

115578

**THE EFFECTS OF SAFE DRINKING WATER AND
SANITATION ON DIARRHOEAL DISEASES
AMONG CHILDREN IN RURAL ORISSA**

Pradeep Kumar Panda

Working Paper No. 278

May 1997

**THE EFFECTS OF SAFE DRINKING WATER AND
SANITATION ON DIARRHOEAL DISEASES AMONG
CHILDREN IN RURAL ORISSA**

Pradeep Kumar Panda
Centre for Development Studies
Thiruvananthapuram

May 1997

This is a revised version of a paper presented at the National Seminar on Rural Water Supply and Sanitation organised by the Centre for Development Studies, Thiruvananthapuram, during 20-22 June, 1996. For constructive comments and suggestions, the author is grateful to all the participants of the seminar, and especially to Henk van Norden, UNICEF, New Delhi and to Jagadish Chander, Rajiv Gandhi National Drinking Water Mission, Government of India. The author alone is responsible for errors, if any.

Abstract

This paper investigates the effects of safe drinking water and sanitation on diarrhoeal diseases among children in rural Orissa. Safe drinking water and good sanitation facilities favour the creation of a hygienic environment, which helps to prevent the incidence of various infectious childhood diseases such as diarrhoea and enables the child to survive. In fact, considerable literature in developing countries in the last two decades documents this relationship. This issue is of particular interest in Orissa, which is characterised by high levels of poverty, low access to safe drinking water and sanitation, and high rates of diseases and deaths among children.

Data for this study come from a field survey conducted in 1989-90 in the Bolangir district of Orissa. The analysis provides strong confirmation regarding the importance of safe drinking water and sanitation when considering children's diarrhoeal episode. The results suggest that safe drinking water and sanitation facilities have a strong negative association with childhood diarrhoea, even after controlling for the effects of relevant socio-economic variables. However, mother's education and per capita income are also inversely related to the occurrence of diarrhoeal episode.

The policy implications of this study, therefore, are quite clear. With a view to achieving a steady decline in diarrhoeal diseases among children, particularly among certain socially and economically disadvantaged groups, basic facilities such as access to safe drinking water and sanitation facilities must be developed in addition to the provision of direct health care and educational opportunities.

JEL Classification: I32, I38, J13

Key words: water supply, sanitation, childhood diarrhoea, health policy, common property resource, child survival

I. Introduction

With substantial improvement in life expectancy, child mortality and complete eradication of small pox, world health conditions have improved more in the past four decades than in all of previous human history (World Bank, 1993). For instance, in 1950, life expectancy in developing countries was 40 years; by 1990, it has increased to 63 years. In 1960, 22 out of every 100 children died before their first birthday; by 1990, the number had fallen to 10. Smallpox, which killed over 5 million people annually in the early 1950s, has been eradicated entirely.

Despite these remarkable improvements, however, enormous health problems remain, especially in low income populations. Moreover, the incidence and nature of diseases tend to be different in developing economies. Infectious diseases, many of which are preventable, under-nutrition and malnutrition are far more prevalent in low income environments (World Bank, 1993; Jamison et al., 1993; Pinstrip-Andersen et al., 1993). It is estimated that 45 per cent of all deaths in developing economies in 1985 can be attributed to infectious and parasitic diseases such as diarrhoea and malaria; these diseases account for 4.5 percent of deaths in industrial market economies (Lopez, 1993). Absolute levels of mortality in developing countries are still unacceptably high; child mortality rates are about 10 times higher than those in the industrial

market economies. It is estimated that if death rates among children in developing countries were reduced to those prevailing in the rich countries, 11 million fewer children would die each year. Almost half of these preventable deaths are a result of diarrhoeal and respiratory illness, exacerbated by malnutrition (Jamison, 1993).

Diarrhoea remains one of the commonest illnesses of children, and one of the leading causes of childhood mortality in developing countries. It is estimated that over 1000 million episodes and 3 million deaths occur each year in children under five years of age in the developing countries (World Health Organisation, 1992; Bern et al., 1992). Many of these children die from dehydration; dysentery and malnutrition are also important causes of death. Diarrhoeal disease also represents an economic burden for these countries, since children with diarrhoea are often admitted to hospital and treated with expensive intravenous fluids and ineffective drugs, even though simple and effective treatment measures are available such as oral rehydration therapy (ORT) (World Health Organisation, 1992). Despite the indication of a decline in diarrhoeal mortality over the past decade in many developing countries (Martines et al., 1991; Sandiford et al., 1991), there are also recent small scale studies that offer clear evidence of continuing high mortality, especially among infants: nearly 20-30 infant deaths per 1000 live births (Kumar, 1987; Begenholm et al., 1989; Bailey et al., 1990).

Of the several interventions that may reduce diarrhoea morbidity and mortality rates (Feachem et al., 1983), the improvement of water supply and sanitation has attracted particular interest (Esrey et al., 1985). With the anticipation that the improvement of water supply and sanitation will have a substantial impact on diarrhoea morbidity and mortality rates, especially in developing regions, the motivation for the International Drinking Water Supply and Sanitation Decade (1981-90) came into

existence. However, in 1990, nearly 855 million people were still without access to safe drinking water and nearly 1.7 billion people do not have access to sanitation facilities worldwide (World Bank, 1992).

The effectiveness of improved water supply and sanitation on diarrhoea and other water related diseases in developing countries have been extensively discussed and debated over the past two decades (White et al., 1972; Saunders and Warford, 1976; World Bank, 1980; McJunkin, 1982; Feachem et al., 1983; Blum and Feachem, 1983; Merrick, 1983; Esrey and Habicht, 1985; Zaidi, 1985). Esrey et al.(1985) reviewed 67 studies from 28 countries in order to analyse the impact of water supply and sanitation on diarrhoea. They found that the median reductions in diarrhoea morbidity rates are 22 per cent from all studies and 27 per cent from a few better-designed studies. Secondly, all studies of the impact on total mortality rates show a median reduction of 21 per cent, while the few better-designed studies give a median reduction of 30 per cent. Lastly, they also found that improvements in water quality have less of an impact than improvements in water availability or excreta disposal. Similarly, the World Bank estimates that the effect of providing access to safe water and adequate sanitation to all who currently lack would result in two million fewer deaths each year from diarrhoea among children under five years of age and 200 million fewer episodes of diarrhoea annually (World Bank, 1992).

Recent empirical work on the positive effects of water supply and sanitation schemes on the health of the populations, although exists, the relationships have not been adequately documented (Briscoe et al., 1986; Briscoe, 1987; Planas, 1988; Wang et al., 1989). Moreover, it is not possible to draw a cause-and-effect relationship from these studies. Briscoe et al., (1986, 1988) addresses the methodological difficulties involved in evaluating the effects of water supply and sanitation, and

suggested improvements in the design of health impact evaluations, including the increased use of the case-control method and rapid assessments to provide information for policy decisions. It is, therefore, recognised that the development of water supply policies that can substantially improve health conditions will depend on better research to determine key factors that could make such policies cost-effective and sustainable (Weil et al., 1990).

This study investigates the effects of safe drinking water and sanitation on diarrhoeal diseases among children in a rural setting in Orissa, India. It asks two questions: First, to what extent does safe drinking water and sanitation affect childhood diarrhoea? Second, how important is this factor in relation to other socio-economic factors, such as women's education and per capita income?

The main body of the paper is organised into four sections: Section II briefly presents some background features of Orissa; Section III describes the survey data and provides the methodology used in this study; Section IV examines the empirical evidence linking safe drinking water and sanitation as well as women's education and per capita income to childhood diarrhoea; and Section V concludes the paper with a few remarks on past experience with the public policy on water supply and sanitation schemes in India and implications for the future.

II. Background

Orissa, which lies on the eastern coast along the Bay of Bengal, has 3.7 per cent of the total population and 4.7 per cent of the land area of the country. The economy of Orissa is predominantly agricultural. The agricultural sector absorbs 80 per cent of the total work force and contributes 50 per cent of the state's domestic product. About 87 per cent of the population of Orissa live in rural areas, compared with 74 per

cent in India as a whole. According to the 1991 Census, the literacy rates are 63 per cent for males and 35 per cent for females in Orissa compared with 64 per cent and 39 per cent for males and females respectively in India (Census of India, 1991).

On the economic front, 48.3 per cent of Orissa's rural population compared to 33.4 per cent nationally lived below the poverty line in 1987-88, according to the officially released Planning Commission estimates. According to the Expert Group on Poverty (1993), the incidence of poverty in rural Orissa was even much higher than rural India (61.5 per cent and 37.6 per cent respectively). Regardless of the debate on the methodology of poverty estimation, it is clear that rural poverty in Orissa is the highest in the country. In 1990-91, Orissa's real annual per capita income was Rs. 1615 compared to Rs. 2239 for India as a whole (Centre for Monitoring Indian Economy, 1993). Orissa is characterised, *inter alia*, by low agricultural productivity and the highest incidence of rural poverty in India. Agricultural modernisation and rural infrastructural development including water supply and sanitation lag behind most of India (World Bank, 1991).

The health conditions of the people of Orissa, measured in terms of mortality and morbidity, are extremely poor. For instance, in 1992, the infant mortality rate was 114 per 1000 live births in Orissa (highest among all states), compared with 79 in all India. As regards morbidity, the recently conducted National Family Health Survey (NFHS) estimates that in India, during the two weeks preceding the survey, seven per cent of children under age four had symptoms of acute respiratory infection (cough accompanied by fast breathing), 20 per cent were sick with a fever, and 10 per cent had diarrhoea¹. As against all India, the childhood

1 For a useful discussion on diarrhoea morbidity and mortality among children in India, see Bhan et al., (1989), Kumar et al., (1987), Mathur et al., (1985), and Sircar et al., (1984), Viswanathan and Rhode (1990).

morbidity in Orissa is higher for all the three diseases mentioned above: 10 per cent of children under age four had symptoms of acute respiratory infection, 32 per cent were sick with a fever, and 21 per cent had diarrhoea (National Family Health Survey, 1995).

On the whole, Orissa is economically, socially and demographically a backward state in India (Panda, 1994a). Therefore, Orissa presents an interesting case study for this research.

III. Data And Methodology

Data for this study come from a field survey conducted in 1989-90 in five villages in the Bolangir district of Orissa. All the 1107 households were covered from the five villages with similar socio-cultural milieu but different levels of development, measured in terms of use of electricity, extent of non-agricultural work and agricultural modernisation. Villages were selected so as to be representative of different development patterns found in rural Orissa. Access to infrastructural facilities was standardised by selecting villages which were similar to such criteria as transport facilities, availability of schools and health services and distance from the nearest town. All the villages are having drinking water points (tube well/bore well) provided by the government, but public provision of sanitation facilities is completely non-existent in these villages. The survey was carried out during the months of September 1989 and February 1990.

The survey utilised a household questionnaire that elicited information from the head of the household on the demographic details of each resident as well as the household's social and economic characteristics. The survey also collected information on the occurrence of the symptoms of the diarrhoeal diseases. In fact, in India as well as in Orissa, diarrhoea is a leading cause of death among children (Central Bureau of Health Intelligence, 1991). In the survey, the second

questionnaire on maternal and child health, elicited information from the currently married women in the age group 15-49 on childhood diarrhoea. Specifically, the mothers of children born during the past four years were asked a series of questions on the incidence of diarrhoea during the last one week as well as last two weeks. In order to obtain correct information on diarrhoeal episode, the women were asked if any of their children under age four had a passage of three or more loose or watery or bloody stools in a 24-hour period. For this paper, the incidence of childhood diarrhoea during the past two weeks preceding the survey has been analysed.

Since the objective of this research is to examine the determinants of childhood diarrhoea, the sample is restricted to households where the woman had at least one child born during the last four years. Restricting the sample in this manner yielded 416 households on which the analysis in this paper is based.

In this paper, logistic regression analysis is carried out to identify the factors that influence childhood diarrhoea. The logistic model does not require any distributional assumptions concerning independent variables (Cox, 1970), and it can be used not only to identify the risk factors but also to predict the probability of success. The general logistic regression model expresses a qualitative dependent variable as a function of several explanatory variables, both qualitative as well as quantitative (Fox, 1984).

If P is the probability of occurrence of childhood diarrhoea, then

$$P = \frac{\exp\{BX\}}{1 + \exp\{BX\}}$$

where B is a vector of the unknown coefficient and X is a vector of covariates that affect the occurrence of childhood diarrhoea. Thus, the general logistic model can further be expressed as:



$$\text{Log}_e [P_i / \{1 - P_i\}] = \beta X = \sum_{j=0}^k \beta_j X_{ij}$$

which expresses the log odds of childhood diarrhoea as a line function of the explanatory variables.

In this paper, we have defined the binary dependent variable that is assigned the value of 1 if a child had diarrhoea in a household during the past two weeks preceding the survey and 0 for the non-occurrence of a diarrhoeal episode in the household. A set of four explanatory variables thought to influence the dependent variable are carefully selected and categorised. The selected explanatory variables and their categories used in this paper are presented below:

Mother's education { 'illiterate', 'primary' and 'middle & above' }

Per capita annual income { low: 'less than Rs. 1200', middle: 'Rs. 1200 to Rs.2399' and high: 'Rs. 2400 and above' }

Source of drinking water { Unsafe: 'pond/river/open dug well' and Safe: 'public tube well/bore well' }

Sanitation { Unhygienic: 'Open space' for human excreta disposal and Hygienic: 'household toilet/latrine facility' }

IV. Results

In the discussion below, we briefly summarise the results from cross-tabulation between selected socio-economic variables and childhood diarrhoea. Subsequently, we discuss the inter-relationship between socio-economic variables by examining zero order correlation matrix. Finally, we discuss logistic regression results to sort out the separate effects of these explanatory variables on the likelihood of occurrence of childhood diarrhoea.

The bivariate relationships between the occurrence of childhood diarrhoea and socio-economic variables are presented in Table 1. The table shows that although nearly two-fifths of the households have experienced at least one episode of childhood diarrhoea, there are significant variations in the occurrence of childhood diarrhoea among the households with different socio-economic characteristics. The level of mother's education has a negative relation with the occurrence of diarrhoeal episode, showing the lowest occurrence of diarrhoea among

Table 1. Percentage distribution of households by occurrence of diarrhoea in at least one child under four years of age, according to selected characteristics, Rural Orissa, 1989-90

Characteristics	N	Occurrence of diarrhoea	No diarrhoea	Total
Total	416	39.2	60.8	100.0
Mother's education				
Illiterate	263	43.7	56.3	100.0
Primary	89	37.1	62.9	100.0
Middle and above	64	23.4	76.6	100.0
Per capita income				
Less than Rs. 1200	144	50.7	49.3	100.0
Rs. 1200-Rs.2399	122	37.7	62.3	100.0
Rs. 2400 and above	150	29.3	70.7	100.0
Source of drinking water				
Pond/river/open dug well	159	53.5	46.5	100.0
Tube well/bore well	257	30.4	69.6	100.0
Sanitation				
Open space	345	42.6	57.4	100.0
Household toilet*	71	22.5	77.5	100.0

Note: * includes sanitary and other latrines.

children to those women who have middle level education or above. The per capita income has also a negative effect on the occurrence of childhood diarrhoea. The households who utilise public 'tube well'/'bore well' sources for drinking water have experienced less diarrhoeal episode among their children than those households who utilise unsafe/contaminated sources of drinking water. The presence of sanitation facility has a inverse relation with the occurrence of childhood diarrhoea, showing the lowest incidence of a childhood diarrhoea among those households who have toilet/latrine facilities.

But cross-tabulation can be misleading at times, so multivariate analysis is necessary to sort out the main factors controlling for other covariates. The first step in this direction is to examine the interrelationships between various socio-economic variables. Correlations between the four explanatory variables are presented in Table 2. Results suggest that (1) mother's education is closely linked to per

Table 2. Zero order correlation matrix showing the relationships between socio-economic variables, Rural Orissa, 1989-90

Characteristics	EDN	PCI	WAT	SAN
EDN	1	.28*	.13	.24*
PCI		1	.18	.37*
WAT			1	.07
SAN				1

Notes: * significant at .05 level or better;

EDN refers to mother's education;

PCI refers to per capita income;

WAT refers to source of drinking water; and

SAN refers to sanitation facility.

capita income and better sanitation facility (household toilet); (2) per capita income is closely linked to better sanitation facility; (3) safe source of drinking water (tube well/ bore well) is unrelated to mother's education and better sanitation facility. It is important to notice that although the correlations mentioned above (especially 1 and 2) are significant and are in the expected direction, the coefficients are not very large.

The results of the logistic regression analysis are presented in Table 3². It shows the simultaneous effect of socio-economic variables on the likelihood of occurrence of childhood diarrhoea in a household. The results suggest that all the four explanatory variables are significant predictors of the occurrence of childhood diarrhoea. Moreover, the effect of the explanatory variables are in the expected direction.

However, of the four predictors, the effect of mother's education on the occurrence of childhood diarrhoea is found to be the most important one. The likelihood remains much lower for women with middle and above level of education (odds ratio is 0.315). In other words, the women with the highest level of education (middle and above) are less than or third as likely as illiterate women to have experienced an episode of diarrhoea in their children. There are many routes through which mother

2. In addition to the logistic regression results presented in Table 3, which is in additive form, we had also attempted a multiplicative logistic model by including relevant interaction terms. We have already noticed in Table 2 that some of the zero order correlation coefficients between the explanatory variables are significant, and relatively larger than others. Therefore, one would expect the first order interaction terms to be significant for the highly correlated variables. But in the multiplicative model none of the interaction terms (especially EDN*PCI, EDN*W and PCI*SAN) are found to be significant. As a result, the multiplicative model does not fit the data significantly better than the additive model. Finally, therefore, we have retained and analysed only the additive model (Table 3), which satisfies the assumption of independence of explanatory variables.

education can influence child health. For instance, increased education brings greater awareness of health in general, and results in a higher value being attached to health and hygiene. Moreover, mother's education may change a whole range of health-improving behaviour beneficial for their children as well as households. Specifically, educated mothers relative to their uneducated counterparts, are more likely to seek information and adopt child care practices, such as preparation of weaning

Table 3. Logistic regression of occurrence of diarrhoea on selected characteristics, Rural Orissa, 1989-90

Characteristics	Logistic coefficient (B)	Odds ratio	P value
Mother's education			
{Illiterate}	—	1.000	—
Primary	-.408	.641	.000
Middle and above	-.915	.315	.000
Per capita income			
{Less than Rs. 1200}	—	1.000	—
Rs. 1200-Rs. 2399	-.366	.698	.000
Rs. 2400 and above	-.642	.517	.000
Source of water supply			
{Pond/river/open dug well}	—	1.000	—
Tube well/bore well	-.552	.596	.000
Sanitation			
{Open space}	—	1.000	—
Household toilet*	-.831	.405	.000
Constant	2.004		
Model chi-square	100.599		
Degrees of freedom(d.f)	6		
Probability	.000		

Notes: (1) * includes sanitary and other latrines.

(2) Reference category is in parentheses.

foods, boiling of drinking water, and personal hygiene. All these health-improving behaviour of mother would result in decreasing incidence of childhood diseases such as diarrhoea. In fact, it has long been shown that maternal education is linked to child survival in developing countries (Caldwell and McDonald, 1981; Cochrane et al., 1982; Hobcraft et al., 1984; Linenbaum, 1990; LeVine et al., 1991; Jejeebhoy, 1995) ³.

As shown in Table 3, the results indicate that per capita income also has a significant negative effect on the occurrence of childhood diarrhoea. High income households are half as likely as low income households to have experienced an episode of diarrhoea in their children. As the literature suggests, the rich households relative to their poor counterparts are better able to buy information and have greater capacity to adopt choices, with low uncertainty, that affect childhood diarrhoea, e.g. a better living condition with hygienic household environment.

As expected, the source of drinking water has a significant independent effect on the occurrence of childhood diarrhoea. The households who utilise public 'tube well'/'bore well' sources for drinking water are three-fifths as likely as households who utilise drinking water from unsafe sources to have experienced an episode of childhood diarrhoea.

The sanitation facility has a significant net effect on the occurrence of childhood diarrhoea. The households who have toilet facilities are two-fifths as likely as households who have no such facilities (open space) to have experienced an incidence of childhood diarrhoea. In fact, in terms

3. The links between maternal education and child health is well established in India, and especially in Kerala state. For a discussion on the role of maternal education in demographic/ health transition in Kerala, see Bhat and Rajan (1990); Kabir and Krishnan (1992); and Krishnan (1976, 1991, 1992).

of the magnitude of the effect, the effect of sanitation on the occurrence of childhood diarrhoea is next to women's education.

Water supply and sanitation conditions directly affect contamination of the household environment and thus may facilitate the dissemination and incidence of various diseases, such as diarrhoea. For instance, safe disposal of human faeces or protection of water supply from contamination will result in the reduction of the incidence of diarrhoea. Therefore, prevention of diarrhoea is linked to the quality as well as the quantity of water supply and to good sanitation (Briscoe, 1984, 1987; Mosley and Chen, 1984).

To summarise, the logistic regression analysis shows that access to safe drinking water (tube well/bore well) and sanitation (household toilet/latrine) are associated with lower risks of childhood diarrhoea, even after controlling for mother's education and per capita income. However, it is important to note that mother's education and per capita income are also significant determinants of childhood diarrhoea. The socio-economic differentials in the incidence of diarrhoeal disease may be due to differences in child care practices, such as preparation of weaning foods, boiling of drinking water, or personal hygiene (Black et al., 1983).

V. Discussion and Conclusions

Although the national health policy places a major emphasis on ensuring health care to all by the year 2000, and water supply and sanitation is identified as one of the key areas which need special attention to reach such goal, the objective of providing safe drinking water and adequate sanitation to all sections of the people remains a distant goal. It also appears almost certain that reaching the goal of health for all by the year 2000 in India is an impossibility. In India, as of 1994, of the 860

million people not more than 30 per cent have access to safe drinking water and not more than 5 per cent have access to sanitation (Muraleedharan, 1994). This unfortunate scenario exists in spite of the fact that drinking water and sanitation were considered as primary health care needs in the light of the Alma Ata declaration. Muraleedharan (1994) further cautions:

“no doubt, several ‘development projects’ (such as Expanded Immunisation Programme) have contributed to increasing child survival rate, but it is doubtful whether such projects, often carried out in isolation from other development efforts, have significantly contributed to the overall growth and development of the children whose lives they have saved.”

The results of this analysis point towards the fact that women’s education, per capita income, access to safe drinking water and sanitation make significant differences in the occurrence of childhood diarrhoea in rural Orissa. Our analysis provides strong confirmation regarding the importance of safe drinking water (tube well/bore well) and sanitation (household toilet) in reducing the incidence of childhood diarrhoea, even after controlling for mother’s education and per capita income. However, in the sample households only 17 per cent of the households have access to some form of latrine facilities. Obviously, these households are economically well off. A large majority of the households do not have access to household latrine. Hence, an important public policy ought to provide subsidised grants to poor households who intend to build household toilets, or alternatively in the short run, the public policy should aim at investments in community latrine facilities separately for males and females in the villages.

As the results of this study show, only 61 per cent of the households are utilising drinking water from public ‘tube well’/ ‘bore well’ points, although the rural water supply schemes do not charge the consumers

for the supply of water through spot sources, and the water supply points are physically accessible by the households in terms of proximity. In fact, the distance to the water supply points from the households, on an average, is not more than 300 metres in all the five villages. In the survey, we also elicited information regarding non-use of drinking water through water supply points. Of the 159 households, who were not utilising drinking water from the spot sources, three-fourths of the respondents mentioned 'heavy rush at the point' as the main reason for not using water from spot sources. In fact, while collecting the data, the author observed that, it took on an average 2-3 hours to collect just two buckets of water from the spot sources by a typical woman (who usually collects water in villages). Clearly, therefore, there is an unmet need for drinking water from spot sources. Therefore, an important public initiative should aim at increasing drinking water points in the villages so as to capture the present non-users of spot sources of drinking water. In fact, the study shows that if more drinking water points are provided in these villages, the utilisation rate of safe drinking water could increase to 90 per cent from the present rate of only 61 per cent.

The study also points to the importance of women's education in reducing the occurrence of childhood diarrhoea. In fact, it is the strongest predictor of childhood diarrhoea. Therefore, increasing female education should form a part of new health and public policy. Since the infant mortality rate in Orissa is the highest in the country, and diarrhoea is a leading cause of these deaths, a more effective education programme on the prevention and treatment of diarrhoea should be designed to reach the poor, and illiterate mothers⁴.

4. Although in India the patterns of disease have undergone a transition from communicable diseases to non-communicable diseases during the last decade, the infectious and parasitic diseases are still predominant, and are major causes of deaths (Panda, 1994b).

In short, the policy implications of the study are quite clear. With a view to prevent diarrhoeal diseases among children, particularly among certain socially and economically disadvantaged groups, access to basic infrastructural facilities such as clean drinking water and hygienic sanitation must be developed, in addition to the provision of direct health care and educational opportunities.

Before concluding the paper, a few remarks on the public policy regarding provision of water supply and sanitation in India are in order. The rural-urban disparities in access to drinking water supply and sanitation continues to be substantial. A major portion (about 80 per cent) of subsidised water is used by the urban rich (house connection) to the neglect of urban poor and rural areas (Kundu, 1991; Reddy and Rathore, 1993). It is really disturbing because most of the social consumption such as drinking water and sanitation are heavily subsidised through government grants to favour the poorer sections of the society. In practice, there seems to be a strong bias in favour of the high income groups resulting in further disparities in the level and quality of basic amenities. A further dimension of rural-urban bias is that while in the case of urban areas the stress is on providing safe and adequate water, in the case of rural areas the objective is simply in terms of covering number of villages with drinking water facilities (Government of India, 1990). As the results of this study show mere availability of drinking water points do not translate into effective utilisation.

Public policies may also reduce, rather than improve, poor people's health and livelihood conditions. For instance, lack of access to cooking fuel as a result of privatisation of common property resources such as forest lands in some parts of the country, indirectly affect health by reducing the ability of poor families to regularly boil drinking water, by compromising the full cooking of food, and by reducing the frequency

of cooking, resulting in increased risk of bacterial contamination of food and water (Agarwal, 1986) ⁵. This has serious implications for child health in poor families. Still another dimension of public policy which may affect child health adversely is that of oral rehydration therapy, which has frequently been favoured over improvements in water supply and sanitation (United Nations, 1990), although the links between quality and quantity of water supply and prevalence of diarrhoeal diseases are well known (World Bank, 1992). However, it should be realised that oral rehydration is simply an immediate response to diarrhoea, while water supply and sanitation investments are essential to prevent diarrhoea to start with (Desai, 1994) ⁶. Despite major differences in ideology and approach, the governments should continue financing efficiently executed and effectively targeted water supply and sanitation projects in developing countries.

The inappropriate public policies in India such as privatisation of common property resource, rural-urban disparities in the access to and utilisation of water and sanitation, highly subsidised drinking water and sanitation schemes favouring the rich, have to be remodified through distributive policies. The distributive policies that are effectively targeted at the poor, ultimately, can go a long way in ensuring prospects for child survival in India.

5. For a discussion on privatisation of common property resources such as forest lands in some parts of India, see Guha (1983, 1985).

6. Since deaths from acute diarrhoea are most often due to the dehydration that results from the loss of water and electrolytes (Black, 1984), the diarrhoeal deaths can be prevented by prompt administration of rehydration solutions. Hence the role of oral rehydration therapy for child survival is emphasised.

REFERENCES

- Agarwal, B. {1986} *Cold Hearths and Barren Slopes: The Wood-fuel Crisis in the Third World*. New Delhi: Allied Publishers.
- Bailey, P. et al. {1990} "A study of infant mortality and causes of death in rural north-east Brazilian community," *Journal of Biosocial Sciences*, 22: 349-363.
- Begenholm, G.C. and Nasher, A.A.A. {1989} "Mortality among children in rural areas of the People's Democratic Republic of Yemen," *Annals of Tropical Paediatrics*, 9: 75-81.
- Bern, C., Martinez, J., de Zoysa, I. and Glass, R.I. {1992} "The magnitude of the global problem of diarrhoeal disease: a ten-year update," *Bulletin of the World Health Organisation*, 70(6): 705-714.
- Bhan, M. K. et al. {1989} "Descriptive epidemiology of persistent diarrhoea among young children in rural north India," *Bulletin of the World Health Organisation*, 67: 281-288.
- Bhat, Mari and Rajan, S. Irudaya {1990} "Demographic transition in Kerala revisited," *Economic and Political Weekly*, September 1-8.
- Black, R.E. {1984} "Diarrhoeal diseases and child mortality," in W. Henry Mosley and Lincoln C. Chen(eds), *Child Survival: Strategies for Research, Population and Development Review*, Supplement to Volume 10.
- Black, R.E., Chen, L.C., Harkavy, O., Rahaman, M.M. and Rowland, M.G.M. {1983} "Prevention and control of diarrhoeal disease," in L.C. Chen and N.S. Scrimshaw (eds), *Diarrhoea and Malnutrition*, New York: Plenum, 297-303.
- Blum, D. and Feachem, R.G. {1983} "Measuring the impact of water supply and sanitation investment on diarrhoeal diseases: problems of methodology," *International Journal of Epidemiology*, 12: 357-365.

- Briscoe, J. {1984} "Water supply and health in developing countries: selective primary health care revisited," *American Journal of Public Health*, 74: 1009-1013.
- Briscoe, J. {1987} "A role for water supply and sanitation in the child survival revolution," *Bulletin of the Pan American Health Organisation*, 2(2): 93-105.
- Briscoe, J. et al. {1986} *Evaluating Health Impact: Water Supply, Sanitation, and Hygiene Education*, Ottawa: International Development Research Centre.
- Briscoe, J. et al. {1988} "Case-control studies of the effect of environmental sanitation on diarrhoea morbidity: methodological implications of field studies in Africa and Asia," *International Journal of Epidemiology*, 17(2): 441-447.
- Caldwell, John C. and McDonald, Peter F. {1981} "Influence of maternal education on infant and child mortality: levels and causes," International Union for Scientific Study of Population, *International Population Conference, Manila*, Vol.2, Leige, Belgium.
- Census of India {1991} *Final Population Totals: Brief Analysis of Primary Census Abstract*, Series 1, Paper 2 of 1992, New Delhi: Government of India.
- Central Bureau of Health Intelligence {1991} *Health Information of India- 1991*. New Delhi: Directorate of Health Services, Ministry of Health and Family Welfare.
- Centre for Monitoring Indian Economy {1993} *Basic Statistics Relating to Indian Economy*, Vol.2: States, Bombay: Economic Intelligence Service.
- Cochrane, Susan, Leslie, Joanne and O'Hara, Donald J. {1982} "Parental education and child health: inter-country evidence," *Health Policy and Education*, 2(3/4): 213-250.
- Cox, D.R. {1970} *Analysis of Binary Data*, London: Chapman and Hall.

- Desai, Sonalde {1994} "Women's burdens: easing the structural constraints," in Gita Sen, Andrienne Germain and Lincoln C. Chen (eds) *Population Policies Reconsidered: Health, Empowerment, and Rights*, Harvard Series on Population and International Health, Harvard University Press.
- Esrey, S.A., Feachem, R.G. and Hughes, J.M. {1985} "Interventions for the control of diarrhoeal diseases among young children: improving water supplies and excreta disposal facilities," *Bulletin of the World Health Organisation*, 63(4): 757-772.
- Esrey, S.A. and Habicht, J.P. {1985} *The Impact of Improved Water Supplies and Excreta Disposal Facilities on Diarrhoeal Morbidity, Growth, and Mortality Among Children*, Cornell International Nutrition Monograph Series, Division of Nutritional Sciences, Cornell University, Ithaca.
- Feachem, R.G. et al. {1983} "Diarrhoeal disease control: reviews of potential interventions," *Bulletin of the World Health Organisation*, 61: 637-640.
- Feachem, R.G. et al. {1983} *Sanitation and Disease: Health Aspects of Excreta and Wastewater Management*, Chistester: John Wiley.
- Fox, J. {1984} *Linear Statistical Models and Related Methods*, New York: John Willy & Sons.
- Government of India {1990} *Draft Eighth Five Year Plan: 1990-95*, Vol. I, Planning Department, October.
- Guha, R. {1983} "Forestry in British and post-British India: a historical analysis," *Economic and Political Weekly*, October 29.
- Guha, R. {1985} "Scientific forestry and social change in Uttarakhand," *Economic and Political Weekly*, 20: 45-47.
- Hobcraft, J.N., McDonald, J.W. and Rustein, S.O. {1984} "Socio-economic factors in infant and child mortality: a cross-national comparison," *Population Studies*, 38:193-224.

- Jamison, D. {1993} "Investing in health," *Finance and Development*, Vol. 30, No. 3.
- Jamison, D., Mosley, W.H., Measham, A. and Bobadilla, J.L. (eds) {1993} *Disease Control Priorities in Developing Countries*, Oxford: Oxford University Press.
- Jejeebhoy, S.J. {1995} *Women's Education, Autonomy and Reproductive Behaviour: Experience from Developing Countries*, Oxford: Clarendon Press.
- Kabir, M. and Krishnan, T.N. {1992} "Social intermediation and health transition: lessons from Kerala," Paper presented in the workshop on Health and Development in India, jointly organised by National Council of Applied Economic Research and the Harvard Centre for Population and Development Studies, at India International Centre, New Delhi, January 2-4, 1992.
- Krishnan, T.N. {1976} "Demographic transition in Kerala: facts and factors," *Economic and Political Weekly*, Annual Number, August.
- Krishnan, T.N. {1991} "Kerala's health transition: facts and factors," Paper presented at the Health Transition Seminar of the Harvard Centre for Population and Development Studies, in November 1989(revised version).
- Krishnan, T.N. {1992} "Population, poverty and employment in India," *Economic and Political Weekly*, Vol. 27, No. 46.
- Kumar, V. et al. {1987} "Oral rehydration therapy in reducing diarrhoea related mortality in rural India," *Journal of Diarrhoeal Disease Research*, 5: 159-194.
- Kundu, A. {1991} "Micro environment in urban planning: access of poor to water supply and sanitation," *Economic and Political Weekly*, No.37, September 14.
- Linenbaum, S. {1990} "Maternal education and child care practices in Bangladesh: the health and hygiene of the middle classes," in

- J. Caldwell, S. Findley, P. Caldwell, G. Santon, J. Braid and D. Broers-Freeman (eds) *What We Know about the Health Transition: The Cultural, Social and Behavioural Determinants of Health, Vol. 1*, Health Transition Center, Canberra: The Australian National University.
- LeVine, R.A., LeVine, S.E., Richman, A., Uribe, F.M.T., Correa and Miller, P.M. {1991} "Women's schooling and child care in the demographic transition: a Mexican case study," *Population and Development Review*, 17: 459-496.
- Lopez, A. {1993} "Causes of death in industrial and developing countries: estimates for 1985-1990," in D. Jamison, W.H. Mosley, A. Measham and J.L. Bobidilla (eds), *Disease Control Priorities in Developing Countries*, Oxford: Oxford University Press.
- Martines, J. et al. {1991} "Diarrhoeal diseases," in D. Jamison and W.H. Mosley (eds), *Evolving Health Sector Priorities in Developing Countries*, World Bank, Washington, D.C.
- Mathur, R. et al. {1985} "Nutritional status and diarrhoea morbidity: a longitudinal study in rural pre-school children," *Human Nutrition: Clinical Nutrition*, 39C: 447-454.
- McJunkin, F.E. {1982} *Water and Human Health*, National Demonstration Water Project, United States Agency for International Development, Washington, D.C.
- Merrick, T. {1983} "The effects of piped water on early childhood mortality in Urban Brazil 1970-76," *World Bank Staff Working Paper*, No. 594, Washington, D.C.
- Mosley, W.H. and Chen, L.C. {1984} "An analytical framework for the study of child survival in developing countries," *Population and Development Review*, 10(Supplement): 25-45.
- Muraleedharan, V.R. {1994} "Health care: from policy to practice," *Economic and Political Weekly*, Vol. 29, No. 25.

- National Family Health Survey { 1995 } *National Family Health Survey, 1992-93: India, Bombay: International Institute for Population Sciences.*
- Panda, P.K. { 1994a } 'Review' of Ashish Bose's "Population of India: 1991 Census Results and Methodology", *Indian Journal of Agricultural Economics*, Vol. XLIV, No. 1:137-139.
- Panda, P.K. { 1994b } "The changing patterns of disease and lifestyle transition in India," Paper presented at the 76th Platinum Jubilee Conference of the Indian Economic Association, jointly organised by Department of Economics, University of Bombay and Indira Gandhi Institute of Development Research in Bombay, February 19-21, 1994.
- Pinstrup-Andersen, P., Burger, S., Habicht, J.P. and Peterson, K. { 1993 } "Protein-energy malnutrition," in D. Jamison, W.H. Mosley, A. Measham and J.L. Bobidilla(eds), *Disease Control Priorities in Developing Countries*, Oxford: Oxford University Press.
- Planas, A. { 1988 } "Implementation of the drinking water supply and sanitation decade in Latin America and the Caribbean," *Natural Resources Forum*, 12(3): 255-266.
- Planning Commission { 1993 } *Report of the Expert Group on Estimation of Proportion and Number of the Poor, 1993*, New Delhi: Government of India.
- Reddy, V. Ratna and Rathore, M.S. { 1993 } "Bias in social consumption: case study of residential water supply in Rajasthan," *Economic and Political Weekly*, Vol. 28, Nos. 32-33.
- Sandiford, P. et al. { 1991 } "Why do child mortality rates fall? An analysis of the Nicaraguan experience," *American Journal of Public Health*, 81: 30-37.
- Sanders, R.J. and Warford, J.J. { 1976 } *Village Water Supply: Economics and Policy in Developing World*, Baltimore: Johns Hopkins University Press.

- Sircar, B.K. et al. {1984} "A longitudinal study of diarrhoea among children in Calcutta communities," *Indian Journal of Medical Research*, 80: 546-550.
- United Nations {1990} *Patterns of First Marriage: Timing and Prevalence*, New York: United Nations.
- Vishwanathan, H. and Rhode, J.E. {1990} *Diarrhoea in Rural India: A Nation-wide study of Mothers and Practitioners*, New Delhi: Vision Books.
- Wang, Z.S. et al. {1989} "Reduction of enteric infectious disease in rural China by providing deep-well water," *Bulletin of the World Health Organisation*, 12(3): 255-266.
- Weil, D.E. Cooper, Alicbusan, A.P., Wilson, J.F., Reich, M.R. and Bradley, D.J. {1990} *The Impact of Development Policies on Health: A Review of the Literature*, Geneva: World Health Organisation.
- White, G.F. et al. {1972} *Drawers of Water*, Chicago: Chicago University Press.
- World Bank {1980} *Health: Sector Policy Paper*, Second Edition, Washington, D.C: The World Bank.
- World Bank {1991} *Gender and Poverty in India*, A World Bank Country Study, Washington, D.C: The World Bank.
- World Bank {1992} *World Development Report 1992*, New York: Oxford University Press.
- World Bank {1993} *World Development Report 1993*, New York: Oxford University Press.
- World Health Organisation {1992} *Readings on Diarrhoea*, Geneva: World Health Organisation.
- Zaidi, S.A. {1985} "The urban bias in health facilities in Pakistan," *Social Science and Medicine*, Vol. 20, No. 5.