

23 Feb, 2009

Uitsluitend voor persoonlijk gebruik / for personal use only



TU Delft Library
Prometheusplein 1
Postbus 98
2600 MG Delft
Tel: +31 (0) 15 27 85678
Fax: +31 (0) 15 27 85706
Email: library@tudelft.nl
www.library.tudelft.nl

Aan: INT. WATER AND SANITATION CENTR
LIBRARY AND DOCUMENTATION UNIT

POSTBUS 2869
2601 CW DELFT

NEDERLAND

Aanvraag nr: 1455124

Uw referentie(s): A089702298 DEIRDRE/REGIS
DEIRDRE / REGIS 17FEB09

Artikelomschrijving:

Aantal kopieën: 5

Artikel: HEALTH IMPACTS IN DEVELOPING COUNTRIES
Auteur: CAIRNCROSS AM
Titel: JOURNAL OF THE INSTITUTION OF WATER AND ENVIRONMEN
Jaar: 1990 **Vol. 4** **Nr. 6** **Pag. 571-575**
Plaatsnummer: 7311

Health Impacts in Developing Countries: New Evidence and New Prospects

By A. M. CAIRNCROSS, PhD, MICE (*Member*)*

ABSTRACT

This review of recent studies of the health impact of water supply and sanitation programmes in developing countries shows that they share many findings, and some methodological problems, with older studies of the subject. Considerable health impacts can occur under appropriate conditions, and it is suggested that the greatest impact can be produced by targeting water and sanitation facilities to those whose existing water sources are furthest away, or whose environment is most faecally polluted.

Another finding is that health benefits stem from the changes in hygiene behaviour which water and sanitation make possible. The measurement of such behavioural changes is a subject in need of development. Nevertheless, it is likely to be easier, more reliable, and more useful to water and sanitation programme managers as an operational evaluation tool than any attempt to measure the health benefits directly.

Key words: Diarrhoea; epidemiology; hygiene; sanitation; water supply.

INTRODUCTION

Attempts to measure the health impact of water supplies and sanitation have a long and chequered history. Many of them have been made by amateur epidemiologists at the behest of the agencies financing the construction of the facilities, and with insufficient planning and rigour. Even some studies supervised by eminent specialists have produced almost useless or meaningless results, after taking years to complete and costing substantial sums of money. This unhappy experience led a panel of experts, convened in 1975 by the World Bank, to conclude that the Bank should not undertake any long-term longitudinal studies of the question¹.

A more sanguine mood prevailed, however, at the international workshop convened in 1983 at Cox's Bazaar, Bangladesh, on 'Measuring the health impact of water and sanitation programmes'. Agen-

cies such as the United Nation's Children's Fund (UNICEF), the World Health Organization and the International Development Research Centre supported the meeting, which gave rise to a set of methodological guidelines² and a document³ explaining how a new technique (the case-control method) could be used to measure impact on diarrhoeal disease, in less time and at lower cost than with conventional methods.

Since that time, new evidence has accumulated. About a dozen studies focusing on diarrhoeal disease have been carried out by reputable research groups, which have endeavoured to incorporate in their methodology the lessons learned at Cox's Bazaar. The results are summarized in Appendix 1. As the Water Decade draws to its close, the time is opportune for (a) a review of the results of this activity, (b) a synthesis of the lessons to be learned from them so far, and (c) careful consideration of their implications for future work.

A review of the published and unpublished results of this new generation of health-impact studies suggests two important conclusions. First, health-impact studies are not an operational tool for project evaluation or 'fine tuning' of interventions. The results are not only unpredictable; they are sometimes so surprising that they offer no firm interpretation. In particular, the short-duration studies sometimes advocated as an operational tool are those which offer least information to assist the interpretation of their results. If no health impact is detected by such a study, the design is too basic, and the sample is too small, to permit any further analysis to discover why this might be so.

Second, notwithstanding the unpredictability of the results of these studies, taken as a whole they provide firm evidence that water supplies, excreta disposal, and hygiene education can have a significant impact on diarrhoeal disease, similar to that indicated by Esrey *et al*⁴ on the basis of the older literature. The overall picture suggested by the recent studies is not very different from that offered by the older ones. Most of the studies suggest that access to water, increased water usage, and improvements in hygiene may have a greater impact on diarrhoea than water quality and excreta disposal.

However, any such conclusion can only be a personal assessment of the literature, because considerable (sometimes insuperable) methodological problems beset anyone seeking to conduct such a study^{5,6} and can cast doubt on the results. One of

This paper was presented for discussion at the Institution's Symposium on *Engineering for Health* held at the University of Manchester Institute of Science and Technology on 27-28 March 1990.

*Senior Lecturer in Tropical Public Health Engineering, London School of Hygiene and Tropical Medicine.

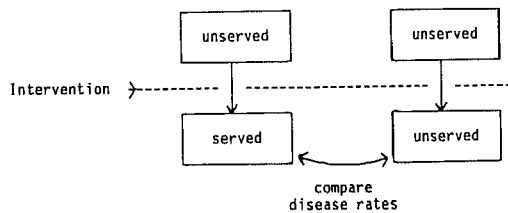
these problems is 'confounding' at the household level, which deserves more thorough consideration than it has received so far. It arises because of the way most health-impact studies are designed.

A MAJOR PROBLEM

Briefly, there are two main approaches to the design of an epidemiological study to measure the impact of water and sanitation on disease: (i) quasi-experimental, and (ii) observational (Fig. 1).

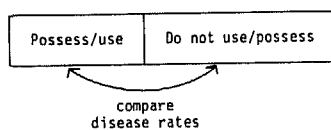
In 'quasi-experimental' studies, the health of two groups of people is studied, one group being provided with water supply and/or sanitation facilities. This is not a true experiment, because it is not possible to allocate people to the groups at random – as is carried out when evaluating drugs and other medical interventions. Apart from any ethical misgivings it might arouse, in most circumstances the strategy is not politically feasible. Moreover, it is often impractical to observe the two groups before the facilities are installed.

Quasi-experimental studies



Observational studies

(a) Conventional



(b) Case-Control

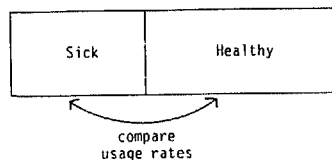


Fig. 1. Types of epidemiological study to measure health impact of water supplies and sanitation

This means that most studies essentially belong to the other type, i.e. 'observational'. The researcher simply observes the health of groups who have and who have not benefited already from water or

sanitation facilities, and tries to eliminate any bias due to the way they have been allocated.

Observational studies are of two basic types: (a) conventional, and (b) case-control. The 'conventional' observational study compares the groups served and not served by the facilities, with regard to their disease rates. The 'case-control' study is the exact opposite of this approach. A group of people who suffer from the disease in question (cases) is compared with a group of comparable people who do not (controls). The investigators compare the proportion of individuals in each group who are served by the facilities, and from this they can deduce the relative odds of becoming sick among those who are served and not served; in other words, the health impact.

These two types of observational study are mirror images of one another, and both have several problems in common. A major question relates to how the facilities have been allocated among the population. In the case of water supply the allocation is often made to whole communities at a time, e.g. a whole village when a hand pump is installed, and is dictated by administrative or technical convenience, political patronage or other factors only loosely associated with health. In the case of sanitation, however, and in some cases the use of a protected water source, the allocation depends on a decision taken at the level of the individual household.

Serious problems arise because the households which are most likely to invest in a latrine, or to prefer a protected source of water, are probably atypical in other respects. The occupiers of the household may be wealthier than average, their members more educated, or simply more aware of the benefits of hygiene; various studies have shown that this is the case. Wealth, education and hygiene consciousness are also associated with a lower incidence of disease. Hence those using water and sanitation facilities will tend to have less disease, whether or not the facilities have any protective effect. This phenomenon is known as 'confounding'. Statistical techniques exist to 'control' for confounding, with a view to eliminating its effect; however, they are effective only if the confounding factor is accurately measured for each household. In practice, wealth is usually assessed from one or more 'proxy' variables, such as the possession of a metal roof, a watch or bicycle, and education in terms of years of schooling of the adults in the household. Hygiene consciousness, as expressed in hygiene practices, is measured crudely or not at all.

Esrey and Habicht⁷ found that sanitation seemed to have a greater impact on diarrhoea incidence than water-supply improvements. It is possible that this apparent finding simply reflects the degree to which studies of the health impact of sanitation have been bedevilled by confounding at the household level, and have only partially succeeded in its control.

HEALTH IMPACTS IN DEVELOPING COUNTRIES: NEW EVIDENCE AND NEW PROSPECTS

Many of the studies where water-quality improvements seemed to reduce diarrhoea, even when conducted by eminently competent researchers, are also open to suspicion.

hard to interpret in this respect, it is clear that in most of those where a significant health impact was found, the provision of water supply or sanitation had been accompanied by improvements in hygiene.

TARGETING FOR HEALTH IMPACT

It is probably not very productive for anyone other than academic researchers to agonize any longer about such methodological problems and whether an impact on diarrhoea exists at all. Some studies have shown conclusively that it does. Most studies, if less conclusive, tend to support the view that water and sanitation can reduce the incidence of diarrhoea by about 25%⁴. Moreover, water supplies and sanitation can have a powerful impact on other infections. Water supplies can almost eliminate Guinea worm⁸ and substantially reduce the prevalence of trachoma⁹ and schistosomiasis¹⁰. Excreta disposal is a prime control measure for intestinal parasitic worms, and most studies of the impact of water and sanitation on the parasitic diseases have underestimated its public-health importance¹¹.

It is perhaps more constructive to ask under what conditions the greatest benefit to health may be obtained. Some researchers have focused on whether the groups which are likely to benefit most are in a particular socio-economic group¹², or have a particular set of infant feeding practices¹³ or level of education¹⁴. However, the policy implications of such studies are obscure. It would often be administratively impossible, and usually politically unacceptable, to target water and sanitation investments explicitly at such groups.

There is another approach to targeting which is clearly politically equitable but has largely been neglected in the health-impact literature, most of which considers water supply and sanitation as interventions defined by the level of service provided. These interventions can only be fully defined with respect to the conditions prevailing before they were implemented. Piped water in a household which previously used a hand pump in the backyard is unlikely to have the same impact as in one which collected its water from a muddy puddle 1 km away. Where previously-existing water and sanitation conditions are least hygienic, provision at a given level of service is likely to have the greatest impact. Few would dispute that it is equitable to target such environmental improvements on those whose environmental conditions are worst; for example, those whose water sources are furthest away or whose environment is most faecally polluted.

Such target groups are also most likely to feel a need for water and sanitation and therefore most likely to pay for it¹⁵. They are also most likely to respond to them by improvements in their hygiene. While the evidence from health-impact studies is

MEASUREMENT OF HYGIENE

'Hygiene' in this context refers to practices such as the washing of hands, food and utensils, or the disposal of children's stools. It may be promoted by better access to water and sanitation or by hygiene education, and improvements in hygiene may be reflected in increased water consumption. It appears that the most significant impacts on disease incidence stem from the behavioural changes which constitute hygiene improvements, and which interventions in the water sector seek to bring about. If no such change in behaviour results from improved water supply or sanitation, the only health benefits which are likely to occur are those stemming from improved water quality; in many settings these are relatively minor or even negligible.

Unless more is known about the conditions for these behavioural changes to occur, it is not possible to know how a health benefit can be expected. However (and this is a third conclusion to be drawn from the recent health-impact studies), all of them had difficulty in measuring the simple behavioural factors such as household water consumption. In some studies these factors were neglected because of an emphasis on water quality. In others an effort was made to examine them, but the study team lacked the necessary expertise or resources. In several, only a simple questionnaire was used, and the results showed too many discrepancies for detailed analysis to be considered worthwhile.

However, the objective study of human behaviour is not impossible, as a wealth of anthropological literature can testify. The problem is that the necessary techniques are not well known in the water and sanitation sector, and no coherent attempt has been made to adapt them to the needs of the sector.

A set of guidelines for the study of hygiene practices would provide practical tools for the operational evaluation of water and sanitation projects. A study of behavioural factors can be carried out more quickly, and much more cheaply, than a health-impact study, and its results would offer far greater power to diagnose problems in an existing programme. For example, a finding that health impact is small does not indicate how the impact can be increased; on the other hand, a finding that, say, latrines are not widely used will suggest measures to improve the situation. In fact, the guidelines envisaged would greatly facilitate implementation of the Minimum Evaluation Procedure for Water Supply and Sanitation Projects¹⁶.

Operational tools for the assessment of changes in hygiene practices would be particularly valuable for the evaluation of hygiene education programmes. Little is known about the relative cost effectiveness of the various possible approaches to hygiene education, and without objective (preferably standardized) methods to measure the impact on the behaviour of each approach, an understanding of this subject is unlikely to improve. Methodological guidance on the measurement of intervening factors would be invaluable to researchers planning any future health-impact studies. It would help them to design their investigations in such a way as to permit a better examination of the pathways by which water and sanitation may influence health. Future interventions can then be designed to maximize their health benefits, although this, it must be stressed, is not a short-term goal.

CONCLUSIONS

1. Reconsideration of the evidence, old and new, on the health impacts of water supply and sanitation programmes in developing countries offers new prospects for programme design and evaluation, by which those impacts can be increased.
2. By considering the existing conditions of water collection and excreta disposal, the provision of water supplies and sanitation facilities can be targeted to the groups which are likely to benefit most from them. These groups are also most likely to be willing to pay for them. On the other hand, it is now clear that these impacts stem from changes in hygiene behaviour.
3. Measurement of the changes will improve the ability to evaluate water, sanitation and hygiene education programmes to make them more effective. However, reliable methods for studying such behaviour has proved elusive, and the assistance of anthropologists is needed to develop better techniques.

ACKNOWLEDGEMENTS

The literature review which prompted this paper was commissioned by the World Bank, whose support is acknowledged. The original version of Appendix 1 was compiled by Mr R. Middleton of Kalbermatten Associates.

REFERENCES

1. WORLD BANK. *Measurement of the Health Benefits of Investments in Water Supply*. Report No. PUN 20. Washington DC, The World Bank, 1976.
2. BRISCOE, J., FEACHEM, R. G., AND RAHAMAN, M. M. *Evaluating Health Impact: Water Supply, Sanitation and Hygiene Education*. Ottawa, International Development Research Centre, 1986.
3. BRISCOE, J., FEACHEM, R. G., AND RAHAMAN, M. M.

- Measuring the Impact of Water Supply and Sanitation Facilities on Diarrhoea Morbidity: Prospects for Case-Control Methods*. Geneva, World Health Organization, Environmental Health Division, 1985.
4. ESREY, S. A., FEACHEM, R. G., AND HUGHES, J. M. Interventions for the control of diarrhoeal diseases among young children: improving water supplies and excreta disposal facilities. *Bull. WHO*, 1985, 63, (4), 757-772.
 5. BLUM, D., AND FEACHEM, R. G. Measuring the impact of water supply and sanitation investments on diarrhoeal diseases: problems of methodology. *Int. J. Epidemiol.*, 1983, 12, 357-365.
 6. KIRKWOOD, B. R., AND MORROW, R. H. Community-based intervention trials. *J. Biosoc. Sci.*, 1989, Suppl. 10, 79-86.
 7. ESREY, S. A., AND HABICHT, J-P. Epidemiologic evidence for health benefits from improved water and sanitation in developing countries. *Epidemiologic Reviews*, 1986, 8, 117-128.
 8. WHITE, G. F., BRADLEY, D. J., AND WHITE, A. U. *Drawers of Water: Domestic Water Use in East Africa*. Chicago, USA, Chicago University Press, 1972.
 9. PROST, A., AND NÉGREL, A. D. Water, trachoma and conjunctivitis. *Bull. WHO*, 1989, 67, 9-18.
 10. UNRAU, G. O. Water supply and schistosomiasis in St. Lucia. *Prog. Wat. Tech.*, 1978, 11, 181-190.
 11. FEACHEM, R. G., BRADLEY, D. J., GARELICK, H., AND MARA, D. D. *Sanitation and Disease: Health Aspects of Excreta and Wastewater Management*. Chichester, UK, John Wiley and Sons, 1983.
 12. SHUVAL, H. I., TILDEN, R. L., PERRY, B. H., AND GROSSE, R. N. Effect of investments in water supply and sanitation on health status: a threshold-saturation theory. *Bull. WHO*, 1981, 59, 243-248.
 13. BUTZ, W. P., HABICHT, J-P, AND DAVANZO, J. Environmental factors in the relationship between breastfeeding and infant mortality: the role of sanitation and water in Malaysia. *Am. J. Epidemiol.*, 1984, 119, 516-525.
 14. ESREY, S. A., AND HABICHT, J-P. Maternal literacy modifies the effect of toilets and piped water on infant survival in Malaysia. *Am. J. Epidemiol.*, 1988, 127, 1079-1087.
 15. CHURCHILL, A. A., DE FERRANTI, D., ROCHE, R., TAGER, C., WALTERS, A., AND YAZER, A. *Rural Water Supply and Sanitation: Time for a Change*. World Bank Discussion Paper No. 18. Washington DC, The World Bank, 1987.
 16. WORLD HEALTH ORGANIZATION. *Minimum Evaluation Procedure (MEP) for Water Supply and Sanitation Projects*. Geneva, Environmental Health Division, 1983.
 17. AZIZ, K. M. A., HOQUE, B. A., HUTLY, S. R. A., MINNATULLAH, K. M., HASAN, Z., PATWARY, M. K., RAHAMAN, M. M., AND CAIRNCROSS, S. *Water Supply, Sanitation and Health Education*. Report of a health impact study in Mirzapur, Bangladesh. Washington DC, The World Bank, 1990.
 18. DANIELS, D. L., AND COUSENS, S. N. *Health Impact Evaluation of the Rural Sanitation Project in Mohale's Hoek District, Lesotho*. London School of Hygiene and Tropical Medicine, 1988.
 19. MERTENS, T. E., FERNANDO, M. A., COUSENS, S. N., KIRKWOOD, B. R., MARSHALL, T. F., AND FEACHEM, R. G. Childhood diarrhoea in Sri Lanka: a case-control study of the impact of improved water sources. *Trop. Med. Parasit.*, 1990, 41, 98-104.
 20. VICTORA, C. G., SMITH, P. G., VAUGHAN, J. P., NOBRE, L. C., LOMBARDI, C., TEIXEIRA, A. M. B., FUCHS, S. C., MOREIRA, L. B., GIGANTE, L. P., AND BARROS, F. C. Water supply, sanitation and housing in relation to the risk of infant mortality from diarrhoea. *Int. J. Epidemiol.*, 1988, 17, (3), 651-654.
 21. SANDIFORD, P. *A Case-Control Study of Environmental Sanitation and Childhood Morbidity in Rural Nicaragua*. MSc dissertation, London School of Hygiene and Tropical Medicine, 1988.
 22. LINDSKOG, P. *Why Poor Children Stay Sick*. Linköping Studies in Arts and Science, No. 16. Linköping University, Sweden, 1987.

HEALTH IMPACTS IN DEVELOPING COUNTRIES: NEW EVIDENCE AND NEW PROSPECTS

23. YOUNG, B., AND BRISCOE, J. A case-control study of the effect of environmental sanitation on diarrhoea morbidity in Malawi. *J. Epidemiol. and Comm. Hlth.*, 1987, **42**, 83-88.
24. BALTAZAR, J., BRISCOE, J., MESOLA, V., MOE, C., SOLON, F., VANDERSLICE, J., AND YOUNG, B. Can the case-control method be used to assess the impact of water supply and sanitation on diarrhoea? A study in the Philippines. *Bull. WHO*, 1988, **66**, (5), 627-635.
25. HUTTLY, S. R. A., BLUM, D., KIRKWOOD, B. R., EMEH, R. N., OKEKE, N., AJALA, M., SMITH, G. S., CARSON, D. C., DOSUNMU-OGUNBI, O., AND FEACHEM, R. G. The Imo State (Nigeria) drinking water supply and sanitation project, 2. Impact on dracunculiasis, diarrhoea and nutritional status. *Trans. Roy. Soc. Trop. Med. Hyg.*, 1990, **84**, 316-321.
26. ESREY, S. A., HABICHT, J-P, LATHAM, M. C., SISLER, D. G., AND CASELLA, G. Drinking water source, diarrhoeal morbidity, and child growth in villages with both traditional and improved water supplies in rural Lesotho, Southern Africa. *Am. J. Publ. Hlth.*, 1988, **78**, (11), 1451-1455.
27. ESREY, S. A., COLLETT, J., MILIOTIS, M. D., KOORNHOF, H. J., AND MAKHALE, P. The risk of infection from *Giardia lamblia* due to drinking water supply, use of water, and latrines among preschool children in rural Lesotho. *Int. J. Epidemiol.*, 1989, **18**, (1), 248-253.
28. ALAM, N., WOJTYNIAK, B., HENRY, F. J., AND RAHAMAN, M. M. Mothers' personal and domestic hygiene and diarrhoea incidence in young children in rural Bangladesh. *Int. J. Epidemiol.*, 1989, **18**, (1), 242-247.
29. PICKERING, H., HAYES, R. J., NG'ANDU, N., AND SMITH, P. G. Social and environmental factors associated with the risk of child mortality in a peri-urban community in the Gambia. *Trans. Roy. Soc. Trop. Med. Hyg.*, 1986, **80**, 311-316.

APPENDIX 1

SUMMARY OF RECENT HEALTH IMPACT STUDIES

LOCATION, SECTOR (SOURCE)	TYPE OF STUDY	PROBLEMS	CONCLUSIONS
Mirzapur, Bangladesh: Rural WS, Sanitation and health education ¹⁷	Longitudinal, children under 5	Difficult to distinguish between effects of different interventions.	<p>Combined package of WSS and health education resulted in significant decrease in diarrhoea and dysentery; relative proportion of children suffering from diarrhoea at any one time fell by 46% in intervention area.</p> <p>Closeness to handpump and use of latrine for disposing of children's faeces also significant.</p>
Mohale's Hoek, Lesotho: Rural sanitation ¹⁸	Case control, children under 5	<p>Water use not studied in detail. Private water source associated with 38% reduction in diarrhoea, but this may be largely a socio-economic effect.</p> <p>Surprisingly, significant improvement in children's height-for-age associated with latrine ownership arouses suspicion that results may be due to latrine owners being unrepresentative of population.</p>	<p>Latrine ownership appears to be associated with 24% reduction in children's diarrhoeas, but this is not quite statistically significant at 5% level.</p> <p>Impact of water supply seems likely to be connected with increased use and better hygiene, rather than improvements in water quality.</p> <p>Preliminary analysis of data showed no apparent difference between VIP, pit and bucket latrines, in respect of health impact.</p>
Kurunegala, Sri Lanka: Rural WS ¹⁹	Case control, children under 5	Apparent impact varies widely between the 5 hospitals at which cases and controls were recruited, ranging between 90% reduction in diarrhoea incidence and no significant reduction at all.	<p>No association between childhood diarrhoea and sanitation, access to water or quantity of water used.</p> <p>Quality of water used has an impact: use of protected sources resulted in about 35% reduction in the risk of diarrhoea on average, even among people claiming to boil their water. Hygienic disposal of children's faeces was also associated with 34% less diarrhoea.</p>