Socioeconomic and Environment Conditions and Diarrheal Disease Among Children in Pakistan

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Abstract

Diarrheal disease poses mortality and morbidity risks to infants and young children. Based on losses in terms of disability-adjusted life years, the World Development Report (1993) estimates that diarrheal disease is the third most burdensome illness among children in the 1 to 5 years age bracket. Using 1990 data, Murray and Lopez (1994) estimated that about 3 million children die every year due to diarrheal disease. Severity of diarrheal illness and alternative interventions are necessary inputs into the government's decision-making. However, there is currently much uncertainty about the most appropriate policies in the context of low-income environments such as Pakistan. The debate could be described in terms of efficacy of economic/behavioural or environment/infrastructure. In this study, we explore the socioeconomic and environment determinants of diarrheal disease for children in Paksitan. The diarrheal determinants equation was estimated by logistic techniques. Diarrheal illness jointly with defensive behaviour was estimated from the reduced form to fully capture the relationship between defensive actions and illness. Such an endeavour will provide decision makers and policy analysts information to formulate policy design for the necessary interventions and respective investment plans for the alleviation of dairrheal disease among children, depending upon the relative contribution of socioeconomic and enviromental factors. For the specific case of Pakistan, socioeconomic development strategies do not necessarily gaurantee lowering the incidence of diarrhea, particularly among children below five years of age, unless supported by environmental interventions.

1. Introduction

Despite developments in the last two decades in the understanding of the etiology[1] and pathogenesis[2] of diarrheal diseases and the discovery of

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[1] The philosophy of causation; the part of a science which treats the causes of its phenomena.

[2] The production and development of diseases. The manner of development of diseases.

an effective oral rehydration solution to treat the majority of patients with watery diarrhea, morbidity rates among young children are still high and diarrhea remains a significant cause of child illness (World Development Report, 1993). Although evidence exists of a reduction in diarrheal mortality during the past fifteen years, no indication has been found of reductions in diarrheal incidence during the same period. This lack of decline points to the need for the development, implementation, and evaluation of effective measures to lower diarrheal morbidity.

As mentioned earlier, the debate can be described in terms of hypotheses about whether the decisive factors are economic or environmental/infrastructure. The economic perspective emphasises attention to and interpretation of household behaviour, and the relationship between the appropriate interventions and the resources and preferences of the households. The technical perspective emphasises more strongly the need to provide households with a plentiful and reliable supply of uncontaminated water and adequate sanitation services. These factors are often closely intertwined. One might find, for instance, that diarrhea incidence is low with clean water, because households are careful in their personal hygiene, and boil water before drinking. In such a setting, an engineering intervention, such as improvement in water quality, could prove ineffective in lowering diarrhea rates because of the importance of behavioural factors. Intervention might still be justified, however, depending on the costs imposed by the defensive behaviour.

All major infectious agents that cause diarrhea are transmitted by the fecal-oral route. These enteric pathogens can be transmitted via contaminated water, and water-borne transmission has been documented for most of them. Improvement in water quality is, therefore, a potentially important intervention. Improvement in water quantity and availability is also important as an aid to hygienic practices which may interrupt the fecal-oral transmission. As all principal infectious agents of diarrhea are shed by infected persons via the feces, hygienic disposal of excreta has the potential to play a role in controlling their transmission. Environmental improvements of these kinds probably contributed to the reduction in diarrheal morbidity and to the control of epidemic cholera and typhoid (Murray and Lopez, 1994).

Childhood diarrhea has been a serious problem in Pakistan. The percentage of children who have suffered from diarrhea are presented in Table-1. Looking at the 2001-02 data, rural and urban rates are now the same. These figures are much lower than those reported in the NHSP[3], which reported that

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[3] National Health Survey of Pakistan, (1996), Pakistan Medical Research Council, Islamabad.

43 percent of children had suffered from diarrhea in Pakistan. This paper reports on the results of an empirical investigation of the effects of socio-economic and environmental variables (water supply, toilet system, sewerage system etc.) on diarrheal disease in Pakistan. Therefore, prior to formulating a "Preventive Strategy" for children in Pakistan, it would be of much importance to have a systematic study about the relative contribution of various socioeconomic and environment factors in determining the risk-incidence of diarrhea among the most vulnerable population of the country (0-5 years children). Such an endeavour would provide a baseline framework in designing the most cost-effective interventions for combating diarrheal disease in Pakistan.

Table: 1 Children 5-Years and Under Suffering from Diarrhea

(Percentage)

Region	Urban	Rural	Both Areas
Punjab	11	12	12
Sindh	13	8	9
NWFP	20	16	17
Balochistan	12	15	14
Overall	**12**	**12**	**12**

Source: PHIS-2001-02

The paper is organised as follows: Section II describes previous research. Section III indicates the analytical consideration used in this paper. Section IV presents the data and variable definition. Section V presents the estimation results. Finally, in Section VI, the key conclusions and the same policy implications are highlighted.

2. Previous Research

The risk of diarrheal morbidity and mortality is greater among families of lower socioeconomic status and in conditions of poor personal and domestic hygiene. Low family income, living in a one-room house, living in a house with an earthen floor, lower occupational status of the head of the family, all have been associated with increased risk of diarrheal morbidity and mortality [Stanton, and Clements, (1987); Mahmood, *et.al.*, (1989); Ashworth and Feachem, (1985); and Hammer, *et.al.*, (1995)]. The risk of diarrheal morbidity and mortality is higher among infants who are not breastfed (Feachem and Koblinsky, 1984). More recent studies in developing countries have confirmed the very substantial role of exclusive breast-feeding in protecting infants against diarrheal incidence, severity, and mortality (Mahmood, *et.al.*,1989). Several studies indicate a risk of increased diarrheal duration and severity among the malnourished [Bairagi, *et.al.*, (1987) and Mehmood, *et.al.*, (1989)]. Although information is scarce on the role of low birth weight as a determinant of diarrheal morbidity, association between intra-uterine growth retardation and impaired immunocompetence, and the strong association between low birth weight and diarrheal mortality in infancy in developing countries, suggest that low birth weight is a risk factor for diarrheal severity and mortality (Barros, 1987, and Ashworth and Feachem, 1985).

Briscoe and John (1984), emphasised the complexities in empirical investigations when there may be interdependencies and "threshold-saturation" effects in transmission routes. Esrey, *et.al.*, (1985) suggest that public interventions may exhibit varying levels of effectiveness in controlling the transmission of diarrheal disease, and that a plentiful water supply and/or adequate sanitation appear to have a greater impact on diarrheal disease than improvements in water quality. Martines *et.al.*, (1991), concluded that effectiveness in lowering disease rates, and particularly the severe and mortal cases, depends on broader preventive strategies including water supply and sanitation, nutrition and education programmes. Using clinical data, Baltazar *et.al.*, (1988) found evidence that adequate sanitation practices reduce the incidence of diarrheal illness.

We postulated that household income is negatively associated with diarrheal disease. Empirically, it has been proved that mother's education plays an important role in reducing diarrheal disease in the household. Other important variables such as family size, share of young children in the house, regional disparity are also important in determining the incidence of diarrheal disease. A recent case-control study in the south of Brazil found that infants in houses with piped water had a diarrhea mortality rate 80 percent lower than those living in houses with no easy access to piped water. In addition to this Brazilian study, numerous studies also analysed the effect of water and sanitation on diarrhea. Therefore, we included water supply system and sanitation system in our model to estimate the impact of these variables on the incidence of diarrheal disease. We also did a regional analysis of diarrheal disease by rural and urban distribution and also at the province level.

3. Analytical Considerations

To find the determinants of diarrheal disease in Pakistan, the methodology of the model is derived from Alberini, A. *et. al.,* (1996). Suppose that individuals engage in defensive behaviour if the value taken by a random variable Y_1 is greater than zero. Let Y_1 be determined by individual/household characteristics (including the wage rate, non-labour income and the cost of defensive behaviour) and risk factors known to the researcher (both sets of variables being summarised into a vector of regressors X_1), and perceived exposure to a risk for diarrheal disease, *R*:

$$Y_1 = X_1\beta_1 + \gamma_1 R + \varepsilon \qquad (1)$$

where ε is the random error term and *R* is known to the subject but not to the researcher. It is assumed that a higher value of *R* implies a higher risk for diarrheal diseases, and thus results in a higher defensive effort. The coefficient γ_1 is thus assumed to be positive because observations on the dependent variable, Y_1, are available only in a binary response format. Further assume that diarrheal disease is observed in a household when a second random variable, Y_2, defined as:

$$Y_2 = X_2\beta_2 + \gamma_2 R + \delta Y_1 + \eta \qquad (2)$$

takes on a value greater than zero. Here X_2 is also a set of individual and household characteristics and sources of risk for diarrheal disease that are observable to the researcher. γ_2 , the coefficient of sources of risk *R* not observable to the researcher is positive, implying that a higher-valued *R* increases the likelihood of contracting the illness. Diarrhea is controlled with the defensive behaviour, Y_1, so that the coefficient δ is negative. Equation (2) is also estimated using binary response techniques. The error terms ε and η are assumed to be independent of each other.

Because the risk factor *R* is not known to the researcher, it cannot be treated as a regressor in the equations for defensive behaviour and diarrheal illness resulting from (1) and (2). It will thus be absorbed into the error terms $v_1 = \gamma_1 R + \varepsilon$ and $v_2 = \gamma_2 R + \eta$. A logistic regression of observed defensive behaviour on the selected regressors yields consistent estimates, provided for diarrheal illness on individual characteristics and defensive behaviour yields inconsistent estimates because the "hidden" risk factor has introduced correlation between one of the regressor - defensive behaviour - and the error term v_2 in the illness equation. The binary dependent variable counterparts of equations (1) and (2) must, therefore, be estimated as a system of simultaneous equations[4].

[4] Only if $\gamma_1 = 0$ is it legitimate to fit the logit equation for diarrheal disease separately without incurring inconsistent estimates.

Equation (1) is essentially already expressed in reduced form, in the sense that it contains only exogenous regressors. Substituting equation (1) into (2) we obtain a second reduced-form equation in which defensive behaviour is eliminated from the regressors and diarrheal disease depends only on individual or household characteristics and unobservable risk:

$$Y_2 = X_2\beta_2 + X_1(\delta\beta_1) + [(\delta\gamma_1 + \gamma_2)R + (\delta\varepsilon + \eta)] \quad (3)$$

The error term of equation (3) (in brackets) is easily shown to be correlated with the error term of the first equation, $v_1 = \gamma_1 R + \varepsilon$. The covariance between the error terms of the reduced-form equations (1) and (3) is equal to :

$$(\delta\gamma_1 + \gamma_2)\gamma_1.Var(R)\delta.\sigma_\varepsilon^2 \quad (4)$$

Since δ is negative, the sign of covariance (4) depends on the sign of $(\delta\gamma_1 + \gamma_2)\gamma_1$ and on the relative magnitude of $Var(R)$ and $\phi_2\gamma$. The quality $\delta\gamma_1 + \gamma_2$ gives the net effect on illness of a change in the unobservable risk (i.e., after the individual's defensive actions). If $(\delta\gamma_1 + \gamma_2) < 0$, each increase in unobserved risk unleashes a defensive response strong enough and effective enough to produce a net reduction in the likelihood of contracting diarrhea. If $(\delta\gamma_1 + \gamma_2) = 0$, the individual can just neutralise an increase in risk through enhanced defensive actions.[5] Finally, if $(\delta\gamma_1 + \gamma_2) > 0$ an increase in unobservable risk results in a higher likelihood of contracting illness. It is easily shown that $(\delta\gamma_1 + \gamma_2) < 0$ results in covariance (4) also being negative. If $(\delta\gamma_1 + \gamma_2)$ is positive, the sign of covariance (4) is undetermined (i.e., a negative covariance does not necessarily imply that $(\delta\gamma_1 + \gamma_2) < 0$).

While the diarrhea equation can be separately estimated by logistic techniques as long as it is expressed in its reduced form (3), we estimate diarrheal illness jointly with defensive actions and illness. We assume that the errors of the reduced-form equations (which incorporate the unobserved risk) are jointly normally distributed. The resulting joint model for the

[5] Two important special cases are (i) γ_1=0 but $\delta < 0$, but $\delta = 0$ (for any value of γ1). Under case (i), people are not aware that washing hands serves as a means of reducing the risk of contagion. They will not, therefore, intensify their defensive behaviour in the face of an increase in the risk of contamination. The covariance, (4), is easily shown to be negative. Under case (ii), the defensive behaviour is completely ineffective in reducing the likelihood of diarrheal disease. The covariance, (4), between the error terms of the reduced-form equations is positive (zero if γ_1=0).

observable in a logistic set of regressors X_1 in the defensive behaviour equation, and X_1 and X_2 in the illness equation.[6] The unobserved risk R is absorbed into the error terms, but its contribution to both defensive behaviour and illness is now adequately accounted for by allowing those error terms to be correlated.

We note that the parameters appearing in equations (1) and (2) can not all be separately identified. As with standard logit equations, our bivariate logit routine estimates the ratios $\exists_1=\exists_1/\phi_1$ and $\exists_2 =\exists_2/\phi_2$, where ϕ_1 and ϕ_2 denote the standard deviations of the reduced-form error terms. ϕ_1 and ϕ_2 can not be identified, nor can the two γ_s and δ, not even for non-overlapping x_1 and x_2.

The diarrheal equation can be estimated by logistic techniques. We estimate diarrheal illness jointly with defensive behaviour from the reduced form to fully capture the relationship between defensive actions and illness. We assume that the errors of the reduced-form equations (which incorporates the unobserved risk) are jointly normally distributed.

4. Data Source

The data for this study was obtained from the Pakistan Integrated Household Survey 2001-02 (PIHS). In this survey, a two-stage random sampling strategy was adopted for data collection. At the first sampling stage, a number for clusters or Primary Sampling Units (PSUs) were selected from different parts of the country. Enumerators then compiled lists of all households residing in the selected PSUs. At the second sampling stage, these lists were subsequently used to select a fixed number of households from each PSU for interviews using a systematic sampling procedure with a random start. This two-stage sampling strategy was used in order to reduce survey costs, and to improve the efficiency of the sample. The number of PSUs to be drawn from each strata in the first stage was fixed so as to ensure that there were enough observations to allow representative statistics to be derived for each main strata of interest.

In each of the selected PSUs, a fixed number of households were selected at random (12 in each urban PSU, 16 in each rural PSU), and a detailed household questionnaire was administered to each of them. In addition, in each rural PSU, a community questionnaire was also completed which gathered information on the quality of infrastructure, the provision of services, and consumer prices prevailing in the community.

[6] See Greene (1993) for details of bivariate logit

At the individual and household level, the PIHS collects information on a wide range of topics using an integrated questionnaire. The household questionnaire comprises a number of different modules, each of which looks at a particular aspect of household behaviour or welfare. Data collected under Round IV included educational attainment and health status of all household members. In addition, information was also sought on the maternity history and family planning practices of all eligible household members. Finally, data was also collected on the household's consumption of goods and services in the last fortnight/month/year, as well as on housing conditions and access to basic services and amenities such as school, water and health center.

The variables used in this paper are presented in Table 2, which consists of socioeconomic and environmental categories. The dependent variable is diarrheal disease in the household age 0 to 5 years of the age bracket.

Table 2: Descriptive Statistics for Selected Variables

Variable	(Units)	N	Mean	Std.Dev.
Diarrhea in Household (0-5 Years)	(0,1)	6928	0.204	0.403
Sindh	(0,1)	6928	0.291	0.454
NWFP	(0,1)	6928	0.174	0.379
Balochistan	(0,1)	6928	0.134	0.341
Young Children in House (0-5)	(Share)	6928	22.06	12.58
Young Children in House (6-10)	(Share)	6928	39.54	15.02
Mother's Education	(Years)	6928	1.536	3.51
Household Size	(Numbers	6928	8.378	3.735
Household Per Capita Income	Log (Rs)	6928	6.717	0.944
Distance Health Facilities	(Ka)	6928	1.212	0.818
Solid Waste System	(0,1)	6928	0.221	0.415
Tap water in House	(0,1)	6928	0.306	0.461
Hand pump water in House	(0,1)	6928	0.354	0.478
Type of Flush System in House	(0,1)	6928	0.344	0.475
Persons per Room	(Numbers	6928	4.368	2.319
Underground Drainage System	(0,1)	6928	0.154	0.361
Urban Area	(0,1)	6928	0.398	0.490

5. Empirical Results

Estimated results are presented in this section. Table 3 reports estimated coefficients of the logistic model, which consists of urban and rural areas. The results are reasonable by both economic and statistical criteria. All three equations used in this chapter show a high goodness-of-fit statistic. We start from the variables the 'share of young children in house age 0-5' and 'share of young children in house age 6-10'. Both variables have a positive relationship with diarrheal disease, which shows that a family which has a large number of children ages (0-5) and (6-10) have much more chances of being victims of diarrheal disease. This trend verifies that a large number of children may not be properly taken care of in the house.

Mother's education is negatively and significantly associated with diarrheal disease, which means that educated mothers can reduce incidence of diarrheal disease in the household. This result is consistent with the World Bank's Report that education and especially maternal education plays a pivotal role in the proper and healthy upbringing of child. In Pakistan, gender discrimination is so much that women's role is not considered in this respect. An educated mother keeps her surroundings and households clean. Moreover, she gives timely attention to health problems of her own and the child. This is because there are certain concepts which are absolutely time driven. Thus time factor can save many un-foreseen happenings, for instance the disease like diarrhea at times becomes fatal if not attended to properly and in time. Moreover, inspite of all the shortcomings, whatever the achievements are made in the health sector the major one which is worth mentioning is the control over communicable diseases.

The variable 'covered drainage system' shows a negative relationship with diarrheal disease in this model. Households connected to the covered drainage system indicated less incidence of diarrheal diseases. According to PIHS-1996-97, some 68 per cent of rural households do not have any form of sanitation system - that is, a means of draining household waste water. The proportion without any system is highest in Balochistan, where 98 per cent of rural households do not have any sanitation system, and the lowest in the Punjab.

Household size has also a positive sign and a significant coefficient, which may represent that large households do not use appropriate economic and engineering facilities. Children from very large families are at higher risk, but also, children from very large families are more likely to be from the lower socioeconomic level. Children from large families are likely to receive less treatment for their illnesses than are children from smaller families.

Tap water has a positive coefficient which means tap water supply in the house may be contaminated. The other variable, solid waste system has a negative sign but is statistically insignificant. It means that well-designed projects combining water supply and excreta disposal may achieve reductions of 35 to 50 percent in diarrheal morbidity (Esrey, Feachem and Hughes, 1985). It is expected that except in areas where other interventions have substantially reduced diarrheal mortality, its effect will be larger on mortality rates than on morbidity.

The main source of drinking water in Pakistan is the hand pump. Hand pumps and motor pumps together provide 61 per cent of households with drinking water, rising to 70 per cent in rural areas.[7] The sign of the variable handpump is a positive one, which shows that this system of water supply increases the incidence of diarrheal disease in the household. It is assumed that water from a hand pump is generally cleaner than from a dug well or river/canal/stream. However, it is important to note that water from a handpump may sometimes be contaminated since no tests are carried out on water quality. This study also verified the contamination of hand pump water.

Another important variable is distance from health facilities. The trend of this variable is positive which indicates that long distance from health facilities increases the incidence of diarrheal disease. Since this only concerns individuals who actually used the services, it cannot be considered to represent access for the population as a whole. For treatment, users of government services reported traveling slightly further than private services, although the proportions who traveled less than 5 km are very similar. For private diarrhea treatment, Balochistan and NWFP had a substantial proportion of users traveling over 5 km.[7]

The coefficient of per capita income is negative which illustrates that per capita income has a negative relation with diarrheal disease. This trend indicates that higher income is negatively associated with diarrheal disease. This result also shows that poor children are mostly affected by diarrheal disease due to non-availability of health facilities. The influence of poverty on socio-economic conditions rather than health condition is very pronounced. It is in its way related to the income effect. In other words, poverty and spending are directly related and directed towards the improvement of public health services[8].

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[7] Pakistan Integrated Household Survey 2001-02

[8] According to the UNFPA report entitled, The State of World Population 1999: *"Poverty is not confined to the poorest countries. Over a billion people are still deprived of basic needs. Of the 4.8 billion people in developing countries, nearly 3/5th lack basic*

Theoretical calculations based on the above sample indicate that promotion of the flush system in the household can reduce diarrhea morbidity in the house. Acute and chronic diarrheal disease is related to inadequate waste removal. Efficient removal of waste from living areas is also likely to reduce the prevalence of skin infections, hepatitis and polio. Surprisingly, the urban dummy has a positive and significant sign, which illustrates that in the urban areas, the incidence of diarrheal disease is higher than rural areas. The problem of solid waste management has acquired alarming dimensions in urban areas, especially over the last decade. Before then, waste management was hardly considered an issue of concern as the waste could easily be disposed off in an environmentally safe manner within the general premises. Contaminated drinking water supply through municipal corporation may also increase the incidence of diarrhea in urban areas. Evidence suggests that waterborne disease contributes to background rates of disease not detected as outbreaks. The waterborne diseases include those transmitted by the fecal–oral route (including diarrhoea, typhoid, viral hepatitis A, cholera, dysentery) and dracunculiasis.[9] The other variable 'persons per room' has also a positive significant sign. This proves that conjunction of the persons in the house can increase the incidence of diarrheal disease. The large number of persons per room may mean improperly managed environment conditions in the house. Owing to this, communal diseases can easily flourish in the unhygienic environment in the house. In this study, province is used as a category variable and the Punjab province is used as a reference category. The Sindh province dummy has a negative sign which shows less incidence of diarrheal disease as compared to the Punjab province.

Specification of urban and rural models which are represented in Table-4 and Table-5 have the same trend except some variables which have different signs and coefficients. For example in the urban model, tap water has a positive but insignificant coefficient, which may be due to the supply of water contaminated in the urban areas. In Pakistan, most of the people still do not have access to safe drinking water, the quality of tap water distributed by the state utilities is considered unsafe for drinking. In Karachi, where diarrhea is the leading cause of childhood death, municipally supplied water is heavily contaminated with fecal organisms.[10] Children rank highest among the adversely affected groups of society owing to water contamination. Vulnerable

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sanitation. Almost 1/3rd have no access to clean water. A quarter does not have adequate housing. 1/5th have no access to modern health services".

[9] Global Water Supply and Sanitation Assessment 2000 Report.

[10] Luby S, Agboatwalla M, Raza A, Mintz E, Sobel J, Hussain S, Husan R, Ghouri F, Baier K, Gangarosa G. Microbiologic Evaluation and Community Acceptance of a Plastic Water Storage Vessel, Point-of-Use Water Treatment, and Handwashing in Karachi, Pakistan. 47th Annual EIS Conference. April, 1998.

as their immune system is, they almost always succumb to virulent diseases. Tap water in rural areas also has a positive insignificant sign but it has a smaller coefficient as compared to urban areas. This tendency indicates that tap water is less contaminated in the rural areas.

Table 3:Logistic Model of Diarrheal Disease
(Both Areas)

Variables	Coefficient	t-statistics
Dependent variable: Diarrhea in the household (0-5) years children		
Constant	-5.2360	-14.96***
Young Children in the House age 0-5 (Share)	0.0338	9.88***
Young Children in the House age 6-10 (Share)	0.0057	1.97**
Mother's Education	-0.0294	-2.36**
Solid waste system	-0.0311	-0.33
Covered Drainage System	-0.0276	-0.21
Household Size	0.0631	6.43***
Tap water in the house	0.0444	0.47
Hand pump in house	0.1567	1.64
Distance Travel for Public /Private	1.8445	20.31***
Log Household Per capita Income	-0.0588	-1.50
Flush System in the House	-0.2947	-3.08***
Persons per Room	0.0291	1.774*
Urban	0.5258	6.09***
Sindh	-0.0806	-0.88
NWFP	0.8756	8.41***
Balochistan	0.3540	2.84***
Sample Size	6928	
Log Likelihood	-2744.98	
LR statistic (16 df)	1524.34	
Probability (LR stat)	0.000	
McFadden R^2	0.22	

Source: Pakistan Integrated Household Survey 2001-02

Note: (i) * at 10 % level of significance (ii) ** at 5 % level of significance (iii) *** at 1 % level of significance

Mother's education has a significant coefficient in the urban model and also negative sign in the rural model. This indicates that mother's education is effective in both areas. Children whose mothers had more years of schooling were less likely to suffer from respiratory infection than children whose mothers were less educated, but mother's education has a significant effect on the reduction of incidence of diarrhea. Children of educated mothers were more likely to be treated for either type of infection. No differences were detected between girls and boys in either disease incidence or treatment in our models.

The other very highly significant variable in the rural model is distance travelled for public/private health facilities. For diarrheal treatment, access actually appears to be slightly better for private services than for government services.[11] This may be because parents are prepared to take their children somewhat longer distances for private services due to less satisfaction with government services. Children living less than one kilometer distance to the health service continued using it more frequently than others. This exhibits that health facilities are very poor and out of access for poor people in the rural areas. This is very obvious when the question of rural urban disparity arises. In Pakistan, it is frequently found that health facilities, be it curative or preventive, are somehow better provided in the urban centres and rural areas are often taken for granted with respect to the provision of facilities and hence are deprived of their basic rights. The variable 'persons per room' also has a positive coefficient, which determines conjunction of the persons in the house may increase the incidence of diarrheal disease in urban as well as rural areas. This conjunction can add immeasurably to discomfort and inconvenience in the house.

[11] Pakistan Integrated Household Survey 2001-02

Table 4: Logistic Model of Diarrheal Disease
(Urban Areas Model)

Variables	Coefficient	t-statistics
Dependent variable: Diarrhea in the household (0-5) years children		
Constant	-5.7624	-8.72***
Young Children in the House age 0-5 (Share)	0.0417	7.56***
Young Children in the House age 6-10 (Share)	0.0019	0.41
Mother's Education	-0.0324	-2.12**
Solid waste system	-0.0500	-0.41
Covered Drainage System	-0.2364	-1.48
Household Size	0.0524	3.34***
Tap water in the house	0.1244	0.91
Hand pump in house	0.0816	0.46
Distance Travelled for Public /Private Health Facilities	3.1445	10.77***
Log Household per capita Income	-0.1104	-1.54
Flush System in the House	-0.2751	-2.00**
Persons per Room	0.0517	1.90*
Sindh	0.3286	2.37**
NWFP	0.6907	4.06***
Balochistan	-0.0180	-0.09
Sample Size	2761	
Log Likelihood	-1090.43	
LR statistic (15 df)	496.54	
Probability (LR stat)	0.000	
McFadden R^2	0.19	

Source: Pakistan Integrated Household Survey 2001-02

Note: (i) * at 10 % level of significance (ii) ** at 5 % level of significance (iii) *** at % level of significance

Table 5: Logistic Model of Diarrheal Disease
(Rural Areas Model)

Variables	Coefficient	t-statistics
Dependent variable: Diarrhea in the household (0-5) years children		
Constant	-5.3005	-12.16***
Young Children in the House age 0-5 (Share)	0.0302	6.78***
Young Children in the House age 6-10 (Share)	0.0079	2.06**
Mother's Education	-0.0233	-0.90
Solid waste system	-0.2003	-1.28
Covered Drainage System	-0.0243	-0.07
Household Size	0.0756	5.81***
Tap water in the house	0.0634	0.44
Hand pump in house	0.2887	2.37
Distance Travelled for Public /Private Health Facilities	1.6843	17.99***
Log Household per capita Income	-0.0329	-0.68
Flush System in the House	-0.3693	-2.64***
Persons per Room	0.0165	0.79
Sindh	-0.3921	-3.10***
NWFP	0.9685	6.99***
Balochistan	0.6143	3.70***
Sample Size	4167	
Log Likelihood	-1618.51	
LR statistic (15 df)	1093.34	
Probability (LR stat)	0.000	
McFadden R^2	0.25	

Source: Pakistan Integrated Household Survey 2001-02

Note: (i) * at 10 % level of significance (ii) ** at 5 % level of significance (iii) *** at 1 % level of significance.

6. Conclusion:

We have developed a model to estimate diarrheal disease employing household-level data collected from all over Pakistan using a relative aggregate indicator of illness in the household (the low rates of illness in our data allow us to successfully model diarrheal illness separately for children) and a cross-sectional approach. We find that several economic, engineering/behavioural and neighbourhood-level variables are associated with illness.

Among the engineering variables, poor reliability of the water supply is most strongly associated with diarrheal illness. The supply of water through a hand pump particularly in the rural areas results in higher incidence of diarrhea. Surprisingly, the water sources that supply urban households (government-piped water) have the highest interruption rates, making those households particularly vulnerable to diarrhea. Given the source of water, more educated households appear to engage in more defensive activities than a poorer household, but the effect of income on diarrhea is weak, to some extent because of the higher frequency of interruptions in the water supply. The availability of a covered drainage system (another variable, which we treat as given in the short term) appears to significantly increase defensive behaviour and decrease the risk of diarrheal illness.

Behavioural attitude is also a major factor in the reduction of diarrheal disease. For instance, diarrhea incidence is low with contaminated water, because households are careful in their personal hygiene, and boil water before drinking. In such a setting, an engineering intervention, such as improvement in water quality, could prove ineffective in lowering diarrhea rates because of the importance of behavioural factors. Poor reliability of the water supply may be associated with diarrheal illness. Interruptions in the water supply, particularly in the cities, are consistently found to interfere with defensive behaviour (washing hands after using the toilet), and result in higher incidence of diarrhea. Given the source of water, a wealthier/more educated household usually appears to engage in more defensive activities than a poorer household. The availability of a washbasin near the toilet area can appear to significantly increase defensive behaviour and reduce the risk of diarrheal illness. Therefore, better water supply system can definitely reduce the mortality rate occurring due to diarrheal disease. Uncleaned toilets, filthy water over-flowing the drainage system, heaps of garbage lying here and there further make the health system deteriorate. In most of the cases of diarrheal disease the root cause is lack of hygiene.

Public interventions can exhibit varying levels of effectiveness in controlling the transmission of diarrheal disease, and a plentiful water supply and adequate sanitation appear to have a greater impact on diarrheal disease than improvements in water quality. Effectiveness in lowering disease rates, and particularly the severe and mortal cases, depends on broader preventive strategies, including water supply and sanitation, nutrition and education programmes. Thus, adequate sanitation practice, literacy and sound knowledge regarding the proper maintenance of hygienic conditions will undoubtedly reduce the incidence of diarrheal illness which ultimately results in child mortality.

But all these factors run in a vicious circle that is poverty, education and health. They are all inter related, rather inter-dependent. If the country really wants to control these fatal diseases, a blend or a synthesis of the efforts made by both the public and the private sectors is needed. This will avoid duplication of responsibilities as well as the risk factors and acquire a cost effective approach to solve the problem. Like all other government departments, the health department also suffers from overlapping problems in the delivery of services thereby resulting in inefficiency. In the specific case of Pakistan, economic development strategies that raise personal incomes and education do not necessarily guarantee lower rates of diarrhea. Some other measures should also be taken to control diarrhea in the future.

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