

Diarrhoeal diseases in Nepal *vis-à-vis* water supply and sanitation status

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ABSTRACT

Diarrhoeal diseases are still a major challenge in Nepal because of inadequate safe water supply, poor sanitation and living conditions. However, several other factors such as the literacy rate, socio-economic status, and social, religious or personal perception of the cause of disease may influence the rate of morbidity and mortality of diarrhoeal diseases. A yearly minimum death of 30,000 and morbidity of 3.3 episodes per child was estimated due to diarrhoea. An environmental health education programme, along with water supply and sanitation intervention, is an effective mitigation measure to reduce diarrhoeal diseases in Nepal.

Key words | diarrhoeal diseases, Nepal, sanitation, water supply

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INTRODUCTION

The rapid growth in population in recent decades with centralized facilities and opportunities available in urban areas has created tremendous overcrowding in urban centres worldwide. Most of the developing nations are unable to meet the demand of the increased population. Problems such as a high population density with an increased number of persons in limited space, an increase in solid waste generation, unhygienic surroundings and an increased demand for water supply and sanitation facilities are evident. It is one of the main reasons that rural and urban poor frequently suffer from waterborne diseases such as diarrhoea, typhoid, dysentery and cholera. Approximately 1.1 billion (one-sixth) of the world's population has no access to dependable water supply and 2.4 billion (two-fifths) lack access to sanitation facilities (WHO and UNICEF 2000). The majority of these people live in Asia and Africa. The developing countries in Asia and Africa face a difficult challenge in dealing with water-related infections. As an example, Levine *et al.* (1976) reported cholera and diarrhoea outbreaks because of the consumption of contaminated tube-well water in Bangladesh. Nath (1996) reported 348 cases of Guinea worm infestation in 11 districts of Rajasthan, India, in 1994 due to consumption of contaminated groundwater.

Diarrhoeal diseases are a major cause of sickness and death among young children in most developing countries (Feachem *et al.* 1983). Cairncross *et al.* (1990) characterized poor people's life in the third world as continuous ill health. The authors made the painful statement that 'most poor die young in the third world'. WHO and UNICEF (2000) reported that about 4 billion cases of diarrhoea occur every year, causing 2.2 million deaths worldwide. Snyder & Merson (1982) reported 744–1,000 million episodes and 4.6 million deaths (based on the 1980 data) due to diarrhoeal diseases in children under 5 years of age in Africa, Asia (excluding China) and Latin America. Moore *et al.* (1965) reported diarrhoea morbidity rates as high as 433 per 1,000 population of all ages and 1,515 per 1,000 children annually in a study in Costa Rica.

Nepal is a developing country with a population of approximately 23.9 million. The majority (80%) of the people reside in rural areas. The economic structure of Nepal is largely characterized by high unemployment and low productivity agricultural patterns. Nearly 80% of the population depends on agriculture as its primary source of income. The literacy rate is quite low: 40.4% (adult >15 years) according to the Human Development Index (HDI) report (UNDP 2001). Nepal is ranked 129th among 162

countries in the world based on the Human Development Index (UNDP 2001). The average per capita income of the people of Nepal is only US\$210 per annum (Nepal South Asia Centre 1998). Infant, child and maternal mortality rates are 74.7, 118 and 47.5 per 1,000, respectively (DoHS 1998/99). Average life expectancy at birth is only 58.1 years (UNDP 2001).

The rapid population increase in Nepal has created similar problems to those in other developing nations. Factors such as illiteracy, traditional perceptions of the cause of disease and poverty have further increased the risk of waterborne diseases. Thousands of deaths have resulted from waterborne diseases such as diarrhoea and gastroenteritis. Diarrhoeal diseases are estimated to be responsible for a minimum of 30,000 deaths annually (DoHS 1998/99). Pokhrel & Kubo (1996) stated that 30,000–40,000 deaths are due to gastroenteritis diseases each year in Nepal. Diarrhoea alone was reported to be responsible for 13% of morbidity and the major reason for hospital admission (3.5%) in 1995 (Sapkota 1997). A number of studies have been conducted in the past two decades regarding the incidence of waterborne diseases and the required intervention programmes in developing countries. However, there are only limited published data available specifically on Nepal on these issues. This study aims to analyse the incidence of diarrhoeal diseases, water supply and sanitation status, and the type of interventions required to reduce morbidity and mortality due to diarrhoeal diseases in Nepal.

WATERBORNE DIARRHOEA IN NEPAL

The ingestion or inhalation of pathogens into the human body by exposure to contaminated drinking water, food and fomites are the major reasons behind the outbreak of diarrhoeal diseases in general. Ono *et al.* (2001) reported on the results of 334 diarrhoeal faecal samples collected from various hospitals in Kathmandu valley and found *Escherichia coli*, *Vibrio cholerae*, *Shigella*, *Rotavirus A*, *Giardia intestinalis* and *Cryptosporidium parvum* in the tested specimens. The presence of enteropathogens was highest in summer (61%) and their presence decreased in

winter (52%), spring (31%) and autumn (25%). The water samples collected from the water supply system of the Kathmandu valley showed one or more bacterial species (75% i.e. 43 out of 57 samples tested) out of which 51% were *E. coli* (22 out of 43). The authors concluded that contamination of the drinking water was the reason for the diarrhoea incidence.

In a similar study, Pokhrel & Kubo (1996) reported on the cholera outbreak in Kathmandu in 1995. These authors indicated the seasonal variation of the diarrhoeal cases showing that the maximum number of incidences occurred in the rainy season (June to November); no case of cholera was observed from December to May. Ise *et al.* (1996) reported a cholera outbreak in 1994 (July–September) in the Kathmandu valley. The authors indicated that the waterborne infection was related to the consumption of contaminated river water. *Vibrio cholerae O1* and enteropathogenic *E. coli* were detected in the stool of the patients. Sherchand & Shrestha (1996) reported on the prevalence of *Cryptosporidium* oocysts (6.8%) in the diarrhoeal patients in Kathmandu valley. Sherchand *et al.* (1996) reported that *Cryptosporidium* had the highest prevalence (1.4%) in the children with abdominal discomfort (ADC) group. In both healthy children (HC) and adults with abdominal discomfort (ADA) the prevalence was 0.4%, whereas the parasite was not found in any specimen from the healthy adults (HA). Shrestha *et al.* (1993) stated that chronic diarrhoea was a consequence of poverty, poor hygiene and environmental contamination.

The outbreaks of gastroenteritis and diarrhoea were reported by various news media in different parts of the kingdom. In 2000 a local daily newspaper, the *Kathmandu Post*, reported outbreaks of these diseases with locations of incidence as follows: 15 May (Sindhuli), 24 May (Jumla), 25 May (Jumla), 29 May (Jumla), 20 July (Jajarkot), 28 July (Kathmandu), 18 August (Kalaiya), 22 September (Dolpa). Similarly, the same daily newspaper in 2001 reported the following diarrhoeal epidemics: 17 April (Gulariya), 29 May (Sindhuli), 31 May (Jajarkot), 10 June (Doti), 2 July (Bhojpur), 4 July (Nawalparasi), 13 July (Doti), 8 August (Morang), 16 August (Dolpa) and 3 September (Rolpa). The death tolls were also reported in some of these incidences. Children were among the victims in most of these cases. The diarrhoeal cases for fiscal

Table 1 | Monthly trends of diarrhoeal new visits in fiscal years 2052/53–2055/56 (DoHS 1997/98–1998/99)

Month	Fiscal year: Nepalese			
	2055/56 (1998/99)	2054/55 (1997/98)	2053/54 (1996/97)	2052/53 (1995/96)
Sharawan (Jul/Aug)	56,450	56,763	51,375	53,138
Bhadra (Aug/Sep)	55,613	50,481	42,708	42,702
Aswin (Sep/Oct)	42,051	33,747	34,978	32,366
Kartik (Oct/Nov)	40,253	31,426	26,776	26,061
Mangshir (Nov/Dec)	30,877	27,682	26,525	23,008
Poush (Dec/Jan)	27,876	25,421	29,135	21,535
Magh (Jan/Feb)	30,510	27,763	24,787	23,713
Falgun (Feb/Mar)	40,957	31,766	30,861	28,220
Chaitra (Mar/Apr)	61,174	45,142	39,146	41,176
Baikash (Apr/May)	55,496	62,619	51,123	50,899
Jestha (May/Jun)	60,232	74,868	58,182	58,015
Ashad (Jun/Jul)	60,331	75,563	61,823	56,951

years 1995/96 to 1998/99 are presented in Table 1 and Figure 1. The incidence of diarrhoeal diseases, deaths and case fatality rate are presented in Table 2.

The actual cases of diarrhoea may be several-fold higher than the numbers shown in Table 1. However, the table shows the trend of morbidity as the seasons change throughout the year. In fact, there may be many unreported cases for various reasons. Firstly, the hospitals or the health posts are far away from the community settlement in many rural areas and the doctors rarely stay in the rural hospitals. As an example, in the case of Dolpa (a rural district), the *Kathmandu Post* in its 15 April (2000) issue, states: 'The lone doctor of the health post left here to attend a seminar in the capital four months back. He had not returned ever since. To make matters worse, even the assistant health workers are missing.' The story of almost all rural areas of Nepal is similar to this. This can be easily seen from the ratio of doctors to the population: 1:13,698

according to 1993/94 data (Suwal 2001). Secondly, adults especially women are usually reluctant to report the incidence in front of others because of illiteracy and possible social embarrassment. The third and the most crucial reason in many cases is the lack of financial resources. Usually, people do not have money for transport, to buy medicine or they fear that the cost of a hospital visit/stay will be unaffordable.

Normally, the dry season starts in the month of Chaitra (March/April) and continues until Jestha (May/June) in Nepal. The rainy season starts in Ashad (June/July) and continues until Aswin (September/October). Waterborne epidemics such as diarrhoea, gastroenteritis, typhoid and cholera occur in these seasons because of inadequate water, poor water quality and unsanitary conditions. In rural Nepal, the major means of excreta disposal are open defecation in pastureland or jungle. Due to illiteracy, lack of awareness and lack of knowledge,

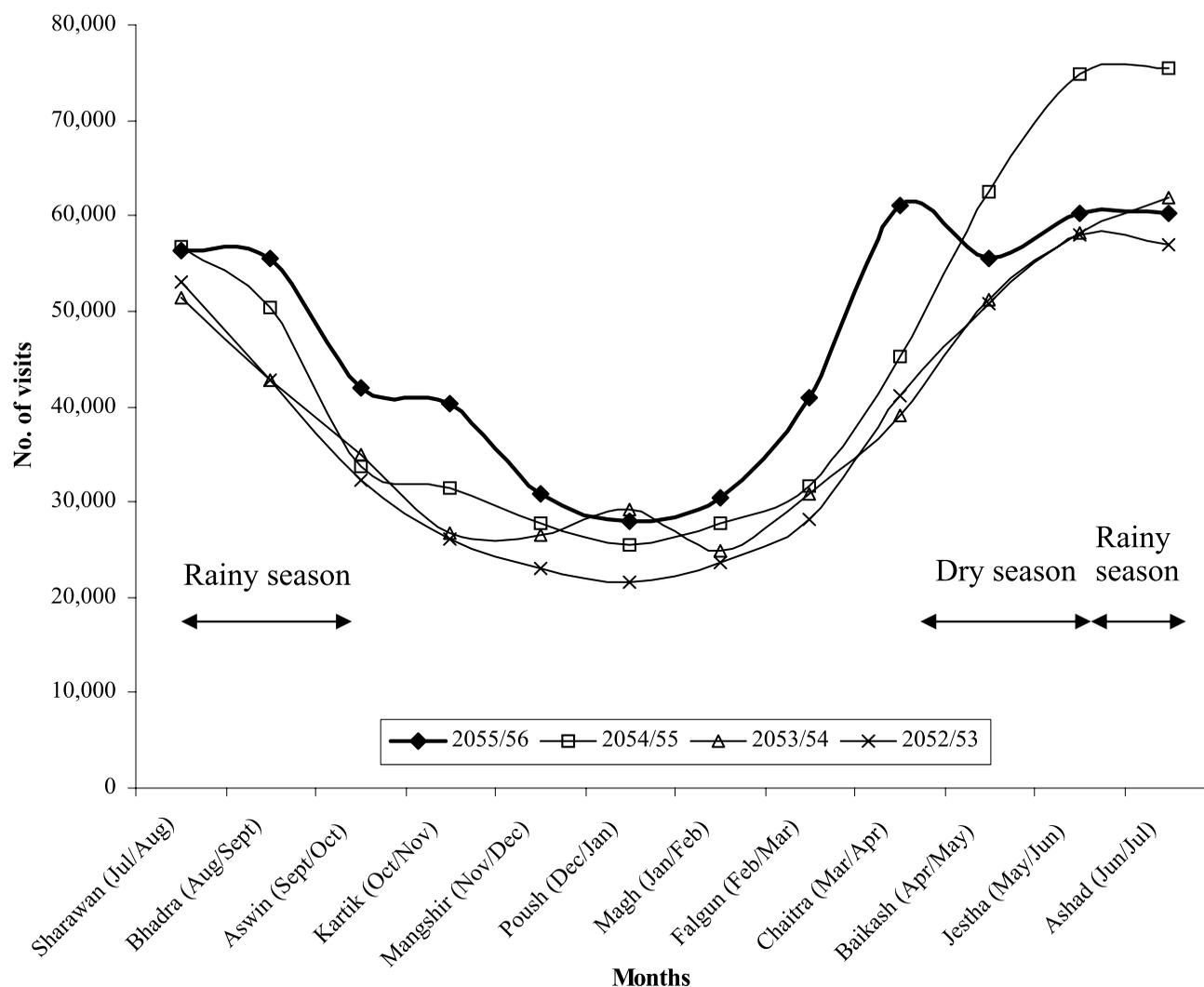


Figure 1 | Monthly trend of diarrhoeal cases in Nepal (DoHS 1997/98, 1998/99).

children and the elderly often defecate around their houses. This unhygienic environmental situation increases the risk of food and water contamination by various disease vectors such as flies, rats and pet animals. The other reason for diarrhoeal outbreaks is limited water availability and poor water quality for drinking and sanitation purposes. During the dry season, there is an acute scarcity of drinking water, while in the rainy season, the quantity of water available is high but most water sources are contaminated with excreted organisms due to surface water runoff. An example of the acute scarcity of drinking water in rural Nepal (Tehrathum district) was reported

in the 8 May (2000) issue of the *Kathmandu Post*, which stated that women in many Village Development Committees (VDCs) of Tehrathum district walked all night to fetch water instead of sleeping. They were compelled to fetch water in pitchers from long distances, as all the natural sources of water had dried up and even if water was carried through pipes, all the pipes were dry. 'Women walk up and down the steep slope with pitcher on their back from about 2 or 3 am to 10 or 11 pm every day' (*Kathmandu Post* 2000).

Data in Table 2 indicate that the number of hospital visits due to diarrhoea had increased compared with the

Table 2 | Incidence of diarrhoeal diseases and case fatality (DoHS 1996/97–1998/99)

Year	Incidence of diarrhoea per 1,000 <5 years of age	Diarrhoeal deaths per 1,000	Case fatality rate per 1,000 <5 years population	Diarrhoeal death <5 years population	Total number of cases
1998/99	172	0.2	0.1	655	561,820
1997/98	171	0.1	0.9	470	543,241
1996/97	154	0.2	1.4	683	477,419
1995/96	131	0.3	2.6	1,010	394,925
1994/95	143	NA	NA	1,279	433,160

NA: No data available.

previous years. The reasons may be increased awareness among the people to report to a hospital and the number of hospitals may have increased. It cannot be concluded from the available data whether the diarrhoeal death rate has decreased. However, the case fatality rate has dramatically reduced. At the same time, the diarrhoeal death rate among 5-year-old children has decreased.

WATER SUPPLY AND SANITATION IN NEPAL

In the beginning of 2000, 82% of the world's population had access to some form of water supply and 60% had access to sanitation facilities. The water supply and sanitation coverage in Asia was reported to be 81% and 48%, respectively (WHO/UNICEF 2000). The water supply and sanitation coverage in Nepal was shown to be 81% and 27%, respectively, in the same report. The urban water supply (85%) and sanitation coverage (75%) was comparatively higher than the rural (water supply 80% and sanitation 20%). These figures for Nepal may be higher than the actual figures. Government data on the achievement of water supply coverage at the end of the 8th five-year plan (1997) was shown as 61% only (Sharma 2000). In Nepal, the lack of access to sanitation is striking. In 2000, the Asian Development Bank (ADB) stated that poor sanitation conditions all over the country were the

major contributors to the country's poor health profile. Poor health of the people means low productivity. The economic loss associated with inadequate sanitation in Nepal was estimated to be US\$153 million in 1996, equivalent to 4.1% of the GDP (WHO and UNICEF 2000). Kelly (1990) indicated that contamination of the water supply system by excreted organisms and water contamination in storage systems were the major reasons for diarrhoeal disease outbreaks in the rural community of Nepal.

The Family Health Survey (1996) reported that only 8.8% of the population of Nepal received piped water in their residences. The percentages of the population depending on the public taps and on the public hand-pumps were 22.7% and 20.9% respectively. Other sources of drinking water were open wells, hand pumps, springs and rivers. The sanitation situation was reported to be very poor. About 77% of the population lacked access to sanitation facilities. Housing conditions were poor and overcrowded in most cases. The survey data showed that 37% of households had 3–4 persons in a room. A study by Stanton & Clemens (1987) in Dhaka, Bangladesh, showed that low family income and living in a one-room house were statistically associated with increased diarrhoea attack. Data on the major drinking water sources, access to sanitation facilities and number of persons to a room (related to Nepal) are presented in Table 3.

Table 3 | Sources of drinking water, sanitation facility and number of persons in a room (Family Health Survey 1996)

Source of drinking water	% served	Sanitation facility	% served	Persons sleeping in a room	% served
Piped water in residence	8.8	Flush toilet	1.2	1–2	39
Public tap	22.7	Traditional pit toilet	12.9	3–4	37
Well in residence	2.1	Ventilated improved toilet	1.0	5–6	17
Public well	5.0	Pan	6.9	> 7	6.7
Hand pump in residence	11.9	No facility	77.3	Other	0.3
Public hand pump	20.9	Other	0.2	—	—
Spring water (kuwa)	18.9	—	—	—	—
River (stream)	7.2	—	—	—	—
Stone tap and other	3.4	—	—	—	—

The present state of water supply and sanitation facility improvement in Nepal is the result of improper planning and inadequate budgets. Sharma (2000) reported that, until the 4th five-year plan (1970–75), no planned emphasis was given to the water supply sector. Sanitation was only involved in the national budget from the 6th five-year plan (1980–85). It seems that water supply and sanitation were given priority in the national plan of Nepal only after the international community began to emphasize water supply and sanitation: ‘water and sanitation for all by 1990’ was the slogan of the World Water Conference in Mar del Plata, Argentina, in 1977 (Bourne 1984). Only in the 8th five-year plan (1992–1997) were social services given the top priority in the national budget (31%); drinking water and sanitation received 6% of the budget.

IMPACT OF WATER SUPPLY AND SANITATION INTERVENTIONS

Numerous factors affect the incidence of diarrhoeal diseases and these factors play a great role in the effectiveness

of intervention programmes. Huttly *et al.* (1987) reported on the impacts of water supply and sanitation projects in five villages in Imo State, Nigeria, where 75% of the illness in young children was associated with diarrhoea compared with 20% in adults. Risk factors included were lower socio-economic status, an unclean domestic environment, use of unpurified water, absence of soap and feeding methods other than exclusive breast-feeding in the early months of infancy. Stanton & Clemens (1987) reported that low maternal education, low economic status, inferior quality of housing, diminished access to water and sanitation facilities and crowding in the household were responsible for an increased risk of diarrhoea in a study at Dhaka, Bangladesh. Victora *et al.* (1988) reported that the lack of piped water supply, absence of flush toilets, residence in a poorly built house and household overcrowding were significantly associated with diarrhoeal death in the metropolitan areas of Porto Alegre and Peloras in southern Brazil.

In a similar study on four slum, squatter and pavement dweller communities of Mumbai City, India, Karn & Harada (2002) reported that neighbourhood water pollution, poor sanitation, poor housing and low family income were the risk factors for diarrhoea, typhoid and malaria

cases in the study area. In a study in Madurai, India, Rajasekaran *et al.* (1977) reported that those households using street tap water were at greater risks (36.78) due to diarrhoea compared with those using tap water within their houses (23.52). Safdar Ashraf & Yunus (1997) reported that the communities using public stand pipes were at a higher risk (88.3%) for typhoid, bacillary dysentery and diarrhoea compared with the risk level (51.8%) in a community with piped water supply in a study in the Indian City of Aligarh.

Interventions such as piped water supply, sanitation, hand washing with soap and hygiene education are considered to be effective tools to control diarrhoeal diseases. Hand washing using soap after toilet use is reported to reduce diarrhoea morbidity. Han & Hlaing (1989) studied the effect of hand washing by soap after defecation and before preparing meals in a low-income community in Rangoon, Burma. The authors reported that diarrhoea incidence among the children in the hand-washing households was significantly reduced compared with the control households. A 40% reduction in the dysentery incidence in children less than 2 years of age was obtained. In a study by Black *et al.* (1981) hand washing with soap was suggested as a possible programme to reduce diarrhoea in children in day-care centres. Hutin *et al.* (2003) reported on the cholera outbreak in Kano City, Nigeria, where a total of 5,600 cholera cases and 340 cholera deaths occurred between December 1995 and May 1996. The authors indicated that a safe drinking water system and hand washing prior to eating food could have prevented a significant number of cases if implemented earlier than the outbreak.

Improvements in water and sanitation facilities are believed to reduce the transmission and ingestion of faecal-oral pathogens, particularly the major infectious agents of diarrhoea (Esrey & Habicht 1986). However, factors such as breast-feeding, income level and the literacy rate of the individual or community play a significant role in the mortality and morbidity rate. Helmer (1999) claimed that the morbidity and mortality from water-related diseases could be reduced dramatically through the provision of safe drinking water supplies and adequate sanitation facilities. Esrey *et al.* (1985) analysed 67 studies from 28 different countries and reported the

impacts of water supply and excreta disposal facilities on reduction of diarrhoeal diseases. The authors indicated that improvements in: (1) water quality, (2) water availability, (3) water quality and water availability together, and (4) excreta disposal facilities could reduce diarrhoeal diseases by median values of 16%, 25%, 37% and 22%, respectively. This showed that the improvement in water quality had less of an impact than did improvements in water availability and excreta disposal facilities. The authors also reported on the impacts of water supply or excreta disposal facility improvements for different literacy rate groups:

Adult literacy rate (%)	Median reduction of diarrhoea (%)
<40	46
40–75	39
>75	32

These figures show that the impact of the facility improvement on the population with a low literacy rate is highest (46%) compared with the populations with higher literacy rates. The reduction in mortality due to diarrhoeal diseases by water supply and sanitation facility improvements was 21%. Esrey *et al.* (1991) evaluated 144 studies related to the impact of improvements in water supply and sanitation facilities on reduction of waterborne diseases. The authors indicated that a reduction of 26% in diarrhoeal morbidity and 65% in mortality could be achieved by the provision of safe water supplies and sanitation facilities. Chongsuvivatwong *et al.* (1994) reported the influence of a piped water supply in reducing diarrhoea morbidity in southern Thailand; a reduction in diarrhoea morbidity of 25% was achieved through the provision of water supply facilities. Baltazar *et al.* (1988) reported the impact of improved water supplies and sanitation facilities in a study in the Philippines; adequate environmental sanitation practices (with respect to both water supply and excreta disposal) reduced the incidence of diarrhoea by 20% compared with that among children of families who did not have adequate sanitation practices.

Other indicators have been reported to correlate with the health status of a country. Kolsky & Blumenthal (1995) reported that access to water, hours per day of piped water

supply, excreta disposal type, use of soap in hand washing, proportion of paved streets, numbers of persons to a room in housing, elevation of the house to prevent flooding, *E. coli* per 100 ml of water and disposal practices of the children's faeces were environmental health indicators for developing countries. Feachem *et al.* (1983) suggested that improved maternal and child health care with a focus on breast-feeding, personal and domestic hygiene and maternal nutrition, improved drinking water and sanitation facilities, and food hygiene could be the main focus of intervention.

DISCUSSION

In the last few decades, a number of studies have been conducted and various outcomes were reported on the reasons behind diarrhoeal diseases, morbidity, nutritional status and mortality of children. However, some of these investigations provided contradictory and confusing results and conclusions, many of which were due to methodological deficiencies (Esrey & Habicht 1986). Blum & Feachem (1983) pointed out that a lack of adequate controls, one-to-one comparisons, confounding variables, health indicator definitions, and failures to analyse by age were the major problems. The need for combined efforts by engineers, social scientists and epidemiologists in evaluating the impact on health of environmental interventions was stressed in the study. Water supply, sanitation and hygiene interventions are definitely complementary to the proverb 'prevention is better than cure' to control diarrhoeal diseases. However, the effectiveness of the outcomes of these interventions largely depends on literacy rates, education of the females in the household, social and religious beliefs and perceptions, and the economic status of the society or the community. An article on how social beliefs and perceptions about the cause of disease affect a community's health was published in a local newspaper in Nepal (*Kathmandu Post* 28 June 2001). The newspaper stated a case in Bhajhang district, where locals barred paramedics from entering a village with people suffering from gastroenteritis. The news further stated,

'the locals impose sanction in communities so as to remain secured from any natural calamities and to appease the deities. Some locals also believe that the disease was spread due to outraged deities rather than the consumption of contaminated water and poor sanitation'.

A similar story about a Darchula district, published in the same news daily on 10 July 2001, stated that, 'a large number of patients die untimely as a result of their conservative religious culture, poverty, ignorance, superstition and belief in traditional faith healers even when they are attacked by a common disease'. Thus, changing people's perceptions about the causes of disease is very important, not only the development of infrastructure. So, interventions in water supply and sanitation should go hand-in-hand with social and educational programmes for the rural population in particular. A study by Tiwari (1998) suggested the urgent need to integrate environmental health concerns and local people's perceptions into the decision making process in order to address the risks associated with contaminated drinking water. Rao *et al.* (1997) reported on a bitter experience of failure of a sanitation programme in India. The authors indicated that people's education and participation were very important to the programme's success.

Diarrhoea is multifactorial in origin and the hygienic use of water can reduce environmental contamination (Esrey & Habicht 1986). The losses due to diarrhoeal diseases (human life, loss of energy and economic loss) are unrecoverable. Verma & Srivastava (1990) reported that the annual cost in India of US\$381 per 100 people in 1981 was due to acute diarrhoeal diseases and the labour loss was 8 days per episode. The lack of safe water and sanitation facilities results in worsening public health conditions, deteriorating quality of life and increased economic costs to society (ADB 2000). Intervention programmes depend on many variables such as health status, socio-economic status and sanitation level. Shuval *et al.* (1981) proposed a threshold-saturation theory where the effect of water supply and sanitation investment on health was of an S-shape progression, meaning that after a certain level of saturation of the facilities, the impact on health would be minimal.

In Nepal, an average household spends about 5.5% of total expenditure (Rs. 572.7 (US\$11.45) per capita

annually based on 1994/95 data) on health care (Hotchkiss *et al.* 1998). The data on public health investments by Nepalese households in areas such as water supply, sanitation and hygiene improvement are not known. A WHO and UNICEF report in 2000 indicated that sanitation was not given priority by the politicians and local leaders in Nepal. This was reflected in a survey conducted in 1997 where 67% of the people surveyed had not felt a need for sanitation. Another survey showed that 54% of the general public and only 11% of local leaders thought that the local development budget should be used to implement water and sanitation programmes (WHO and UNICEF 2000). The reasons for the lack of interest among local leaders and the people in investing in water supply and sanitation might be their perceptions, beliefs and lack of knowledge. Regmi & Fawcett (1999) reported on the need to involve women in designing drinking water projects in Nepal as women are the key players in water collection, handling, cooking, childcare and household hygiene work. The authors reported that women complained that they had to spend 4–5 times longer for water collection after they received improved water services due to improper location of the public stand post. This was because the tap stands and the tube-wells were located along the roadside, where the women could not wash their clothes or bathe comfortably because of a lack of privacy. The women also complained that the problem occurred because they were not involved in the decision on the location of the stand post.

The provision of sufficient quantities of clean water by itself will not reduce the incidence of water-related diseases, especially among children, the most vulnerable group. It is important to implement broad-based, customer-level training and education programmes to increase awareness of the critical linkage between health, hygiene and sanitation practice so that maximum benefits can be obtained from investments in water supply and sanitation improvements (ADB 2000).

CONCLUSIONS

Based on the literature review and the data on public health in Nepal, the following conclusions are drawn:

- i. Diarrhoeal diseases are a major threat in Nepal due to inadequate and unsafe water supply, poor sanitation and poor living conditions.
- ii. Environmental awareness, knowledge about the causes of disease and behavioural changes related to social beliefs should be incorporated into intervention programmes along with improving water supply and sanitation.
- iii. Public participation in interventions and the involvement of women in designing the drinking water, sanitation and hygiene improvement programmes are important for their success.
- iv. Environmental health and sanitation information should be incorporated into the education programme in schools.

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