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The Relationship between the WES Interventions and the Incidence of Diarrhoea

SYED MUBASHIR ALI and RIZWAN UL-HAQ

INTRODUCTION

Access to clean drinking water and sanitation facilities have a direct positive impact on health through prevention of water-borne diseases, especially diarrhoeal morbidity of children. Lack of WES (Water and Environmental Sanitation) services and poor hygiene practices in Pakistan contribute significantly to the prevalence of diarrhoea, a major cause of infant death and children less than five years of age. The estimates show that about 30 percent of total deaths among children are attributed to diarrhoeal disease [Gallup (2001); UNICEF (2000)], and 4.1 years in life expectancy can be added if water borne diseases are eliminated [Ali and Haq (2003)]. Hence, reduction of diarrhoeal morbidity stands out as an important policy goal, which can ultimately lead to reduction in infant/child mortality. In this paper, we shall examine the relationship of WES interventions with that of the incidence of diarrhoea among children under age 10.

REVIEW OF LITERATURE

The important role-played by safe water, adequate sanitation and better hygiene practices in preventing diarrhoeal and other related diseases are well documented in the literature. A significant number of epidemiological studies have been conducted in countries of Asia and Africa, evaluating the impact of water supply and sanitation conditions, which establish a strong relationship between WES and human health status. However, these studies as a whole do not still provide any concrete conclusion to an effective way of conceiving and implementing such services that could determine the impact on health indicators [Heller (1999)].

Esrey, *et al.* (1985) in his extensive review of 67 studies from 28 countries shows that improved water supply and sanitation reduces diarrhoea by 16–37 percent. The health impact further increases if these services are combined with other sanitary measures of cleanliness and hygiene. The studies show a 30 percent median reduction in diarrhoea morbidity due to improved water supply, 36 percent reduction due to sanitation alone and 33 percent due to hygiene practices (Figure 1).

Syed Mubashir Ali and Rizwan ul-Haq are Senior Research Demographer and Staff Demographer respectively at the Pakistan Institute of Development Economics, Islamabad.

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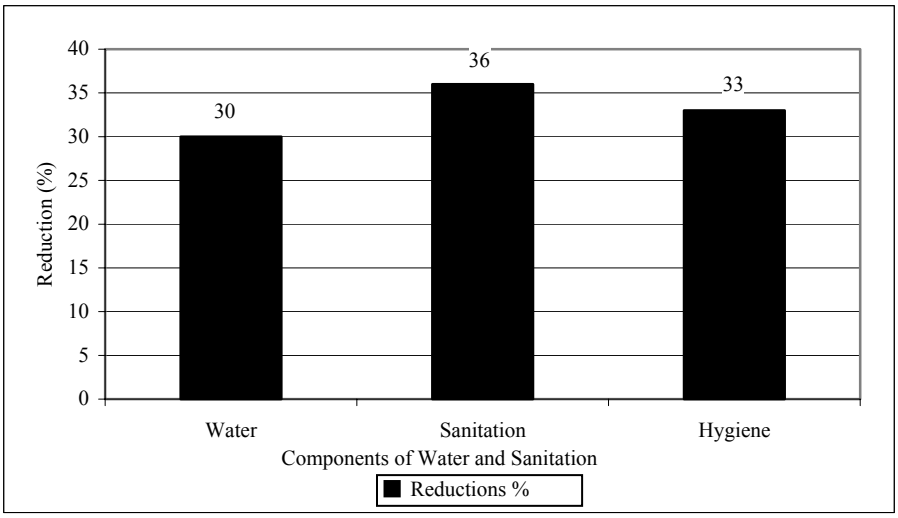
Fig. 1. Expected Reductions in Diarrhoeal Disease from Improvement in Water and Sanitation.



Another World Bank Study [Anquing (2000)] utilising urban indicators for 237 cities in 110 countries conducted by the UN Centre for Human Settlements (UNCHS) in 1993, examined the impact of water and sewerage connection on child mortality. The results suggest that if coverage of potable water access increases from current mean level of 86 percent to 95 percent, the child mortality rate would decline from 46 per 1000 to 39 per 1000 live-births. If the level of potable water is at 70 percent, as for most cities in Africa, the child mortality would increase to 60 per 1000 live births. Similarly, if the household sewerage connection increases from 53 percent to 60 percent, the child mortality rate would decline from 77 per 1000 to 74 per 1000 live-births. If the level of sewerage connection is as low as 15 percent as in most African countries, the child mortality would reach 95 per 1000 live-births.

The results of another study on diarrhoea morbidity differentials among children in Pakistan show that after controlling for a number of household variables, the presence of latrine with flush system in the household had a significant negative impact on the occurrence of diarrhoea among children under five years of age than those with no latrine facilities. However, contrary to expectations, safe source of drinking water, piped/motor pump inside the house, did not show significant association with diarrhoea morbidity [Arif and Ibrahim (1998)]. The explanations given for this unexpected relationship are that many water supply schemes in Pakistan, as in other developing countries, may be ineffective in reducing diarrhoea because it may be the quality and usage pattern of water in the home that largely determines the impact on diarrhoea. It is likely that water storage conditions in home may result in increased contamination [Esrey, *et al.* (1984)].

Similarly, the presence of a latrine in the household does not necessarily mean that a child uses it. In many communities, especially in traditional rural settings, young children are often permitted to defecate indiscriminately. So the usage pattern of latrine is important in determining the health impact. Thus, increased water availability, its quality, safe disposal of human feaces, and improved personal and household hygiene may lead to a major reduction in occurrence of diarrhoea. The WHO (2000) estimates also indicate that at least 60 percent coverage of water and sanitation facilities is optimal to have significant impact on improving health status indicators.

DATA

The data for this study has been taken from WES survey conducted in 2002 and PIH survey 2001-02. The WES survey was conducted by PIDE in three villages namely Matore, Nathia and Miana Mohra situated in Rawalpindi district in Tehsil Kahuta. After a physical survey of many villages around a radius of about 150 kilometres of Islamabad, the village of Matore was selected as a model village due to the availability of WES facilities in the village, whereas the other two adjacent villages were selected as non-model villages with relatively poor WES conditions. The reason for selecting two villages without WES interventions was to have comparable number of households with that in the model village. To obtain relevant information about WES conditions in relation to prevention of diseases in the selected villages, two questionnaires—one community questionnaire and the other household questionnaire were used.

Covering all households in the selected villages, the individual questionnaire was administered to household head or the available adult member in the house. A unique characteristic of all the three surveyed villages is that many houses (roughly 20 percent) were found locked. In Matore, the owners of these houses are out stationed either because of the army service or migration to gulf countries or UK. Many residents of Nathia and Miana Mohra were reported to have moved to Rawalpindi city on account of their children's education or doing small business. In all, a total of 559 households were covered in the survey, 268 in Matore with WES services (referred to as model village hereafter), 188 in Nathia and 103 in Miana Mohra, making a total of 291 households without WES interventions in the two villages (referred to as non-model village hereafter). However, in all there were 189 houses in the non-model villages and 145 in model village where at least one member of the household was a child under age 10. In this way a total number of 334 households were included in the analysis.

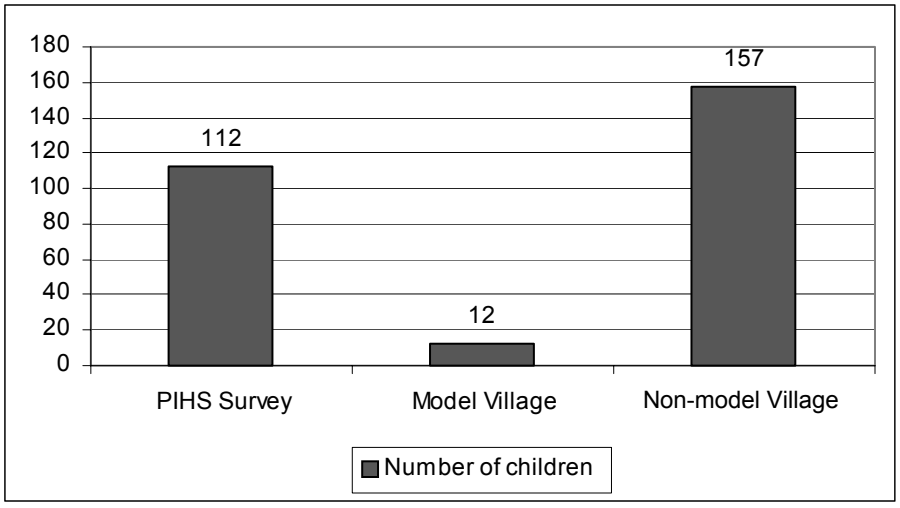
The other data set used here is the 2001-02 PIHS, where we have the information of the diarrhoea morbidity for the children under age 5. For the sake of a comparison with WES survey data we have selected the rural data of 2001-02 PIHS. The analysis was carried out on 8576 children under the age of 5 years.

Impact Analysis of WES Facilities and Diarrhoea

It may be noted here that due to limited and small-scale sample of the WES survey, the results cannot be generalised at national or provincial levels. However, the results of the survey indicate differential impact of WES facilities on the overall incidence of diarrhoea under case—control study analysis among the children and give at least a comparative picture with the 2001-02 PIH survey which is conducted at national level.

The impact of WES facilities on the incidence of diarrhoea—a major cause of infant and children death in Pakistan—is examined in this section. The results of the WES survey show that the incidence of diarrhoea in the last one month from the date of survey was 12 per 1000 children residing in the model village, 157 per 1000 children in the non-model villages and 112 per 1000 children under 5 years of age in 2001-02 PIHS. The incidence of diarrhoea estimated from 2001-02 PIHS is a representative figure for children under 5 years of age in the rural areas of Pakistan. Certainly this is a very high rate of diarrhoeal incidence. The incidence rate estimated from model and non-model villages indicates that diarrhoeal incidence is 13 times lesser when WES facilities are provided (see Figure 2).

Fig. 2. The Incidence of Diarrhoea among Children in the Last One Month (per 1000 Children).



Regarding WES facilities, the results indicate that poor quality of water, lack of sanitation facilities and poor hygiene behaviour markedly increase the chances of diarrhoea among children of rural areas. For example, the incidence rate of diarrhoea is 173 per 1000 population due to unsafe water supply in the non-model village as

compared to none in the model village (Figure 3).[1] But what is important to note here is that despite improved water supply, the incidence of diarrhoea among children in the non-model village remains very high. Actually, the main source of safe water in the non-model villages is the subsoil water accessed by means of hand/motorised pump. Precarious overall environmental and sanitation conditions cause contamination of subsoil water in these villages thus resulting in high incidence of diarrhoea.

The over all incidence of diarrhoea due to unsafe water supply in the rural areas of Pakistan is 131 per 1000 children under 5 years of age. Interestingly, the incidence of diarrhoea is also very high among children of households where improved water is supplied (see Figure 3). In rural areas of Pakistan, 70 percent of the households obtain water from hand/motorised pump [PIHS (2001–02)], this water gets contaminated because of poor environmental and sanitation conditions in and around villages. A study using Pakistani data found that the supply of water through a hand pump in the rural areas results in higher incidence of diarrhoea [Toor and Butt (2003)].

Similarly, better type of latrine in the house such as flush/pour flush reduces the incidence of diarrhoea in the two types of villages in the Rawalpindi district as well as in the rural areas of Pakistan (Figure 4). But a distinct result emerges from this analysis is that the incidence of diarrhoea in the households with improved latrine facilities is substantially high particularly in non-model villages and in rural areas of Pakistan. On the other hand, in the model village, the incidence of diarrhoea is much lower even among houses where latrine facility is not available; implying that the incidence of diarrhoea is reduced when WES interventions are introduced as a package as is the case in model village. As stated earlier, WHO (2000) studies indicate that 60 percent of water and sanitation facilities is the optimal level to have significant impact on improving health status indicators.

Regarding the impact of sanitation system for liquid waste, the children of houses connected to covered drains or soak pit are much less affected by diarrhoea than those with open drains or no sanitation system. This is evidenced in the two types of villages (Figure 5).

But the incidence of diarrhoea varied in the three population. For example, in the model village the incidence rate of diarrhoea was only three per 1000 children for houses connected to covered drain or soak pit as compared to nine per 1000 children for houses connected to open or no drains. In non-model village, the incidence rate is much higher i.e. 70 per 1000 children for houses connected to open or no drains. The situation in the rural areas of Pakistan is even poorer as 130 for every 1000 children are affected by diarrhoeal disease in the houses connected to covered drains and 111 per 1000 children for houses connected to open or no drains. The reversal of the pattern in the PIHS requires further investigation, however, the increased number of

[1]There were only 8 households using a well as their main source of water. The level of subsoil water in the model village was quite deep, implying less likelihood of water contamination.

Fig. 3. The Incidence of Diarrhoea in Children, by Water Facility in the Last One Month (per 1000 Children).

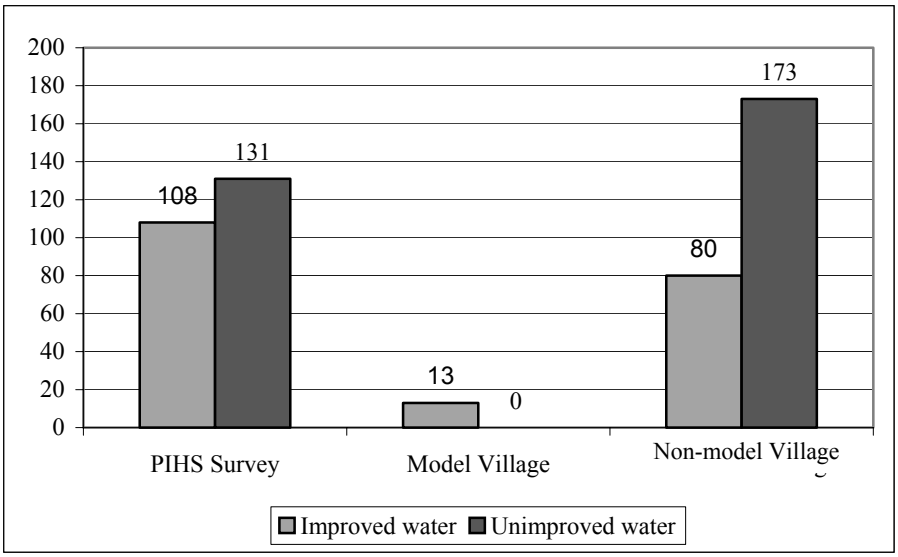
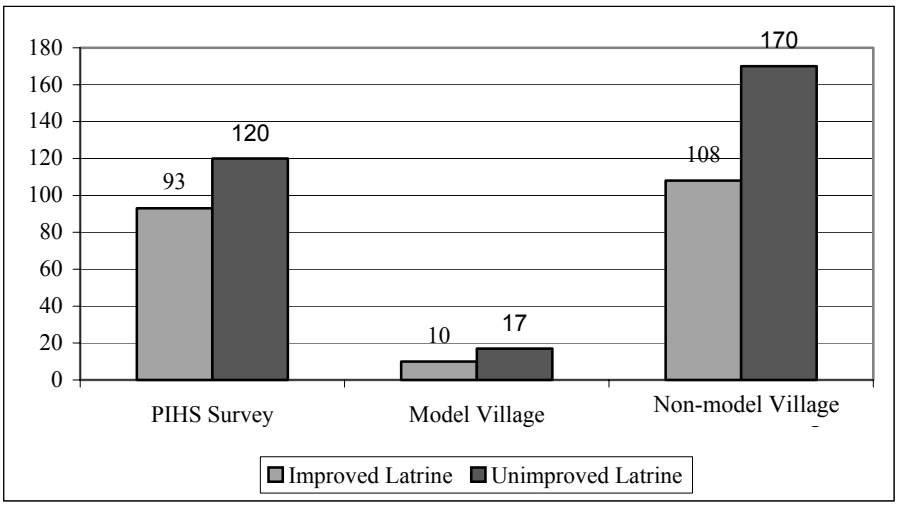
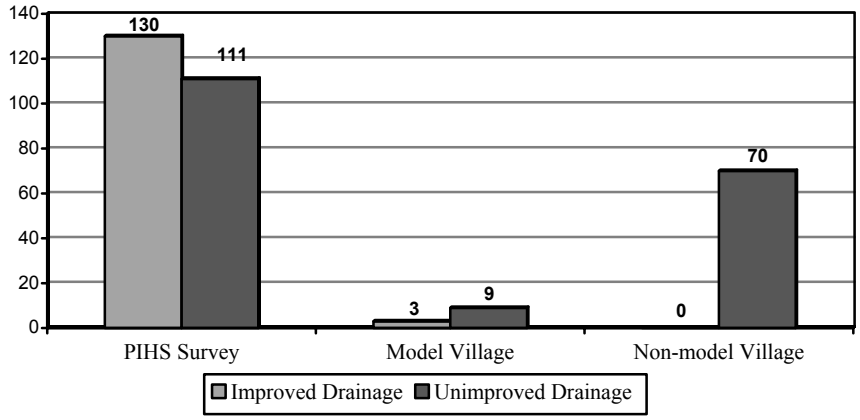


Fig. 4. The Incidence of Diarrhea in Children, by Latrine Facility in the Last One Month (per 1000 Children).



diarrhoeal incidences in the two types of villages among children of houses connected to open drains or no drains is because open drains are often blocked thus providing environmental pollution and a breeding place for germs leading to increased risk of diseases including diarrhoea (Figure 5).

Fig. 5. The Incidence of Diarrhea in Children, by Sanitation System in the Last One Month (per 1000 Children).



Good hygiene practices in the form of hand-washing particularly with soap especially after urination or defecation have positive impact on reduction of Diarrhoea. The findings of the two villages confirm the above stated argument as the hygienic practices of washing hands with water and soap after urination or defecation reduces the incidence of diarrhoea manifold. This situation holds true in both type of villages but in the non-model village its impact brings about over 10 times difference in the incidence of diarrhoea (Figure 6).

Educational attainment particularly by head of the household has multiple benefits. One of many benefits is that the inhabitants of a household where the head is educated are generally aware and conscious about cleanliness and hygiene practices. In other words, education has close link with the sanitation and hygiene practices, which in turn reduces the incidence of diarrhoea. Although Figure 7 in general confirms this relationship, yet small difference particularly in the rural areas of Pakistan in the incidence of diarrhoea among children of educated and uneducated heads of household demands investigation of this relationship further.

In sum, the impact analysis of WES facilities on the incidence of diarrhoea in the surveyed communities has shown significant results. As Matore is a relatively more developed village in terms of infrastructure and WES facilities, the difference in the impact of the availability or non-availability of a facility is not very large. On

Fig. 6. The Incidence of Diarrhoea in Children, by Hand-washing Practices in the Last One Month (per 1000 Children).

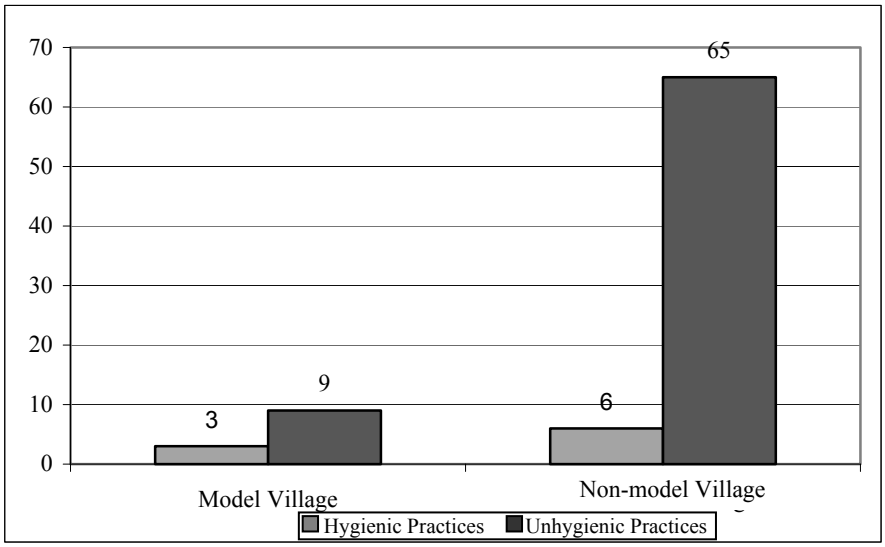
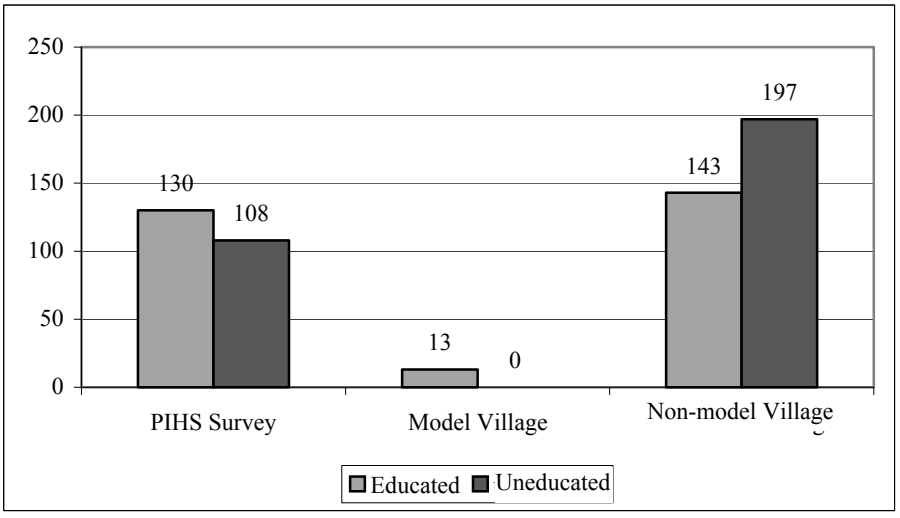


Fig. 7. The Incidence of Diarrhea in Children, by Education Status of the Head of the Household in the Last One Month (per 1000 Children).



the other hand, the impact is generally large in the non-model village. The small impact of improved type of latrines in non-model village may be attributed to the fact that a large majority of the population in these villages goes to the open spaces for urination and defecation; thus polluting the environment with germs and bacteria, and making the population almost equally susceptible to the risk of disease of diarrhoea.

Multivariate Analysis

In the foregoing section, we have observed the unadjusted effect of WES interventions on the incidence of Diarrhoea. In this Section, we show the net effect of each and every variable included in the model on the incidence of diarrhoea.

The Model

The model for data collected from WES survey is as follow:

$$YC_i = \alpha + \beta_1 Log(Ii)_i + \beta_2 E_i + \beta_3 W_i + \beta_4 Li + \beta_5 D_i + \beta_6 Pi + \mu_i$$

and for PIHS survey it is:

$$\ln \frac{p}{(1-p)} = \alpha + \beta_1 Log(Ii)_i + \beta_2 E_i + \beta_3 W_i + \beta_4 Li + \beta_5 S_i + \mu_i$$

Where

YC_i = Total number of incidences of diarrhoea among the children during last 30 days;

$\ln \frac{p}{(1-p)}$ = Where p is the probability of occurring an incidence of diarrhoea in the last month.

$Log\ (I_i)$ = Logarithm of the Annual income of the household;

E_i = Educational status of the head of the household; 1 is assigned to those who have passed 5 classes or more and 0 to those who have never gone to school or have studied up to 4 class;

W_i = Type of Water facilities taking the value of 0 for unimproved water and 1 for improved water facility;

L_i = Type of Latrine in the household taking the value 0 for unimproved type of latrine and 1 for improved type of latrine;

D_i = Type of drainage system taking 0 and 1 value for poor and improved sanitation system respectively;

P_i = Hand-washing practices after defecation and urination taking the value 0 and 1 for unhygienic and hygienic practices respectively; and

S_i = Sex of the child; 0 for female and 1 for male child.

METHODOLOGY

The two different types of models are applied on the two data sets. This was necessitated because the type of information on diarrhoea in the two data sets was different. In the WES survey, we have information about the number of incidences of diarrhoea for children under age 10 in the last 30 days regardless of their sex. A semi logarithm linear model is applied on the WES data. In PIHS survey we have information about the diarrhoea morbidity in the form whether it has occurred in the last 30 days among children under 5 years of age or not. We have applied Logistic Regression Model with the dummy dependent variable taking a value of 1 if there is an incidence of diarrhoea and 0 otherwise.

Independent Variables

Logarithm of annual income. The annual income of the household is included in the model as log of Income. This was done in order to make the data consistent in magnitude with other variables. As most of the people are engaged in agricultural activities in the rural areas of Pakistan, we chose to include annual income in the model instead of monthly income which is affected by seasonal variations.

Educational status. Another variable included in the model is the education of the head of the household as described earlier under E_i variable in the model. The reason for taking class 5 as a benchmark for educated heads is because the results of many studies based on Pakistani data proves that effect of education on personal behaviour changes significantly after class 4.

Type of drinking-water. In these models we have taken the variable of 'water' in the form where improved water means piped water, supplied inside or outside the house, hand/motorised pump and tubewell whereas all other sources are included in the unimproved category of drinking water.

Type of latrine. For the latrine facility latrines connected to sewer, septic tank and closed drains whether flush or pour flush, are included in the improved category whereas all other types are included in the unimproved category of latrines.

Drainage Facility. The sanitation facility in terms of liquid waste going to covered drains or underground sewerage is included in the improved sanitation facility. All others are categorised as unimproved sanitation facility.

Hand-washing practices. Hand-washing practices are assumed to be 'hygienic' if hands are washed with soap or water almost all the time after both urination and defecation whereas all other practices are included in the category of 'unhygienic practices'.

Sex of the child. Sex of the child is included in the second model where value of 1 is assigned to male and 0 to female child.

RESULTS

In the preceding section, we have tried to establish the association between various WES indicators and the incidence of diarrhoea. By applying the techniques of Multiple Regression Analysis and Logistic Regression Model, we will estimate the net effect of each and every factor included in the model so as to ascertain the determinants of diarrhoea.

Equation 1 in Table 1 present the regression results of WES survey data pertaining to children less than 10 years of age. The results in Equation 2 of Table 1 pertain to 2001-02 PIHS data of children less than 5 years of age. In an exercise to avoid multi-co-linearity among the predictor variables, a correlation matrix was produced for each equation separately. The correlation coefficients of all the variables cited in Equation 1 were not found to be high enough to produce multi-co-linearity problem. However, the variable of drainage facility in the equation pertaining to PIHS data had to be dropped because of the data problems mentioned earlier (see Figure 5).

Table 1

Estimated Regression Equations for the Determination of the Predictors of Diarrhoea

Explanatory Variables	Equation -1 (WES Survey)	Equation -2 (PIHS Survey 2001-02)
Constant	–.668	–1.699
Education	–.0886	–.133
	(.562)	(.281)
Log of Annual Income	–.0217	–0.025
	(.902)	(0.289)
Latrine Facility	–.014	–0.259
	(.917)	(.001**)
Water Facility	–.266	–0.171
	(.041**)	(.047*)
Hygiene Practices	–.238	–
	(.061*)	–
Drainage Facility	–.079	–
	(.767)	–
Sex of the Children	–	0.125
	–	(.069*)
–2 Log Likelihood	–	5969.2
Chi Square	–	22.36(5)
N	334	8576

Note: *P* values are given in the parenthesis.

**Significant at the 0.05 percent level (2-tailed).

*Significant at the 0.1 percent level (2-tailed).

Overall, the results are in the expected direction. The variables of 'hygiene practice' and water facility in Equation 1 are found to be the important determinants of the incidence of diarrhoea. The effect of 'water facility' on diarrhoea is significant at 5 percent level and 'hygiene practice' at 10 percent level. In Equation 2, the variables like 'latrine facility' and 'water facility' are significant at 5 percent level whereas, 'sex of the child' is significant at 10 percent level. Interestingly, water facility is significant in both the data sets implying that the provision of safe potable water can reduce the incidence of diarrhoea significantly among children. Hand-washing practice with soap and water especially after urination and defecation lowers the incidence of diarrhoea among children. An educated head of the household in general maintains overall good sanitary conditions, which in turn helps in reducing the incidence of diarrhoea. But somehow effect of education is not significant in both the data sets. Likewise, variable of income also does not exert significant effect on the incidence of diarrhoea.

It is generally observed that availability of flush or pour-flush toilet facility is far from satisfactory in Pakistan whereas, the situation in rural areas is dismal. According to 2001-02 PIHS data 41 percent rural households have a toilet facility and only 26 percent household have flush toilet facility. Equation 2 shows that the presence of toilet facility in the house significantly reduces the incidence of diarrhoea. Moreover, 'sex of the child' variable also suggests significantly more morbidity among the male than the female children in rural areas of Pakistan.

SUMMARY AND CONCLUSION

It is clear from the above analysis that the availability of WES facilities greatly reduces the incidence of diarrhoea. The incidence is 13 times higher in the non-model village as compared to the model village. Moreover, multivariate analysis of WES data also shows that availability of potable water and hygiene practices are the important determinants of the incidence of diarrhoea.

As the data on hygiene practices in the 2001-02 PIHS was not included, the latrine facilities in addition to water facility emerged as important determinants of diarrhoea in Equation 2. This data set also shows that the incidence of diarrhoea is significantly higher among male than female children.

It is clear here that hygiene practices, latrine facility, and supply of potable water are the most important factors, the provision of which can reduce the incidence of diarrhoea drastically among children. The results also show that socio-economic development strategies do not necessarily guarantee reduction in the incidence of diarrhoea particularly among children unless supported by WES interventions.

Although diarrhoeal mortality has been considerably reduced during the past two decades because of the increased use of ORS, the incidence of diarrhoea still remains widely prevalent in Pakistan. This situation demands implementation of a target-oriented policy-making. By providing WES facilities and promoting hygiene

practices through media campaign particularly in the rural areas, a greater control over the incidence of diarrhoea can be achieved.

REFERENCES

Ali, Syed Mubashir, and Rizwan ul-Haq (2003) A Comparative Analysis of Gain in Life Expectancy of Specified Causes of Death in Pakistan. In Population and Sustainable Development in Pakistan, 3rd Conference Proceedings, Population Association of Pakistan.

Anquing, Sho (2000) How Access to Urban Potable Water and Sewerage Connections Affects Child Mortality. Development Research Group. World Bank.

Arif, G. M., and S. Ibrahim (1998) Diarrhoea Morbidity Differentials among Children in Pakistan. *The Pakistan Development Review* 37:3, 205–230.

Esrey, S. A., *et al.* (1985) Interventions for the Control of Diarrhoeal Diseases Among Young Children: Improving Water Supplies and Excreta and Disposal. In *Bulletin of the World Health Organisation* 63:4.

Gallup/BRB (2001) Report on "National KAP Study on Sanitation and Hygiene Practices". Islamabad.

Heller, Leo (1999) Health Impacts of Lack of Adequate Water Supply and Sanitation: Status and Prospects for Future Research. Pan American Health Organisation.

Pakistan, Government of (2002) *Pakistan Integrated Household Survey 2001–02*. Islamabad: Statistics Division, Federal Bureau of Statistics.

Toor, I. A., and M. Sabihuddin Butt (2003) Socio-economic and Environment Conditions and Diarheal Disease Among children in Pakistan. *The Lahore Journal of Economics* 8:3.

UNICEF (2000) *The State of the World Children*. New York: Oxford University Press.

UNICEF/GOP (2000) Country Programme for Children: 1999–2003. Master Plan of Operations, Pakistan.

World Health Organisation (WHO) (2000) Inter-sectoral Decision-making Skills in Support of Health Impact Assessment of Development Projects. Final Report on Addressing Health Opportunities in Water Resources Development, Geneva.