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Community-based Hygiene Education to Reduce Diarrhoeal Disease in Rural Zaire: Impact of the Intervention on Diarrhoeal Morbidity

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Haggerty P A (Centre for Human Nutrition, London School of Hygiene and Tropical Medicine, 2 Taviton St., London WC1H 0BT, UK), Muladi K, Kirkwood B R, Ashworth A and ManunEbo M. Community-based hygiene education to reduce diarrhoeal disease in rural Zaire: Impact of the intervention on diarrhoeal morbidity. *International Journal of Epidemiology* 1994; **23**: 1050–1059.

Background. Diarrhoeal disease is a leading cause of morbidity in young children in rural Zaire. Few diarrhoea prevention programmes have been implemented in Bandundu Province, where available data suggest an annual prevalence rate of 10%. The urgent need to reduce diarrhoeal morbidity in Zaire, together with the potential effectiveness and feasibility of hygiene education as a diarrhoea prevention strategy, led to the development of the present research project.

Methods. A randomized, controlled trial of an education intervention to reduce diarrhoea through improved personal and domestic hygiene behaviours was conducted in 18 geographically separate village clusters (sites) in rural Zaire. For 12 weeks baseline information on the diarrhoeal morbidity of 2082 children aged 3–35 months was collected at weekly home visits, and structured observations of hygiene practices related to diarrhoea were made on a subset of 300 families. Intervention messages addressed disposal of animal faeces from the yard, handwashing after defecation and before meal preparation and eating, and disposal of children's faeces. Three months after the start of the intervention and exactly 1 year after the baseline studies, a second diarrhoeal morbidity study and a second observational study were conducted in order to evaluate the intervention.

Results. Children in intervention communities experienced an 11% reduction in the risk of reporting diarrhoea during the peak diarrhoeal seaon, compared to controls ($P < 0.025$). The largest differences were seen among children aged 24–35 months, with those from intervention communities reporting significantly fewer episodes, shorter mean durations and hence fewer days of diarrhoea. There was some evidence that greater reductions in diarrhoea occurred in sites where the quality of the intervention, a scored measure of volunteer efficacy and community participation, was highest.

Conclusions. The results of this study suggest that hygiene education may be an effective approach to reduce the incidence and duration of diarrhoeal episodes in rural Zaire. Children aged 2 years appear to benefit the most. A Hawthorne effect of the education may contribute to diarrhoeal reductions.

Despite remarkable improvements in diarrhoeal mortality due to improved case management and the use of oral rehydration therapy (ORT), diarrhoea still accounts for about one-third of all deaths among children under 5 years and for much morbidity. Practical inexpensive methods to reduce diarrhoeal morbidity and lower mortality are still needed in poor countries.

Many studies have suggested that the promotion of good hygiene may be an effective diarrhoea prevention strategy, yet our understanding of the potential impact of hygiene education is incomplete. Only a small number of interventions aimed at specifically improving personal and domestic hygiene have been planned. Feachem's estimate[1] that effective educational programmes may reduce diarrhoeal incidence by as much as 48% was based on just three studies, two of which focused exclusively on handwashing and were conducted in highly controlled clinic or nursery settings; such large reductions may not be possible in less controlled environments. Substantial reductions in diarrhoeal incidence were reported more recently from

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community-based randomized trials in Burma[2] and Bangladesh.[3] However the findings from these studies are also difficult to apply generally. In Burma the intervention addressed just one behaviour, i.e. handwashing, and therefore no inferences can be drawn about the effectiveness of hygiene education when other behaviours are included. In Bangladesh, despite improvements in diarrhoea incidence behaviours targeted by the intervention did not appear to have improved, making interpretation of that trial's results problematic. The urgent need to reduce diarrhoeal morbidity, together with the potential effectiveness and feasibility of hygiene education as a diarrhoea prevention strategy, led to the development of the research project described below.

In this report the results of a randomized controlled trial of a community-based educational intervention designed to reduce diarrhoeal morbidity in children in rural Zaire are described. The intervention was based on four key messages intended to influence personal and domestic hygiene practices, including: (1) disposal of animal faeces from the yard by sweeping twice per day; (2) handwashing before meal preparation and before eating, (3) handwashing after defecation and washing both the child's buttocks and hands after the child had defecated; and (4) proper disposal of children's faeces.

MATERIALS AND METHODS

The study took place in a rural region around Kikwit in Bandundu Province, Zaire. A baseline survey of the diarrhoeal morbidity of 2082 children aged 3–35 months (from c.1875 families) residing in 18 geographically separated sites was conducted between October and December 1987. Concurrently, 300 randomly sampled sentinel families were visited once for prolonged, structured observations of child feeding and hygiene practices postulated to be related to diarrhoea. The observational data were used to identify potential behavioural risks for diarrhoea and to facilitate the design of key hygiene messages that were the basis of a community-based educational intervention.

Following the baseline diarrhoeal and observational studies, all sites were ranked from lowest to highest according to age-adjusted mean days of diarrhoea. Thus ordered, the first two sites were grouped to form a pair (pair 1), and each two subsequent sites were similarly grouped (pairs 2–9), and then one in each pair was chosen at random to receive the intervention, the other to serve as a control. Thus nine sites participated in an educational programme intended to reduce diarrhoeal morbidity through improved hygiene practices, and the nine remaining sites served as controls. The intervention was implemented from July to December 1988 by trained community volunteers. Three months after the start of the intervention, a second diarrhoeal and second observational study were undertaken, using the same methods used at baseline 1 year earlier. Diarrhoeal morbidity and hygiene behaviours related to the educational messages were then compared between the intervention and control communities.

Acquisition of Observational Data

At each site approximately 16% of families with study children or 300 sentinel families in total, were randomly chosen for an observational study of child feeding and personal and domestic hygiene practices related to diarrhoea. A family consisted of people residing together and sharing the same cooking pot. For each sentinel family a replacement family was also randomly chosen, the replacement being included in the study if the original family moved or declined to participate.

Ethnographic data were first obtained by trained field workers (observers) using focus groups and 24-hour activity recalls among women in non-study villages. These data were used to develop a structured observation recording form which was extensively pretested. At each site, for sentinel families, observations were made of hygiene in the home and the yard, water use and storage, food preparation and consumption, child defecation and child care patterns. In addition, timed observations were made of target child activity and caretaker practices related to breastfeeding and feeding the child other liquids/solids. Visits were announced on the previous day to ensure that women would be at home, although the purpose of the visit was not revealed. Each visit began at 0600 h and lasted up to 7 hours. At the time of the visit observers explained only that they wished to observe the typical activities of young children that could be related to their health, and asked that family members take no notice of the observer and conduct their activities as usual. Observers remained outside the home and refrained from eating with the family until the observations were complete.

Each of the observers was assigned to families randomly, and was blind to the diarrhoeal histories of these families. At the end of each day observers reviewed each other's observation forms and the team leader reviewed the forms a second time to ensure that any errors or omissions were corrected. Following completion of observations at each site, the forms were sent to the central office in Kikwit, where the data were coded on a separate form before entry into a microcomputer.

Educational Intervention

Formulation of the intervention. In developing an educational intervention to improve personal and domestic hygiene, our goal was to develop three or four key mesages focused on behaviours that could be observed and changed within a relatively short time, using existing community resources at relatively low cost. We reasoned that messages should promote behaviours already practised by some in the community and that could be shown to correlate with reduced rates of diarrhoea.

Message development was based on comparative analysis of diarrhoeal rates established from the community survey, ethnographic data and observed hygiene practices. In addition, we used empirical evidence from other studies[1,4–6] which demonstrate associations between certain hygiene practices (specifically, handwashing and disposal of faeces) and reduced rates of diarrhoea. Four messages were developed, including: (1) disposal of animal faeces from the yard by sweeping at least twice per day; (2) handwashing before meal preparation and before eating; (3) handwashing after defecation and washing the hands and buttocks of young children following defecation, and (4) disposal of children's faeces. When promoting yard sweeping, the removal of sweepings into a proper garbage pit was emphasized. Disposal of child faeces emphasized digging, or improving, pit latrines and the promotion of handwashing encouraged the use of soap.

Implementation of educational intervention. The four key messages formed the basis of a non-formal educational programme implemented at intervention sites by female residents, called community volunteers. Two or three female volunteers, selected from each site by community leaders were trained intensively for 1 week by two experienced, university-educated women (trainers) working with the project director in Kikwit. Trainers planned non-formal lessons based on culture-specific experience, and illustrated the messages using songs, stories, proverbs, analogical reasoning, and locally drawn posters. Trainers emphasized the use of village-wide meetings, home visits and small-group discussions as strategies to disseminate messages and monitor message implementation.

Intervention monitoring. Trainers travelled to each of the sites periodically to monitor the activity of the volunteers, to document the community participation process, and to reinforce the volunteers' training. At these visits they met individually with volunteers and community leaders, held group meetings, helped volunteers resolve difficulties, and made unannounced visits to random families to observe message implementation. For each site they kept a log of qualitative observations assessing the volunteer's performance and community involvement using indicators, including: the number of community members recruited to assist the volunteers; the frequency of meetings and group discussions; the frequency of home visits; the frequency of problems encountered and actions implemented to resolve them; perceived changes in village hygiene practices; and perceptions of villagers' knowledge and awareness of messages. Intervention and monitoring continued for 6 months.

Activities in control sites. In order to control for the potential Hawthorne effect of the intervention on hygiene practices, i.e. the possibility that behaviour might change due to the care and attention given to intervention communities, we felt it was necessary to develop a service or educational programme for control sites, and that any such 'placebo intervention' needed to be implemented with the same intensity and quality of resources as for the intervention sites. We considered several placebo interventions unrelated to diarrhoea, but rejected them because they risked undermining our credibility, because villagers would find it incongruous for us to collect weekly diarrhoea data if we were concurrently promoting an intervention to reduce, for example, malaria. Therefore a 'control intervention' was developed, based on two key messages intended to prevent dehydration during a diarrhoeal episode: (i) continue to breastfeed the child during a diarrhoeal episode, and (ii) give rice water to the child during diarrhoea. These messages were selected for control sites on the premise that they would be unlikely to influence diarrhoea incidence, although they could possibly reduce the duration of episodes. Community volunteers from control sites were selected and trained in the same way as intervention site volunteers, although their training was separate. Posters, songs, proverbs and slogans were developed for the control volunteers' training. Monitoring of activities at the control sites was conducted in an identical manner to that at the intervention sites.

Evaluation of the Intervention

Beginning 3 months after the start of the intervention, exactly 1 year after the baseline studies, a second diarrhoeal morbidity study and a second observational study of hygiene practices were conducted, in order to evaluate the impact of the intervention on diarrhoeal morbidity, hygiene practices and child growth. Approximately one-third of the total study sample at baseline had entered their fourth year of life and were therefore too old at follow-up, hence these children were replaced by an equal number of new infants. A new subsample of 293 sentinel families was randomly selected for the follow-up observational study.

Data collection methods during the follow-up study were the same as those used during baseline, with a few exceptions. The observation recording form was revised to record mainly behaviours addressed by the intervention and was, therefore, more focused. For the community survey, interviewers were placed at sites where they could speak the same dialect of the local language as the residents. At baseline this factor had not been considered.

Data Analysis

To evaluate the impact of the intervention on diarrhoeal morbidity, data analysis was conducted separately for sites and for children. For the site-level analyses, the age-adjusted mean number of episodes at each site (i.e. the site incidence rate) was calculated and adjusted for age, and statistical tests were based on the variation between sites.[7] Both pre- to post-intervention changes in diarrhoea between intervention and control sites and post-intervention differences in diarrhoea were studied. Analyses also took into account the baseline levels of morbidity and the quality of the intervention at each site. Non-parametric tests were used throughout these analyses.

For the child-level analyses, during the pre- and post-intervention periods the number of episodes of diarrhoea, the total number of days with diarrhoea, and mean duration of diarrhoeal episodes were studied according to the child's age, sex and study group, using either standard normal deviate (SND) tests or analyses of variance. The number of episodes and of days of diarrhoea were adjusted for incomplete follow-up, and a logarithmic transformation was used to study the number of days with diarrhoea. Both the number of days with diarrhoea and the mean duration of episodes were adjusted for reporting discrepancy: these methods are described in an earlier report.[8] Chi-squared tests or χ^2 tests for trends were employed, where appropriate, to compare distributions of the diarrhoea variables grouped into two or more categories.[9,10]

We present results of analyses concerning all reported episodes of diarrhoea. Additional analyses of severe episodes with blood, or fever, or both, and persistent episodes, will be described in a separate report.

RESULTS

Of the 1954 children enrolled in the follow-up study, 1764 (90.3%) had $\geqslant$9 complete weeks of diarrhoeal morbidity data. The remaining 190 were excluded from the analyses. In four children with $\geqslant$9 weeks of data, information on age was not reliable and they were therefore excluded from analyses involving this variable.

Comparability of Study Groups at Baseline

Table 1 shows that matching and randomization of sites largely equalized diarrhoeal rates between the two study groups, although there was still considerable inequality in incidence rates within pairs, particularly in pairs 6–9. Despite randomization, overall the control group had episodes of slightly longer duration than the intervention group ($P < 0.02$).

TABLE 1 *Baseline darrhoeal rates in matched pairs of sites in Bandundu, Zaire, during 12 weeks of study, October–December 1987*

Pair	Geometric mean days		No. of episodes		Duration of episodes	
	Intervention	Control	Intervention	Control	Intervention	Control
1	0.82	0.58	0.49	0.38	3.80	3.23
2	0.87	0.92	0.46	0.56	3.50	4.00
3	1.80	1.97	0.96	1.15	5.32	3.58
4	2.10	2.21	1.41	1.35	3.72	3.14
5	2.52	2.26	1.31	1.27	3.44	3.97
6	3.34	6.15	1.19	2.71	6.84	3.33
7	10.51	8.60	3.29	2.64	3.92	4.86
8	14.71	13.24	3.17	2.38	5.45	7.94
9	18.78	18.97	4.59	3.39	4.71	6.96
All	4.15	4.44	1.93	1.82	4.70	5.15

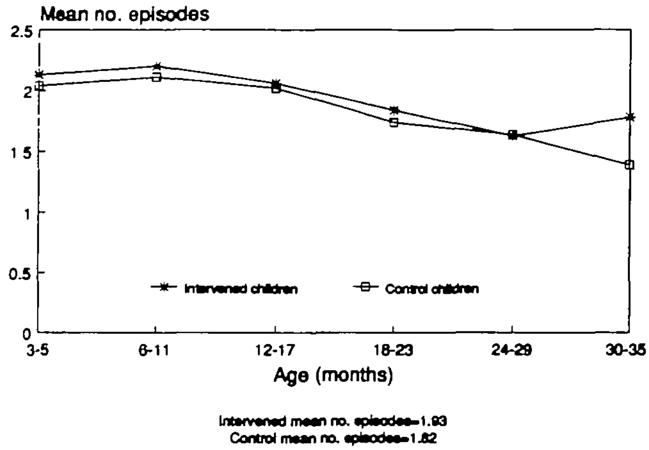

FIGURE 1 *Baseline diarrhoea rates during 12 weeks October–December 1987*

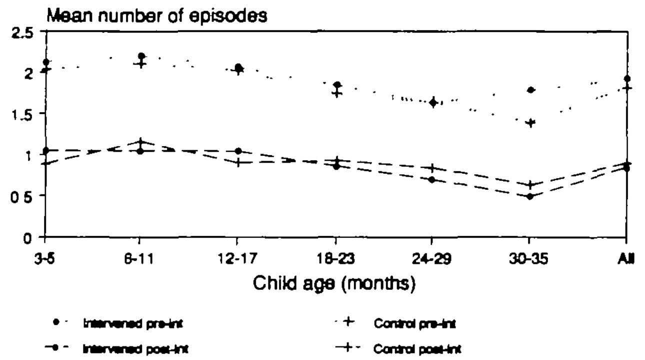

FIGURE 2 *Mean number of episodes of diarrhoea pre- and post-intervention, according to child age and study group*

In both study groups, an average of about two episodes of diarrhoea per child were reported and episodes declined with age from infancy to 35 months (Figure 1). The mean reported duration of episodes was approximately 5 days in both groups.

Pre- to Post-intervention Reductions in Diarrhoeal Rates in Intervention and Control Children

During the post-intervention period, diarrhoeal morbidity was greatly reduced relative to the previous year among all children in both study groups. Diarrhoeal incidence rates declined by approximately 50% in each group (Figure 2), and the reductions were highly significant within each age category in both groups (SND tests, $P < 0.0001$ in every case). The mean durations of episodes declined from the pre- to post-intervention periods in both study groups also, but mainly among children aged $\geqslant$24 months.

Pre- to Post-intervention Changes in Diarrhoeal Incidence at Intervention and Control Sites

To differentiate the impact of the intervention from the overall observed reduction of diarrhoea, the changes in site incidence rates from the pre- to post-intervention periods in both intervention and control sites were compared. In six out of nine sites in each study group incidence rates declined (Figure 3). At the three control sites where post-intervention incidence rates were actually worse (pair numbers 1, 2 and 4), the increases were larger than at the three intervention sites where incidence rates worsened (pair numbers 2,3 and 5). The overall difference in the percentage reduction of diarrhoea between the nine intervention and nine control sites was tested using the Wilcoxon signed rank test, taking the pairing of sites into account. This test was not significant ($P = 0.51$). When the same test was applied to compare differences between intervention

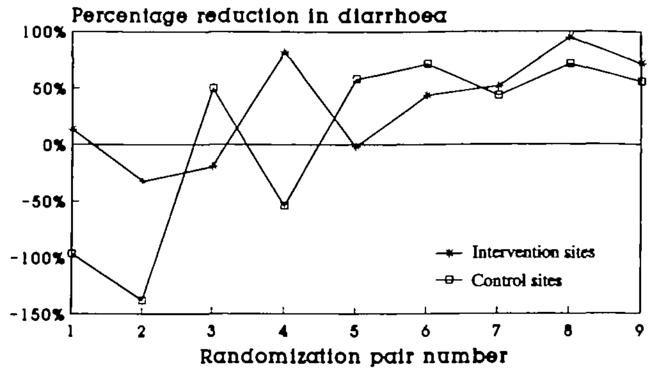

FIGURE 3 *Percentage reduction in diarrhoea according to baseline matched pairing of sites*[a]

[a] Sites ordered and grouped into pairs for randomization, using baseline mean no. days of diarrhoea (Table 1)

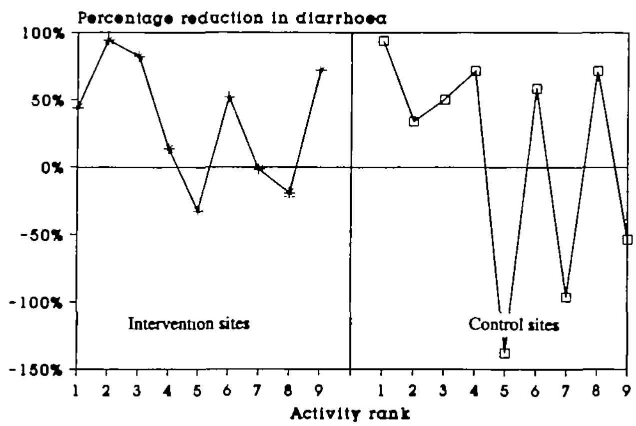

FIGURE 4 *Percentage reduction in diarrhoea by site activity rank*

and control site incidence rates stratified by child age, there were, once again, no significant differences between the study groups.

Lastly, percentage reductions were compared taking into account the quality of the volunteers' activities and community participation. Figure 4, which gives intervention activities ranked from best (1) to worst (9), shows that the percentage reductions were greater at intervention compared to control sites. However, the Wilcoxon signed rank test indicated that the differences in percentage reductions between sites with equal activity ranks were not significant ($P = 0.44$). There were, furthermore, no differences between intervention and control sites when site incidence rates were stratified by child age.

Correlates of Pre- to Post-intervention Reduction in Diarrhoea

Whilst there were no apparent differences between the study groups in the pre- to post-intervention percentage reductions in diarrhoea, either according to randomization pair number or to intervention activity rank, Figures 3 and 4 indicate that diarrhoeal reductions may have been associated with pair number and with activity rank. In Figure 3, percentage reductions appear to increase with increasing pair number (i.e, with increasing baseline incidence rates). Similarly, an association between the percentage reduction in diarrhoea and intervention quality is suggested by Figure 4. When the closeness of this association for all sites considered together, and for site incidence rates stratified by child age, were tested using Kendall's rank correlation coefficient (W), no significant correlation emerged.

Comparison of Post-intervention Diarrhoeal Rates between Intervention and Control Children

One year after baseline, overall, children in intervention sites had a reported mean of 0.85 episodes of diarrhoea, while children in control sites had 0.90 episodes

(NS). Diarrhoeal incidence declined with age in both groups (Figure 2) and was lower in the third year of life among intervention compared with control children, however this was not statistically significant (P = 0.09).

There was no discernible evidence of a trend towards fewer episodes of diarrhoea in intervention compared to control children after the intervention (Table 2). Nevertheless, proportionately fewer children in intervention sites were reported to have diarrhoea than at control sites. The relative risk of a child reporting diarrhoea at any time during the post-intervention surveillance period at intervention sites was 0.89 of that of controls (95% confidence interval [CI]: 0.84–0.98), representing an 11% reduction in reporting risk ($P < 0.025$).

TABLE 2 *Distributions of children between study groups according to number of episodes of diarrhoea, post-intervention*

Episodes No.	Intervention children No.	(%)	Control children No.	(%)	P
0	450	(54.9)	464	(49.1)	
1	192	(23.4)	266	(28.2)	
2	98	(11.9)	129	(13.7)	
3+	80	(9.8)	85	(9.0)	0.23*
0	450	(54.9)	464	(49.2)	
1+	370	(45.1)	480	(50.8)	< 0.02**

* Significance of χ^2 test for trend (1 df), 0–3+ episodes, χ^2 = 1.52.
** Significance of χ^2 test, 0 versus 1+ episodes, χ^2 = 5.53.

The intervention appeared to reduce the total time children had diarrhoea. Children with diarrhoea from intervention sites showed a significant trend towards shorter durations of episodes than those with diarrhoea from control sites (Table 3, P = 0.04). This trend was most evident in the proportions of children with durations >3 days. The reduction in the total time with diarrhoea was, not surprisingly, reflected in fewer days of diarrhoea among intervention compared to control children (χ^2 trend, $P < 0.025$).

The trend toward fewer total days of diarrhoea among intervention children, was apparent for all age categories except infants aged 3-5 months, and intervention children had, overall, a geometric mean of 1.4 days of diarrhoea, compared to 1.7 days for the control group (P = 0.04). The mean duration of episodes for all ages combined was similar in both study groups, about 4.2 days per episode, however intervention children aged 24–29 months had somewhat shorter episodes than control children of the same age (P = 0.08).

TABLE 3 *Distributions of children between study groups according to mean duration of episodes, post-intervention*

Mean duration of episodes (days)	Intervention children No.	(%)	Control children No.	(%)	P
1-<2	58	(15.7)	62	(12.9)	
2-<3	99	(26.8)	100	(20.8)	
3-<4	82	(22.2)	120	(25.0)	
4-<6	76	(20.5)	121	(25.2)	
6+	55	(14.9)	77	(16.0)	0.04*
Children No.	370		480		

* Significance of χ^2 test for trend (1 df), χ^2 = 4.20.

Comparison of Post-intervention Diarrhoeal Rates at Intervention and Control Sites

The impact of the intervention was evaluated further by analysing age-adjusted site incidence rates, since sites were the unit of randomization in this study (Table 4). For each randomization pair the Wilcoxon signed rank test was used to assess the significance of differences between sites with equal randomization pair numbers. This test was insignificant, as were similar tests considering site incidence rates stratified by child age.

To explore whether the impact of the intervention differed according to the quality of volunteers' activities and community participation, the site incidence rates were compared according to intervention 'activity ranks'. Post-intervention differences in incidence rates between sites of equal activity rank were studied, again using the Wilcoxon signed rank test. This test was not significant (P = 0.77), and further analyses (i.e. differential analyses by child age) were not pursued.

DISCUSSION

Because the intervention was addressed to communities, and not to individual households, the evaluation focused on the differences in diarrhoeal rates between the intervention and control sites. These analyses revealed few significant differences between the two study groups, either in the comparisons of post-intervention site incidence rates or the comparisons of pre- to post-intervention percentage reduction in incidence rates. These results do not signify that the intervention had no effect. The most likely explanation

TABLE 4 *Post-intervention diarrhoeal incidence rates at intervention and control sites according to randomization pair number*[a]

Pair	Intervention sites	Control sites	Incidence rate ratio[b] Adjusted	Crude	Intervention-control difference
1	0.44	0.74	0.57	(0.68)	−0.30
2	0.59	1.33	0.44	(0.62)	−0.74
3	1.11	0.58	1.91	(1.43)	0.53
4	0.25	2.13	0.12	(0.23)	−1.88
5	1.34	0.50	2.68	(1.80)	0.84
6	0.70	0.77	0.91	(1.00)	−0.07
7	1.57	1.50	1.05	(0.79)	0.07
8	0.15	0.71	0.21	(0.30)	−0.56
9	1.31	0.22	5.95	(2.93)	1.09
All	0.85	0.90	0.94	(0.89) $P = 0.03$[c]	−0.05 $P = 0.81$[d]

[a] Site incidence rates adjusted for child age. Randomization pair number based on ordering of sites matched according to baseline diarrhoeal rates.
[b] Incidence Rate Ratio. Adjusted column represents ratio of age-adjusted site incidence rates within pairs. Crude column represents ratio of relative risk within pair stratum (unadjusted for age).
[c] Significance of stratified Mantel-Haenszel summary estimate of incidence rate ratio (0.89). Mantel-Haenszel summary estimate and associated test based on crude relative risks within each stratum, thereby controlling for effect of site. Estimate not controlled for age.
[d] Significance of Wilcoxon signed rank test.

for the lack of statistical significance at site level is that comparisons were dependent on the variation among nine pairs of sites. In all probability, any differences between the study groups due to the intervention would need to have been quite large to be detected by the site-level analyses; these tests had little power to discern the moderate differences which the child-level analyses suggest are due to the intervention. In fact, when the Wilcoxon test was used to assess the differences between pre- and post-intervention site incidence rates, separately for intervention and control sites, the differences among the intervention sites approached significance ($P = 0.08$), whereas among the controls they did not ($P = 0.21$), suggesting that the aggregate decline in the intervention sites was larger.

Moreover, when child-level analyses were conducted, a Mantel-Haenszel summary estimate of the relative risk of diarrhoea in matched pairs of intervention and control sites (IRR = 0.89, $P = 0.03$), revealed that children at intervention sites experienced an 11% lower risk of diarrhoea than those in control sites with similar baseline rates. Children from intervention communities also had shorter durations of episodes and, hence, fewer total days of diarrhoea than children from control communities with comparable baseline rates. The largest differences were observed among children aged 24–35 months. In a similarly focused study of a hygiene educational intervention in Bangladesh[5] the impact was greatest in the 12–35 month age group. This suggests that personal and domestic hygiene practices may be more important aetiological factors for diarrhoea in these older children, than for infants. Children >12 months are breastfed less frequently, play farther away from the home and may be cared for by siblings only slightly older than themselves. Greater mobility and less direct maternal supervision would undoubtedly increase their risk of exposure to environmental contamination relative to younger children. In contrast, among infants, factors other than personal and domestic hygiene behaviours may be of relatively greater importance in determining diarrhoeal rates, e.g. the use of colostrum, the age of introduction of weaning foods, the use of non-human milk.

The fact that the intervention appeared to reduce the length of diarrhoeal episodes, particularly in the older children, raises the possibility that there may have been a differential effect of the intervention on specific pathogenic organisms known to be associated with longer episodes, e.g. shigella,[14] and that such organisms may be more amenable to hygiene education.

Analyses of the correlations of percentage reductions in diarrhoea with randomization pair number and with intervention activity rank were performed to determine whether the intervention had differential effects. It appeared that larger reductions occurred at sites with high baseline incidence rates for both intervention and control groups, however these differences were not borne out by statistical analysis. If the intervention did have a stronger impact on sites with the worst initial rates, it is possible that in these sites proportionately more bad behaviours were practised, and therefore the opportunities for correcting these behaviours were more numerous.

Similar results emerged from the study of the correlations between percentage reduction and intervention activity rank: although the correlation was not significant, the appearance of a possible correlation in the three intervention and three control sites having the highest scores suggested that greater reductions occurred in sites where community volunteers and/or residents were more enterprising. Differences in behavioural changes and in growth rates according to activity ranks (analyses not presented here) reinforce this view.

Whilst the comparison of the differences in diarrhoeal reductions between intervention and control sites provides a measure of the intervention's impact, the fact that incidence rates decreased markedly in both groups relative to baseline deserves attention. The most likely explanations for the large declines in both groups are either: (i) annual fluctuations in diarrhoeal rates; or (ii) a Hawthorne effect occurred, i.e. an effect due not to message content per se, but to the continuous presence of community volunteers and interviewers; or (iii) communities wanted to show that they had carried out interventions which they knew were aimed at diarrhoea and purposely underreported. Large annual fluctuations in diarrhoeal rates have been documented in this area of Zaire previously (Vernon A A, 1990 and WHO, 1986, personal communication). Health facility data from the Diarrhoeal Diseases Control Programme in Bandundu indicate that from 1985 to 1989 annual hospital admissions for diarrhoea among children $\leqslant 5$ years of age fluctuated widely, with the highest percentage (11%) reported in 1987, and the lowest (4%) in 1988. This suggests that the large declines observed in the present study reflect, at least in part, the general regional decline between 1987 and 1988. As regards the Hawthorne effect, the presence of the research team may have stimulated villagers' general awareness of diarrhoea and its causes (as well as other illnesses and their causes). In control areas, furthermore, volunteers (as free agents) may have promoted other health and diarrhoea messages based on their own previous knowledge, in addition to the control messages. It is unlikely that message leakage from intervention to control sites could account for these reductions, since all sites were geographically well separated and field monitors, being on the alert for message leakage,reported only one instance which was of minor importance.

Difficulties Encountered

The sustained involvement and activity of community volunteers was pivotal to the success of the intervention, since the volunteers were the principal community resource used. Several of the volunteers were, however, inadequately selected by their communities or poorly motivated. Although project leaders visited each site twice prior to the training period to explain the goals of community volunter selection to village leaders, this was insufficient. As might be expected, those volunteers who performed poorly during training or exhibited poor motivation were less effective in their communities. A related, severe problem was the inability of trainers to visit volunteers frequently to provide technical, managerial and moral support, due to poor roads, insufficient and expensive transport, inadequate vehicle repair, and poor supplies of fuel. For similar reasons, it was impossible to regroup volunteers in Kikwit at any point during the intervention for refresher training and an exchange of volunteer experiences.

A further difficulty was that the time frame planned for the study was too short in a number of ways. Between message development and implementation of the intervention there were only 2 months, allowing little time for re-selection of inappropriate volunteers. Also, although the educational posters were pretested, there was insufficient time to pilot message dissemination in the field using the methods promoted during training. Perhaps most pertinently, the time frame of the intervention was in all probablility inadequate to achieve the full potential of behaviour change at the community level. Adoption of the prescribed behaviours in even the most active sites was only gradual.

Implications of the Findings

On balance, the results of this study suggest that the observed reductions in diarrhoeal rates were attributable to the intervention. The results presented here should, however, be considered in tandem with the evaluations of the project's impacts on behaviour and nutritional status: these analyses (forthcoming) reinforce the conclusion that the changes in diarrhoeal rates were due to the intervention. Improvements in hygiene behaviours and child growth followed similar patterns to the diarrhoeal reductions with respect to baseline measurements and intervention quality. Moreover, analyses of the growth data, like the diarrhoeal data analyses, suggested the intervention had a stronger impact on children in the third year of life.

There have been few community studies from which to predict the reductions that might be expected from personal and domestic hygiene interventions, and it is likely that greater reductions could occur. To assess the potential benefit of personal and domestic hygiene education fairly, similar approaches should be studied in settings where operational constraints do not pose a major obstacle to community volunteer monitoring and support, where greater emphasis is placed on volunteer selection and training in message dissemination methods, and where sufficient time is allowed to elapse before the final evaluation, in order to maximize behavioural change. The comparative effect of focusing a similar approach (with these improvements) on children 24–35 months of age, would also merit further study.

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