significant association with the distance from the handpump (Table). However, disposal of

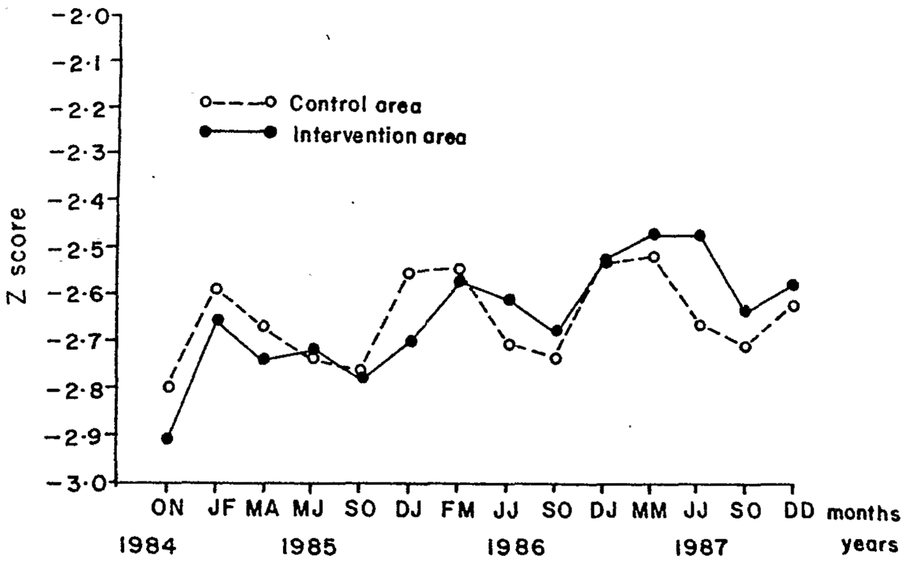

Fig. 1. *Variations of weight-for-age during the study.*

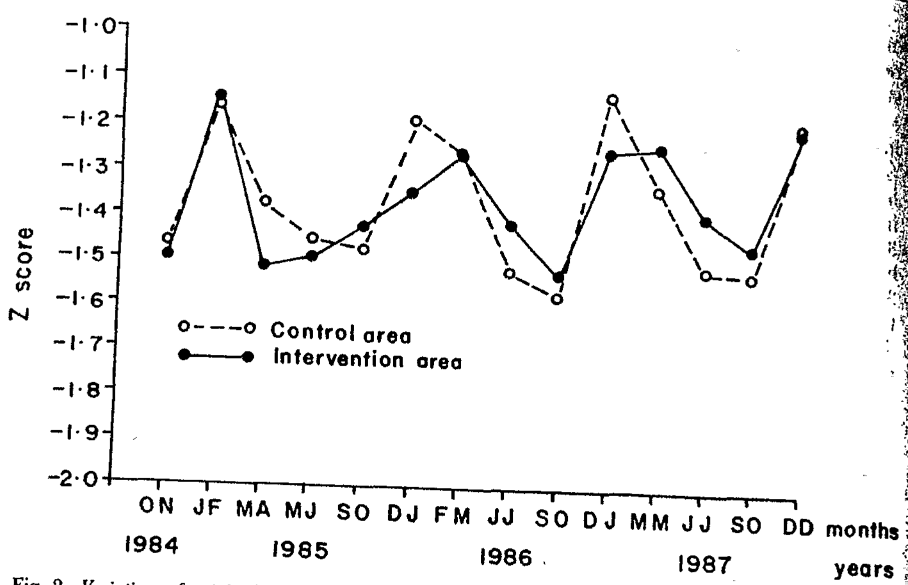

Fig. 2. *Variations of weight-for-height during the study.*

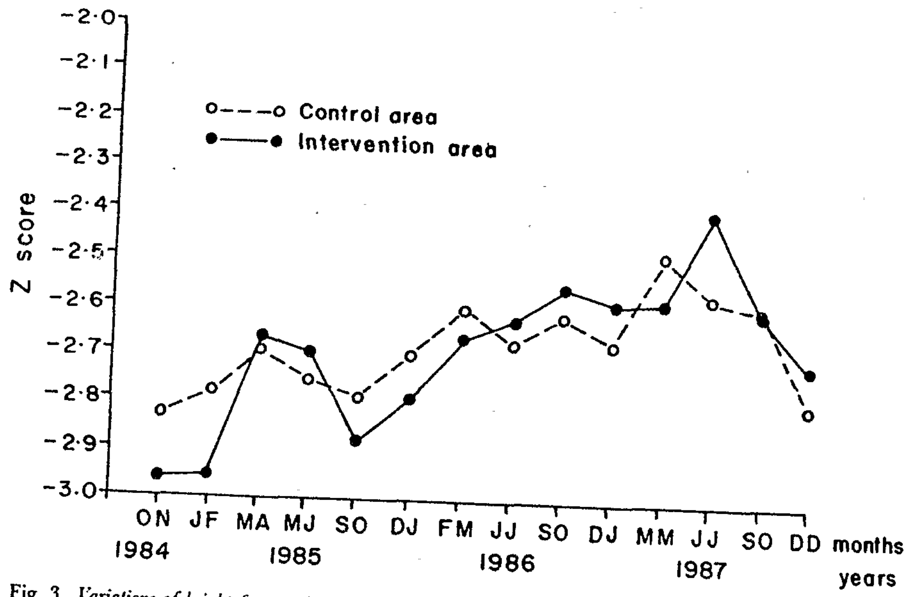

Fig. 3. *Variations of height-for-age during the study.*

Table. *Nutritional status (by Z-score) in relation to water and hygiene indicators for children from the intervention area.*

Risk factor	*1986* *W/A*	*H/A*	*W/H*	*1987* *W/A*	*H/A*	*W/H*
Handpump-distance						
<25 m	−2.62	−2.59	−1.39	−2.58	−2.54	−1.35
25–49 m	−2.56	−2.57	−1.34	−2.63	−2.59	−1.42
50+ m	−2.57	−2.57	−1.33	−2.47	−2.52	−1.23
P-value*	0.9	>0.9	0.9	0.3	0.8	0.1
Defaecation of children/disposal of faeces in latrine						
Yes	−2.54	−2.52	−1.34	−2.43	−2.50	−1.21
No	−2.58	−2.60	−1.35	−2.62	−2.57	−1.40
P-value	0.7	0.5	0.9	0.05	0.6	0.01
Use of handpump water for all major domestic activities in the wet season						
Yes	−2.76	−2.77	−1.48	−2.62	−2.62	−1.36
No	−2.51	−2.50	−1.29	−2.48	−2.51	−1.27
P-value	0.01	0.02	0.03	0.2	0.3	0.3

*One-way analysis of variance or *t*-test was used to compare group means.

faeces of children in the latrine has some significant effects on W/A and W/H in the last year of the study. Better patterns of children's defaecation and disposal of faeces were associated with higher W/A and W/H Z-scores at the end of the study period, but surprisingly, exclusive use of handpump water was associated with a significantly higher level of malnutrition in 1986 (Table).

Discussion

Although the incidence of diarrhoea in the invervention area after the water and sanitation interventions was 25 per cent lower than in the comparison area, there is no evidence that this was associated with an improvement in nutritional status. This can be explained in different ways. First, an overestimation of the impact of the project on diarrhoea incidence has to be considered. Project staff and the community under investigation knew that the aim of the study was to decrease the diarrhoea incidence and an under-reporting of diarrhoea episodes in the intervention area cannot be ruled out. Hence it is possible that the actual impact of the intervention on diarrhoea incidence was smaller than reported here and not large enough to affect the nutritional status of children. Investigators, however, were aware of this possibility and made all efforts during training and supervision to ensure that such a bias would not occur. Moreover, the magnitude of the difference of diarrhoea incidence between the two areas and its consistency over time make this explanation unlikely.

Another interpretation of the present finding is that diarrhoea is not the major determinant of nutritional status in rural Bangladesh. This hypothesis is supported by the pattern of seasonal variation of nutritional status and diarrhoea: malnutrition is most prevalent in September and October when food availability is at its lowest and also when diarrhoea incidence is low. On the other hand, malnutrition is at its lowest level during the annual peaks of diarrhoea between March and May (Aziz *et al.*, 1989). Similar seasonal variations of diarrhoea incidence and prevalence of malnutrition were reported in previous studies from a similar community (Black *et al.*, 1983; Brown, Black & Becker, 1982). Food availability, and not diarrhoea incidence, may be the most important factor determining nutritional status in rural Bangladesh.

Our findings are at odds with those of previous studies from St Lucia (Henry, 1981), Lesotho (Esrey *et al.*, 1988) and Nigeria (Huttly *et al.*, 1989), which suggested that improvement of water supply and sanitation had a favourable impact on the nutritional status of children. This may be due to different levels of diarrhoea incidence, of malnutrition, or of food availability in different settings. It may be also that in these projects, nutritional status improved independently of the effect that the water supply had on the prevalence of diarrhoea. The study from Lesotho reported an improvement of nutritional status despite slightly higher diarrhoea rates in children from families who had access to improved water supply (Esrey *et al.*, 1988). Provision of water near the house saves time for the mothers who become available for child care and this may also explain some of the findings. Trace element composition of different sources of water is rarely examined and may also explain an effect of water supply on growth independent from diarrhoea. Maybe the lower nutritional status observed in this study among children from households exclusively using handpump water can be explained in these terms.

The level of input also varies between studies and this may explain the difference of the results: water and sanitation interventions may have an effect on diarrhoea morbidity only after a low level of environment contamination has been reached (Kawata, 1978; Shuval *et al.*, 1981). It is possible that the individual household water supply provided in St Lucia was more effective to reduce diarrhoea, and hence to improve nutritional status, than handpumps provided in Bangladesh.

Our results also conflict with two other studies from Nigeria (Tomkins, 1978) and India (Hebert, 1984) showing an association between type of water supply and nutritional status of young children. These studies, however, were observational and the confounding effects of socio-economic factors cannot be ruled out to explain their findings.

The level of reduction of diarrhoea achieved in the intervention area of this study could not bring about an impact on the nutritional status of the children. To achieve a strong effect on nutritional status perhaps a greater reduction in diarrhoea is essential. This was found to be the case in the studies conducted among the infants in the poor districts of greater Khartoum (Zumrawi, Dimond & Waterlow, 1987) and among the Gambian village children between the ages of 0.6 and 3 years (Rowland, Cole & Whitehead, 1977).

The lack of impact of this intervention on nutritional status does not mean that it had a negligible health impact. Diarrhoea is associated with an increased risk of dying independently of its effect on nutritional status (Briend, Wojtyniak & Rowland, 1987) and its reduction may result in a lower mortality, even in the absence of any visible nutritional impact.

In summary, this study suggests that the impact of water and sanitation interventions may remain undetected if assessed by measures of nutritional indicators and that measures of diarrhoea indicators are still needed to assess their efficacy. It also suggests that water and sanitation interventions, however useful they may be to prevent diarrhoea, may not be an effective approach to prevent malnutrition in many areas of rural Bangladesh.

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