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Can the case–control method be used to assess the impact of water supply and sanitation on diarrhoea? A study in the Philippines

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Use of the case–control approach offers the promise of a rapid yet valid method for assessing the impact of improved environmental sanitation practices on diarrhoeal disease. Here, we report on a field trial of this approach in Cebu, Philippines. The results suggest that when only two exposure categories are used the method can be applied in the field and can yield valid and sufficiently precise results, rapidly and at a moderate cost. However, for studies of the interactions between water supply and excreta disposal (and other risk factors of diarrhoea), the sample sizes have to be increased substantially. It was found that among children of families with adequate environmental sanitation practices (both with respect to water supply and excreta disposal) the incidence of diarrhoea reported to clinics was 20% less, and that of pathogen-positive diarrhoea was 40% less, than that among children of families who did not have adequate practices.

In recent years much attention has been paid to the methodological issues involved in assessing the impact of improved water supply and sanitation facilities on health. It has been shown that such studies have been plagued by a series of methodological problems (*1*), that useful studies are those which give rapid results at a relatively low cost (*2*), and that the case–control approach offers promise as a rapid, inexpensive method for making such assessments.[a] Here we report the results of a field trial in an urban and periurban setting in the Philippines. In the trial, families were categorized as having adequate environmental sanitation practices when they had both good quality water in their homes and adequate excreta disposal practices. The specific hypothesis tested in the study was whether the incidence of diarrhoea (as reported to clinics) among children from families who had adequate environmental sanitation practices was less than that among children from families whose environmental sanitation practices were inadequate.

METHODS

Study area

The case–control study was conducted in metropolitan Cebu, an area with a population of slightly >1 million that embraces both the city of Cebu and rural areas of the island of Cebu in the central Philippines. The estimated infant mortality rate is 50 per 1000, and diarrhoeal diseases constitute the second most important cause of morbidity among the population.[b] The site was selected primarily because a large prospective study of child morbidity, growth, and mortality is also being conducted in the area,[c] the results of which, when available, can be compared with those of the rapid, inexpensive case–control study described here.

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[a] BRISCOE, J. ET AL. *Measuring the impact of water supply and sanitation facilities on diarrhoea morbidity: prospects for case–control methods.* Unpublished document (WHO/CWS/85.3 CDD/OPR/85.1).

[b] CEBU HEALTH DEPARTMENT. *The City Health Department Reports.* Cebu, 1983, p. 63.

[c] POPKIN, B. ET AL. *Infant mortality: underlying and intermediate determinants.* Study supported by National Institute of Health Research Grant 1 RO1 HD 19983–01A1. University of North Carolina, 1985.

About half of the population in the area use public or private boreholes as their primary source of water. The municipal water system, which consists of deep wells, covered reservoirs, chlorinators, and an extensive distribution system, serves an additional 30% of the population. About 10% of the population use water from open dug wells and about 10%, water from unprotected springs. Water is readily available to most of the population; for example, 13% have their water source in their house or garden, while only 20% must walk more than 3 minutes to reach the source.

Adequate excreta disposal facilities (flush toilets, water-sealed latrines, or pit latrines) are available to two-thirds of the population, while the remaining one-third defecate in fields, on river banks, or on the seashore.

Study period

In the Philippines, as in many other parts of the world, the incidence of diarrhoea exhibits two seasonal peaks. The major peak is during the warm, rainy months of July, August, and September, while the minor peak occurs in the cooler months of January and February (Research Institute of Tropical Medicine, Philippines, private communication, 1984). An analysis of cases of diarrhoea among young children who reported to health centres in Cebu confirmed the importance of the maximum in the warm, rainy season: for example, in 1983, 32% of all cases of childhood diarrhoea occurred during July and August. As in most other developing countries, it was expected that the warm-weather diarrhoea maximum was primarily caused by bacterial pathogens.[d] Because it is bacterial rather than viral pathogens that are most susceptible to improvements in water supply and sanitation conditions (*3*), the case–control study was conducted during the warm summer months, and recruitment of children took place from mid-June to mid-October 1985.

Sample size

The sample size for the study was determined using the following criteria:

— between 40% and 60% of the population had access to an adequate water supply and sanitation facilities;
— it was of public health interest to detect a reduction in diarrhoeal disease of 33%, i.e., odds ratio = 0.67;
— there should be a 90% chance of detecting this reduction at the 5% significance level; and
— one control would be chosen for each case.

In this way the minimum sample size was calculated to be 460 cases and 460 controls.[d]

[d] See footnote *a*, p. 627.

Selection of cases and controls

The study subjects were selected from 16 clinics, about half of which are located in the city proper, while the rest are situated in small municipalities or adjacent rural areas. It was found necessary to use this number of clinics because outpatients were examined only once per week, on the so-called "morbidity day".

A case was defined as a child aged <2 years who was brought to one of the study clinics with diarrhoea. All cases seen at the clinics on a "morbidity day" during the recruitment period that satisfied this definition were included in the study.

Controls were defined as children aged <2 years who were brought to the clinic because of an acute respiratory infection, and who had not had diarrhoea during the previous 24 hours. At the beginning of the recruitment period, the first child examined after a case and who satisfied these criteria was chosen as a control. During the first 2 months of recruitment, however, the number of cases identified was substantially lower than had been expected, based on a review of the previous year's clinic records. This may have arisen for either of two following reasons: the incidence of diarrhoea in the community had been declining (an explanation supported by the Cebu Health Department); reduced recruitment occurred in some health centres because the physicians and nurses were not present at a regular "morbidity clinic day". It was therefore decided to choose two controls for each case, and those selected were the first two potential controls interviewed after a case had been recruited.

From June to October 1985, a total of 289 potential cases and 403 potential controls were identified and asked to participate in the study. Of these, 281 cases and 384 controls subsequently took part. Among the reasons for not participating were refusal by the mother (4 cases, 19 controls), failure of the interviewers to locate the house of the study subject (1 case), and failure to contact the mother or other reliable informant despite two home visits (3 cases).

Data collection

A two-part questionnaire was developed for the study. The first part was administered at the clinic and gathered information on the age and sex of the child, the clinical history of diarrhoea (for cases) or acute respiratory infections (for controls), recent (within the previous week) history of diarrhoea in the family, weight and height of the child, and reported source of water. The second part of the questionnaire was administered during a follow-up home visit and was designed to collect data on the sociodemographic characteristics of the household, infant feeding prac-

tices, use of health services, the distance to the clinic, as well as environmental information, including questions on the child's source of drinking water, quantity of water used by the household, how often the child was bathed, type of excreta disposal facilities, and the method of solid waste disposal. Observations were also made by the interviewer on the type of water source, distance from water source to the home, and general sanitary condition of the dwelling. The questionnaires were translated into Cebuano and pre-tested. For both cases and controls about 95% of the respondents were the children's mothers.

The field support staff consisted of a supervising physician and five nurse-interviewers, all of whom worked full-time on the project. Also, a sanitary engineer and a technician provided training in, and supervised the collection of, the environmental data. The supervising physician conducted spot-check interviews of the respondents twice a week. With the exception of the answers concerned with the quantity of water used by the household, the agreement was high between the responses recorded during the original and the repeat interview.

Rectal swabs were taken from all cases and controls by the nurse-interviewers at each clinic and examined for rotavirus, campylobacter, enterotoxigenic *Escherichia coli*, salmonella, shigella and *Vibrio cholerae* using standard methods.[e]

Definition of exposure variables

It was hypothesized that in the study area the risk of diarrhoea in a young child would be affected by the bacteriological quality of the water consumed, the quantity of water used for personal hygiene purposes, and the excreta disposal facilities used by the household.

Water quality. Faecal coliform counts were obtained from over 300 water sources and a similar number of household containers in the study area.[e] These data revealed that the quality of water from the municipal supply and most boreholes was much better than that from dug wells and springs. Also, the concentration of faecal coliforms was greater if the water was not poured from the household storage container but was removed using a scoop or cup. One third of the respondents reported habitually boiling the child's drinking water. The exposure status of children with respect to water quality was defined as shown in Fig. 1.

Water quantity. In the development of the survey instruments a great deal of attention was given to the questions designed to estimate the quantity of water used by the household. Several problems were, however, still encountered. For example, the number of water containers fetched per day differed in 13% of the follow-up questionnaires from that reported in the initial questionnaire, a discrepancy rate much greater than that for any other question. A change of only one container in the reported number fetched would cause a 10–30% change in the per capita consumption of water, and consequently large variations in the estimated water consumption. In addition, there was considerable variation in reported water-use practices, with some families performing certain activities (dishwashing, bathing, laundering) at the water source and other activities at home. Estimates of consumption of water for purposes other than laundering clothes and estimates corrected for bathing were calculated both per household and per capita. An analysis of the data indicated several apparently questionable results. For example, although similar results were found in two other cities in the Philippines (*4*), it seems improbable that there would be no increase in the level of consumption when the travel time to the water supply was 30 seconds rather than 5 minutes. It was therefore decided not to use the data on water quantity, but only to control for the effect of hygienic behaviour by including information on the frequency with which the child was bathed.

Excreta disposal. Determination of whether a child had been exposed to adequate excreta disposal practices was based on two factors: the reported use by the mother of an adequate excreta disposal facility (flush

a. *Water quality*

Source of water		Municipal supply or borehole		Dug well or spring	
Method used to remove water from container:		Poured	Scooped	Poured	Scooped
Treatment method:	Boiled	Exposed	Exposed	Exposed	Exposed
	Not boiled	Exposed	Unexposed	Unexposed	Unexposed

b. *Excreta disposal*

		Excreta disposal facilities:	
		Adequate	Not adequate
Sanitary condition around house:	Generally clean	Exposed	Unexposed
	Generally not clean	Unexposed	Unexposed

Fig. 1. Definition of exposure variables used in the study. (a) Water quality. Exposed = "exposed to improved water quality". (b) Excreta disposal. Exposed = "exposed to improved excreta disposal practices"; flush toilets, water-sealed latrines, and pit latrines were considered to be "adequate diposal facilities". The sanitary conditions around houses were determined by observations of the presence or not of faeces, flies, and odours.

[e] See BALTAZAR, J. *Progress Report to National Academy of Sciences, CRG Grant No. REA-PH-4-85-50*, 1986.

toilet, water-sealed latrine, or pit latrine) and the field worker's assessment of the sanitary condition around the house (based on the presence or not of faeces, flies, and odours). As shown in Fig. 1, if the reported excreta disposal facilities were adequate and the area around the house was generally clean, the child was classified as "exposed" to adequate sanitation, otherwise as "unexposed".

Overall exposure classification. There is some evidence (*5–7*) that, under poor socioeconomic conditions, improvement of a single environmental factor is a necessary but not a sufficient condition for reducing the incidence of diarrhoeal diseases and that a measurable impact on health should be expected only when improvements in both water supply and excreta disposal practices occur. Accordingly, children were categorized as "exposed to good environmental sanitation" if the family used water of good bacteriological quality and the excreta disposal practices were considered adequate. All other children were defined as "not exposed to good sanitation".

Statistical analyses

The effects of the exposure variables on the study children were determined by logistic regression analyses, taking account also of confounders and effect modifiers. Adjusted odds ratios and 95% confidence intervals were calculated.

The following potential confounders were identified for the known risk factors of diarrhoeal disease: age, sex, education level of the head of the household and of the mother, feeding practices, level of health services use (as indicated by enrolment in "under-six clinics"), number of children aged <5 years in the household, and frequency of bathing the child. Family history of diarrhoea in the past week and nutritional status were initially candidates as potential confounders. Both of these are, however, influenced by water supply and sanitation and thus occupy an intervening position in the causal pathway under investigation: their inclusion, therefore, would have led to biased odds ratios (*8, 9*).

Two other variables were treated as potential confounders although they are not risk factors for diarrhoea. First, since cases and controls were matched on the basis of the clinic, and since the clinic of recruitment was related to the exposure status, the clinic needs also to be controlled for as a selection confounder (*10*). For this purpose, the 16 clinics were classified into four groups based on the predominant types of water supply and sanitation facilities. Second, house-to-clinic distance was also included as a confounder to eliminate bias caused by an association between distance to the water service and the different distances that cases and controls lived from the clinic.[f]

RESULTS

Characteristics of study subjects

The distribution of selected characteristics for cases and controls are shown in Table 1. The majority of the study subjects were infants. Cases were slightly older than controls (68% versus 73% of whom were respectively <1 year of age), while the sex distributions were similar. The current nutritional status of cases (as measured by weight-for-height data) was inferior to that of controls (24% versus 16% more than 2 standard deviations below the NCHS median value (*11*)), while the long-term nutritional status of cases and controls (as measured by height-for-age data) was similar (24% versus 26% more than 2 standard deviations below the NCHS median value).

Diarrhoeal etiology

Rectal swabs from 285 children with diarrhoea and from 389 children (including specimens from children who were not interviewed at home) with no gastrointestinal symptoms were analysed for the most common bacterial and viral diarrhoea pathogens (Table 2). Enteric pathogens were detected in 39% of cases and 27% of controls ($P<0.001$). The differences in isolation rates between cases and controls were substantial and statistically significant for enterotoxigenic *E. coli* (15% versus 6%; $P<0.001$) and shigella (3% versus 0.3%; $P<0.05$).

Effect of water supply and sanitation on diarrhoea

In accordance with the study design, the principal investigation analysed whether the incidence of diarrhoea (as reported to clinics) among children from families with adequate environmental sanitation practices (with respect to both water supply and excreta disposal) was less than the incidence among children from families whose practices were inadequate.

The distribution of cases and controls according to these two levels of exposure is shown in Table 3. Five cases and eight controls were excluded from the crude analysis because they had only been breastfed and their mothers denied giving them water. Additional cases and controls were excluded from the logistic regression analysis because of missing information on some of the potential confounders. The results indicate that improved sanitation practices were associated with a reduction in the relative rate of diarrhoea (odds ratio=0.80). Under the null hypothesis (odds ratio=1), the probability of obtaining, by chance, an estimated odds ratio of ≤ 0.8 is about 9%.

In order to control for confounding, an adjusted

[f] See footnote *a*, p. 627.

Table 1. Distribution of selected characteristics for cases and controls, Cebu, Philippines

	% of cases (n = 281)	% of controls (n = 384)
Child's age (months)		
0–5	23	36
6–11	45	38
12–17	21	15
18–24	11	11
Child's sex		
Male	53	52
Female	47	48
Feeding pattern		
Unsupplemented breastfeeding	8	15
Supplemented breastfeeding	67	60
No breastfeeding	25	25
Duration of disease symptoms (days)		
1–2	39	14
3–7	54	68
8–14	6	15
>14	1	3
Nutritional indicators		
Low weight-for-length	23	17
Low length-for-age	34	33
Occupation of head of household		
Farm worker or tenant	3	2
Fisherman	9	6
Wage worker	34	33
Self-employed	53	57
Unemployed	<1	1
Other	1	1
Mother's educational level		
0–3 years, elementary school	11	9
4–7 years, elementary school	35	36
1–4 years, high school	38	38
≥1 year, college	13	15
Unknown	3	2
Excreta disposal facility		
Flush toilet/latrine	64	65
None	36	35
Water supply		
Piped	36	42
Boreholes	53	48
Dug wells	10	10
Springs	<1	<1

Table 2. Distribution of enteric pathogens isolated from diarrhoea cases and control children, Cebu, Philippines

Pathogen	No. of cases (n = 285)[a]	No. of controls (n = 389)[a]
Campylobacter	42 (15)[b]	44 (11)
ETEC[c]: ST+	23 (8)	5 (1)
LT+	14 (5)	16 (4)
LTST+	6 (2)	2 (0.5)
Salmonella	20 (7)	30 (8)
Rotavirus	16 (6)	16 (4)
Shigella	7 (3)	1 (0.3)
Vibrio cholerae	1 (0.3)	1 (0.3)
Multiple infection	16 (6)	10 (3)
None detected	173 (61)	284 (73)

[a] Includes specimens from 14 cases and 14 controls not interviewed at home.

[b] Figures in parentheses are percentages.

[c] ETEC = enterotoxigenic *Escherichia coli*.

odds ratio was estimated using a logistic regression analysis with all the potential confounders incorporated. The adjusted odds ratio and confidence intervals (Table 3) are close to the crude values, which indicates that there was little confounding in the data set.

The study was designed only to examine the effect of "adequate" versus "inadequate" environmental sanitation. If the number of exposure groups exceeds two, it is unlikely that statistically significant results

Table 3. Crude and adjusted odds ratios and 95% confidence intervals (C.I.) for association between clinical diarrhoea and the number of interventions

No. of interventions	No. of cases	No. of controls	Odds ratio	95% C.I.
Crude analysis				
0–1	176	220	1.00	—
2	100	156	0.80[a]	(0.58, 1.10)
Total[b]	276	376		
Logistic regression analysis[c]				
0–1	172	213	1.00	—
2	99	151	0.79[d]	(0.56, 1.13)
Total[e]	271	364	—	—

[a] Crude odds ratio.

[b] Exposure information was incomplete for 5 of the 281 cases and 8 of the 384 controls in the study.

[c] Potential confounders included in the analysis are age, sex, education of the head of houseold and the mother, feeding practices, level of health services utilization, number of children <5 years of age in the household, and frequency of bathing the child.

[d] Adjusted odds ratio.

[e] Information on confounders was incomplete for 5 of the 276 cases and 12 of the 376 controls in the crude analysis.

will be obtained. It has been proposed that, because the results of analyses other than those specifically incorporated into the study design will not be statistically significant, subanalyses of data are meaningless and should not be undertaken (*12*). In contrast, other workers argue that, although any conclusions drawn from such non-significant findings are necessarily tentative, these can, nevertheless, provide insights, particularly in combination with other, perhaps also non-significant, results from similar studies in other settings (*13*).

The data obtained were analysed to determine the strength of association according to the number of interventions. While, as expected, the confidence intervals always include unity, the results (Table 4) suggest that there is a progressive decline in the odds ratio as the number of interventions is increased ($\chi^2=2.13$; 1 degree of freedom; $0.1<P<0.2$).

Of importance also is whether the effects of water supply and sanitation on diarrhoea depend on the feeding status of the child. A recent study in Malaysia suggested that when water supply and sanitation improved, the absolute reduction in mortality rate was greater among non-breastfed than breastfed children (*14*). While the study design, outcome measure, and exposure measure in the Malaysian were different from those in the present study, it was, nevertheless, interesting to assess the interaction of environmental improvements and feeding practice among our study subjects.

The data were stratified into the following categories, depending on the children's feeding status: "fed supplements" and "not fed supplements". The former group included children who were not breastfed or who were breastfed but given supplements, while the latter group included only children who were exclusively breastfed (and given water). For those children who were fed supplements, the odds ratios were essentially the same as those in Table 4. Because of the small numbers of infants who were not fed supplements it was, however, not possible to make even a tentative inference concerning the effects of environmental interventions on this group.

Table 4. Adjusted odds ratio and 95% confidence intervals (C.I.) for the association between number of interventions and episodes of diarrhoea reported to the study clinic

No. of interventions	No. of cases	No. of controls	Odds ratio	95% C.I.
0	51	56	1.00	—
1	121	157	0.92	(0.56, 1.50)
2	99	151	0.74	(0.44, 1.25)
Total	271	364	—	—

The hypothesis underlying the investigation was that improvements in environmental sanitation affect the transmission of those diarrhoeas that are caused by enteric pathogens, especially those that are transmitted by bacterial pathogens. In a supplementary analysis, therefore, cases were restricted to those children with clinical diarrhoea who were positive for any of the enteric pathogens examined, while controls were restricted to children who reported to the clinic with respiratory infections and who were negative for all diarrhoeal pathogens. Table 5 shows the odds ratio for the full (all diarrhoea cases) and the restricted sample (diarrhoea cases for which a bacterial pathogen was isolated). The results indicate that when cases and controls were restricted on the basis of faecal microbiology, the effect meaures became consistently and markedly stronger; for example, reductions in diarrhoea incidence were about twice as great (19% versus 9% for one intervention and 43% versus 26% for both interventions).

Finally, it is of interest to note that the frequency of baby bathing, which was used as a surrogate for hygiene behaviour, had no discernible effect (odds ratio, 1.05) on diarrhoeal disease.

DISCUSSION

The study had two aims. First, there was a methodological objective, i.e., to develop and field test a protocol for the use of a case–control approach to assess the impact of improved environmental sanitation practices on diarrhoeal disease. Second, there was a substantive objective, i.e., to assess the effects of improvements in environmental sanitation practices on diarrhoeal disease in Cebu and to draw conclusions that would be relevant to water supply, sanitation, and health planning in this area.

Before discussing these issues, however, the validity and precision of the estimates of effect will be examined.

Validity of the estimates

The estimates of the odds ratios calculated may deviate systematically from the true odds ratio because of selection biases, misclassification biases, and biases caused by confounding.

We have previously outlined procedures for minimizing selection bias in case–control studies of this sort.[g] If the eligibility criteria for controls are carefully defined, it is likely that cases and controls will be drawn from the same geographical, social, and economic groups and probable that under the null

[g] See footnote *a*, p. 627.

Table 5. Adjusted odds ratio and 95% confidence intervals (C.I.) for the association between clinical diarrhoea and the number of interventions derived from the full sample (all cases of diarrhoea) and a sub-sample (cases of diarrhoea caused by a bacterial pathogen)

	All cases of diarrhoea			Cases of diarrhoea caused by bacteria		
No. of interventions	Odds ratio	95% C.I.	No. of cases + controls[a]	Odds ratio	95% C.I.	No. of cases + controls[b]
0	1.0	—	107	1.0	—	60
1	0.92	(0.56, 1.50)	278	0.81	(0.40, 1.61)	156
2	0.74	(0.44, 1.25)	250	0.57	(0.27, 1.21)	149

[a] No. of cases = 271; no. of controls = 364.
[b] No. of cases = 105; no. of controls = 260.

hypothesis (true odds ratio, 1) cases and controls will have an equal chance of being "exposed" to a good water supply and sanitation conditions. The probability of serious selection bias in the study appears to be low.

Misclassification bias can arise as a result of incorrect information on both disease and exposure status. The basic classification for disease status used in the study was based on symptomatology. Because of the method of recruiting cases (symptoms reported by mothers and confirmed by a clinic physician or by the nurse-interviewer), there was little possibility of misclassification of disease status. If, however, an alternative case definition had been used—such as those with diarrhoea caused by an enteric pathogen—then there is substantial misclassification. Since such misclassification would be non-differential, its effect would be to bias the odds ratio towards unity. As shown in Table 5, the reductions in the frequency of diarrhoea are about twice as great when cases were defined as "diarrhoea reported to the clinic and caused by enteric pathogens" rather than simply as "diarrhoea reported to the clinic".

Information on the variables used to define exposure categories was generally obtained by administering questionnaires in the home and, where feasible, also by direct observation. As far as water supply is concerned, the information obtained is probably valid, with the possible exception of that on water treatment, which was reported by the mother. In this instance, the information supplied by the mothers of cases may be less accurate than that obtained from the mothers of controls; however, since only 13% of subjects used boiled water, it is likely that any biases arising from this effect would be small.

Information on disposal of excreta was obtained not only by questioning mothers about the availability and use of latrines, but also from observations made by field workers on the presence of faeces in the vicinity of the houses. While an analysis of these data failed to reveal any individual interviewer bias, the validity of the data remains uncertain.

Detailed information was collected on all potential confounders and account taken in the analysis of their possible effects. It appears unlikely that any bias in the estimates of the odds ratio arose from confounding.

As noted above, the site chosen for the case–control study coincided with that of an ongoing large prospective study of, *inter alia*, the effect of water supply, sanitation, and feeding conditions on diarrhoeal diseases among children aged 2 years. Because of the size and complexity of such large longitudinal studies, the results of the prospective study are not yet available. When the analysis of the prospective study is complete, it will be possible to compare the results of the "rapid and inexpensive" case–control study with those of the "slow and expensive" prospective study, thereby providing a test of the results of the case–control study.

Precision of the estimates

The results indicate that when both water supply and excreta disposal practices were improved there was an appreciable reduction in the relative frequency of diarrhoeal episodes. The precision of the estimate is approximately that which had been designed for.

It is, however, pertinent that only 281 cases and 384 controls (instead of the 460 cases and 460 controls required by the study design) were recruited over the 4 months. Bearing in mind that 16 clinics were used to recruit children for the study it would appear that inability to recruit sufficient numbers of participants may be a potentially serious problem in case–control studies of this type.

There were, however, several reasons why recruitment was particularly difficult in Cebu. First, at the time of the study the public clinics in the area provided a low level of service, with sick children being examined only one day per week. Second, in Cebu

and other areas of the Philippines respiratory diseases have supplanted diarrhoeal diseases as the leading cause of child morbidity (Research Institute of Tropical Medicine, Philippines, private communication, 1984). As a result the number of cases seen at the 16 recruitment clinics in the study year was considerably lower than that expected from scrutiny of the previous year's records of those clinics.

From the experience gained in the present study and also in a companion study in Malawi (*15*) it would appear that difficulties in obtaining the target sample size only arise if (as in Cebu) a large portion of individuals with diarrhoea are not treated at clinics and diarrhoea is no longer the major cause of morbidity among young children.

When an attempt was made to assess the impact of more than two exposure categories on diarrhoeal disease, the confidence intervals around the point estimates increased considerably. However, in the particular case of three exposure levels, the confidence intervals obtained were such that the results, which accorded with prior expectations, could tentatively be regarded as indicating a broad trend. When an attempt was made to assess the interaction of environmental variables with feeding status, however, the estimates were too imprecise to allow even a tentative conclusion to be drawn.

CONCLUSIONS

Methodology

The results obtained confirmed that case–control studies of the effect of improved environmental sanitation on diarrhoeal disease can be carried out rapidly, at modest cost, and can produce valid estimates of effect. Sample sizes consisting of about 500 cases and 500 controls are adequate to detect reductions in disease frequency of 33% or more. It was also shown that, for cases reported to the study clinics, the impact of improved environmental sanitation practices was much greater on diarrhoeas caused by enteric pathogens than that on diarrhoeas from all causes.

The results also indicated that a case–control study can provide inconclusive but, nevertheless, suggestive evidence on some hypotheses that it was not specifically designed to investigate. In particular, it was possible to explore the effects on diarrhoeal disease of one versus two environmental improvements. Also, it was demonstrated that the outcome of some interactions, such as that of environmental improvements and feeding practices on diarrhoeal disease cannot be addressed by case–control studies of this size because the estimates of effect are too imprecise.

Policy issues

The results of this study are pertinent only for the children who used the public clinics during the warm rainy months. Improved environmental sanitation practices were associated with a 20% reduction in all episodes of diarrhoea and a 40% reduction in episodes of diarrhoea caused by enteric pathogens that were reported to the clinics.

Improved water supplies are constructed primarily for reasons (time savings, amenity benefits, and direct economic benefits) other than to improve the health of the users (*16*). Prior epidemiological studies in the Philippines (*4*) and preliminary results from an ongoing prospective study of diarrhoeal diseases conducted in Cebu (C. Moe, personal communication, 1988) suggest that, except where contamination levels are very high, improvements in water quality alone have little effect on diarrhoeal diseases. Provision of improved water quality may, however, be necessary if other improvements in environmental conditions, such as better excreta disposal practices, are to have a beneficial effect. The results of the study suggest that the combined effect of water quality and excreta disposal practices on diarrhoeal diseases in Cebu is substantial.

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RÉSUMÉ

LA MÉTHODE CAS-TÉMOINS PEUT-ELLE ÊTRE UTILISÉE POUR ÉVALUER L'IMPACT DE L'APPROVISIONNEMENT EN EAU ET DES CONDITIONS D'HYGIÈNE SUR LA DIARRHÉE? EXEMPLE D'APPLICATION AUX PHILIPPINES

La méthode cas–témoins offre un moyen rapide et pourtant valable d'évaluer l'effet d'une amélioration des conditions d'hygiène sur les maladies diarrhéiques. Le présent article rend compte d'un essai d'application de cette méthode sur le terrain à Cebu (Philippines).

On a considéré comme cas les enfants âgés de moins de deux ans atteints de diarrhée qui ont été conduits à l'un des 16 dispensaires publics de la ville de Cebu ou de ses environs. Les témoins étaient des enfants âgés de moins de deux ans qui ont été conduits au dispensaire pour une infection respiratoire aiguë mais qui n'avaient pas eu de diarrhée au cours des 24 heures précédentes. Au départ, on a choisi un témoin par cas; toutefois, le recrutement des cas étant plus lent que prévu, on a décidé par la suite de retenir deux témoins pour un cas. Au cours des cinq mois qu'a duré l'étude (juin à octobre 1985), on a identifié 289 cas potentiels et 403 témoins potentiels.

Les données cliniques ont été recueillies dans les dispensaires publics, tandis que les informations socio-démographiques et environnementales ont été obtenues ultérieurement lors de visites à domicile. Des échantillons ont été prélevés par écouvillonnage rectal sur tous les cas et tous les témoins afin de rechercher la présence de rotavirus, d'*E. coli* entérotoxinogène, de salmonelles, de shigelles et de *Vibrio cholerae*.

On a pratiqué des analyses de régression logistique pour évaluer les effets des conditions d'alimentation en eau et d'élimination des excreta sur l'incidence de la diarrhée, tout en tenant compte des facteurs modificateurs et des facteurs confondants.

Les résultats de l'étude montrent que, dans les familles où les conditions d'hygiène étaient satisfaisantes (tant en ce qui concerne l'approvisionnement en eau que l'élimination des excreta), l'incidence de la diarrhée était environ 20% plus faible que dans les familles où ces conditions laissaient à désirer. Dans l'hypothèse nulle (odds ratio=1), la probabilité d'obtenir par hasard un odds ratio égal ou inférieur à 0,8 est d'environ 9%.

D'autres analyses ont montré que le odds ratio diminuait progressivement (mais pas de façon statistiquement significative) lorsque le nombre d'interventions augmentait et que l'amélioration des conditions d'hygiène était deux fois plus efficace (odds ratio=0,6) lorsque les cas ne comportaient que des diarrhées provoquées par des entéropathogènes.

L'étude semble indiquer que la méthode cas–témoins est applicable sur le terrain lorsque le nombre de catégories d'exposition est limité à deux. Elle permet alors d'obtenir rapidement et à un coût raisonnable des résultats valides et suffisamment précis. Toutefois, si l'on veut examiner les interactions entre l'approvisionnement en eau et l'élimination des excreta (et peut-être d'autres facteurs de risque), il faut utiliser des échantillons beaucoup plus importants.