

# **DIARRHOEAL MORBIDITY AMONG YOUNG CHILDREN IN ERITREA: ENVIRONMENTAL AND SOCIO-ECONOMIC DETERMINANTS**

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**Abstract:** Diarrhoeal disease is widely recognized as a major cause of child morbidity and mortality in many developing countries, particularly in sub-Saharan Africa. In Eritrea, diarrhoeal disease is one of the most frequent causes of childhood and a major contributor to child mortality. Yet, except some descriptive reports by the National Statistics Office, no systematic univariate or multivariate analysis of the factors that influence the prevalence of diarrhoeal morbidity among young children exists in Eritrea today. The main purpose of this paper is to examine the effect of some environmental and socio-economic factors that determine childhood diarrhea in Eritrea. The data used come from the 1995 Eritrea Demographic and Health Survey (EDHS). The method employed is logistic regression. The results show that type of floor material, household economic status and place of residence are significant predictors of diarrhea. The study also discovers an important relationship between diarrhoeal morbidity and age of child and number of children living in the house with particularly high prevalence of diarrhea at the age of weaning and in households with large number of living children. However, the effects of toilet facility and maternal education were not found to be statistically significant when other factors are held constant.

## **1 Introduction**

Diarrhoeal diseases remain one of the most important causes of morbidity and mortality in developing countries, especially in African countries. Diarrhea which is characterized by an increase in water evacuations or some watery evacuation with blood or mucus relative to the usual pattern of each individual (Teran, 1991), has been found to be a major contributor to illness and death, particularly among children in

sub-Saharan Africa (Kirkwood, 1991). According to WHO report (WHO, 1996), in the African region, diarrhoeal diseases are still leading causes of mortality and morbidity in children under five years of age. This same report indicates that each child in the said region has five episodes of diarrhea per year and that 800,000 die each year from diarrhea and dehydration.

It is widely recognized that exposure to diarrhea pathogens in developing countries is conditioned by such factors as age of the child, quality and quantity of water, availability of toilet facilities, housing conditions, level of education, household economic status, place of residence, feeding practices, and the general sanitary conditions (personal or domestic hygiene) around the house (Teran, 1991; Diame, 1990; Timaeus and Lush, 1995). In Ethiopia, the incidence of diarrhea was found to be higher in the second half of the infant life (Yohannes, et al., 1992), when inborn immunity is weaker and exposure to contaminated weaning foods is increased. These authors also showed that children living in households with some kind of toilet facility are less likely to be sick than children in households which do not have toilet facilities. In Ghana, the risk of having diarrhea was found to be significantly associated with toilet facility, where children living in houses with toilet facilities are about 50% less likely to contract diarrhea than children living in houses with no such facilities (Tagoe, 1995). The same study indicates that the prevalence of diarrhea varies according to education of mother being significantly lower among children of more educated mothers (secondary or higher) than among children of mothers with no or primary education. This is probably because more education provides the knowledge of the rules of hygiene, feeding and weaning practices, the interpretation of symptoms and enhances timely action to childhood illness (Kirkwood, 1991; Diame, 1990). A comparative study of urban areas of Ghana, Egypt, Brazil and Thailand by Timaeus and Lush (Timaeus and Lush, 1995) clearly indicates that children's health is affected by environmental conditions and economic status of the household. According to these authors, children from better-off households have lower diarrhoeal morbidity and mortality in Egypt, Thailand, and Brazil. Such differentials in diarrhoeal diseases by household economic status is probably due to differences in child care practices, for instance preparation of weaning foods and personal hygiene (Timaeus and Lush, 1995).

At present, a great concern in morbidity and mortality, especially among young children is shown in Eritrea by the health planners. To this effect the Ministry of Health has introduced and implemented a program known as Participatory Hygiene and Sanitation Transformation (PHAST) through the construction of community and school latrines and undertaken national clean up days yearly in order to reduce sanitary and hygiene related diseases.

However, the success of any health policy or health care intervention depends upon a correct understanding of socio-economic, environmental and cultural factors which determine the occurrence of diseases and deaths. Until 1995 any morbidity information available was derived from clinics and hospitals. But, incidence of diarrhea obtained from hospitals represent only a small proportion of all illnesses because many cases do not seek medical attention (Black, 1984). Thus, hospital records may not be appropriate for estimating incidence of diarrhea and are too sketchy to be used for program developments. The first attempt to obtain population-based morbidity data was the Eritrea Demographic and Health Survey (EDHS) conducted in 1995. Although DHS data certainly do not allow one to attribute child morbidity to specific causes for all births they probably are robust and could be useful, for example, in studying child morbidity for the last two weeks before the survey. The main purpose of this study is to assess the prevalence of diarrhea among young children in Eritrea and to examine the environmental and socio-economic characteristics that determine diarrhoeal morbidity using the EDHS data. A description and categorization of the variables used in the analysis are provided in the Annex.

## **2 Materials and Methods**

It is difficult to give a precise definition of diarrhea because the frequency with which stools are passed and the consistency of the stools depend very much on diet and varies from one individual (or society) to another. In the EDHS survey, diarrhea was defined as the passing of liquid, watery or loose stools. For living children born three

years prior to the survey, mothers were asked whether their children had experienced diarrhea during the period of two weeks before the survey. Information was obtained from each child's mother the presence of blood or mucus in the stools and the number of bowel movements on the worst day. Information was also sought on any treatment given at home, including use of oral rehydration therapy, and on mode of feeding, specifically whether the child was on breast-feeding, bottle feeding, weaning or adult diet or a combination of any of the above.

The data for this study come from the EDHS carried out in 1995 as part of the international program of DHS. In the EDHS, data was collected during the harvesting season of the year (i.e., September to December 1995). Among others, information on diarrhea and other health related factors was collected from a total of 5,054 women in the reproductive age span. The analysis is confined to children aged between 0 and 35 months who are living with their mother at the time of the survey. This produces a data set comprising about 2,153 children.

The statistical method employed is logistic regression since a logistic regression method is appropriate when outcomes are dichotomous and no observations are censored. For the  $i^{\text{th}}$  individual this model can be expressed as

$$\ln(q_i/1-q_i) = \beta_0 + \sum \beta_m x_{mi}$$

where  $q_i$  is the probability of a child being ill with diarrhea during the reference period,  $\beta_0$  is the baseline constant,  $x_{mi}$  is an array of (m) independent variables, and  $\beta_m$  is the corresponding vector of unknown regression coefficients, which we estimate via a maximum likelihood procedure using the SPSS-PC logistic program (Hosmer, 1989). The estimated coefficients ( $\beta_m$ ) when exponentiated, are interpreted as the odds of diarrhoeal morbidity ( $q/1-q$ ) for individuals with certain characteristics relative to the odds of diarrhoeal morbidity in a reference (or baseline) group of individuals, that is, as relative odds or odds ratios. For rare events like diarrhoeal diseases,  $q$  is small and the odds ratio translates to a relative risk (Collett, 1991).

### 3 Results

Table 1 presents the odds ratio from the univariate model, the prevalence rate of diarrhea according to the demographic, environmental and socio-economic variables. In order to examine the net effects of the variables included in the univariate model, we also estimated a series of nested multivariate models (Table 2). The patterns of diarrhea prevalence show some important variations by age (Table 1). The risk of having diarrhea in the two weeks reference period in Eritrea clearly indicates a peak at the age of 6-11 months. In that age group, the risk of having diarrhea is over three times higher than those children aged 0-5 months (reference group). After 6-11 months age, the risk of having diarrhea in the two weeks period decreases as the child gets older. The significant effect of age is retained even after the other variables are controlled for (Table 2).

There is a significant association between the number of children living in the house and diarrhoeal morbidity in both the univariate and multivariate models. The univariate results in Table 1 show that the probability of having diarrhea is about 60% higher if there are six or more children living in the house than if the number of children is less than three. This difference remains the same even when the other environmental and socio-economic variables are held constant.

In the univariate model, availability of toilet facility in the household is associated with a 27% reduction in risk of diarrhea. However, this pattern of risk disappears, and increases positively after controlling for type of floor material, maternal education, household economic status and rural-urban residence. Table 1 shows that children living in houses with non-dirt floor are 43% less likely to have diarrhea than those living in houses with dirt floor. Even after controlling for other variables the difference in the risk of diarrhea remains significant, although it is weakened after the addition of household economic status and place of residence. Education of mother shows a significant negative association with the risk of diarrhea in the univariate model, but does not show any significant effect after adjusting for the influences of other variables. The results also indicate that household economic status is an important predictor of child diarrhea in Eritrea. The probability of having diarrhea is 33-38% lower for children from medium and high economic groups than children

from low economic group (Table 1). However, after controlling for other variables, the significant effect of high economic status disappears. In the multivariate model, only children from households with medium economic status have significantly lower risk of diarrhea. Place of current residence is strongly associated with diarrhoeal prevalence in both the univariate and multivariate models. In the univariate analysis, compared to children living in rural areas, children living in urban areas are 46% less likely to have diarrhea. When the other variables are taken into account, the difference in the risk of diarrhea still remains significant.

Table 1 Odds ratios and prevalence rate of diarrhea during the two weeks preceding the survey by the selected demographic, environmental and socio-economic variables

<b>Variables</b>	<b>Diarrhoea Odds ratio</b>	<b>Diarrhoea Prevalence rate</b>	<b>Total no of Children</b>
<b>Age of child (months)</b>			
0-5	1	11.7	395
6-11	3.27***	30.1	372
12-23	2.79***	26.9	662
24-35	2.15***	22.1	724
<b>Number of children living in house</b>			
<=2	1	19.1	780
3-5	1.30**	23.5	806
6+	1.64***	27.9	567
<b>Availability of toilet facility</b>			
no facility	1	24.1	1707
facility	0.73**	18.8	446
<b>Type of floor material</b>			
dirt	1	25.0	1673
non-dirt	0.57***	16.0	480
<b>Maternal education</b>			
no education	1	25.2	1508
education	0.65***	18.0	645
<b>Household economic status</b>			
low	1	26.9	1137
medium	0.62***	18.4	777
high	0.67**	19.7	239
<b>Place of residence</b>			
rural	1	25.0	1714
urban	0.54***	15.3	439
Total			2153

\*\*\* Factor level significant at <1%, \*\* Significant at <5%

Table 2 Odds ratios of child diarrhea (probability of having diarrhea in the two weeks reference period) associated with demographic, environmental and socio-economic variables

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
<b>Age of child (months)</b>					
0-5	1	1	1	1	1
6-11	3.25***	3.30***	3.33***	3.32***	3.36***
12-23	2.79***	2.81***	2.81***	2.85***	2.88***
24-35	2.09***	2.11***	2.10***	2.10***	2.12***
<b>Number of children living in house</b>					
<=2	1	1	1	1	1
3-5	1.29**	1.29**	1.25*	1.24*	1.24*
6+	1.62***	1.61***	1.54***	1.56***	1.56***
<b>Availability of toilet facility</b>					
no facility	1	1	1	1	1
facility	0.74**	1.09	1.13	1.21	1.39*
<b>Type of floor material</b>					
dirt	-	1	1	1	1
non-dirt	-	0.54***	0.58***	0.61**	0.70*
<b>Maternal education</b>					
no education	-	-	1	1	1
education	-	-	0.83	0.92	0.96
<b>Household economic status</b>					
low	-	-	-	1	1
medium	-	-	-	0.68***	0.71***
high	-	-	-	0.83	0.92
<b>Place of residence</b>					
rural	-	-	-	-	1
urban	-	-	-	-	0.62**
df	6	7	8	10	11
<b>Model statistic</b>	68.43	81.2	83.04	92.12	97.91

\*\*\* Factor level significant at <1%, \*\* significant at <5%, \* significant at <10%

## **4 Discussion**

While it is widely recognized that diarrhea is a major cause of child morbidity and mortality and it is affected by several socio-economic, environmental and behavioral factors, this has rarely been confirmed by longitudinal studies or clinical diagnosis. There are a number of studies on diarrhoeal morbidity based on cross-sectional surveys. However, the measurement of diarrhea from such surveys is complicated and comparison across different background characteristics is difficult. There are both conceptual and technical problems associated with information on prevalence of diarrhea obtained retrospectively from cross-sectional studies. First, seasonal differences of occurrence in diarrhea are difficult to be taken into account in such studies. Longitudinal studies may be more appropriate to provide data in different seasons (van Ginneken, 1991). Second, during the survey, neither the children were examined nor mothers were given a precise definition of what constitutes an episode of diarrhea. These questions measure the mother's perception of her child's health rather than morbidity according to clinical examination. This may create variations among different socio-economic groups because perception of illness is not the same across different social groups. Third, loss of memory of events as well as misinterpretation of the reference period can also contribute to the problems associated with the prevalence of diarrhea (Bateman and Smith, 1991; Gaminiratne, 1991). In this case, properly designed longitudinal or clinical studies are ideal tools for the collection of diarrhoeal morbidity in children and on other factors that are related to diarrhea. Nonetheless, in the absence of longitudinal or clinical information, cross-sectional surveys, like the EDHS offer the opportunity to examine the patterns and determinants of child diarrhea during two weeks prior to the survey. Such estimates may be of relevance to health development programs in Eritrea.

In general, the results show that the risk of having diarrhea in the two-weeks reference period reaches its peak at 6-11 months and then begins to fall with increasing age of child. This pattern resembles to those found in many studies of sub-Saharan Africa. In Ethiopia, for instance, the peak occurs among infants 6-11 months of age and those



between 12 and 23 months (Habtemariam, 1994), with 24 to 59 months old at lowest risk. In Nigeria, the prevalence of diarrhea was found to be highest among children 6-12 months of age, the period when most children are weaned (Olugbemi, et al., 1994). The low risk of diarrhea during the age 0-5 months observed in this study clearly indicates the protective effect of exclusive breast feeding in the first six months of life (in Eritrea, supplementary foods start between ages 4 and 6 months). In addition to breast milk, inborn immunity and less exposure to contaminated agents during the early period contributes to the lower prevalence of diarrhea. On the other hand, the prevalence peaks when the child has lost inborn immunity and when it is exposed to different types of infections from eating food prepared by unclean water and from unhealthy environment.

Number of children living in the house is another important demographic variable that influences diarrhoeal prevalence, where the risk of having diarrhea rises as the number of children living in the house increases. The risks of having diarrhoeal morbidity associated with the number of children remain highly significant after adjusting for all the socio-economic and environmental variables in the model.

Availability of toilet facility showed a significant association with diarrhoeal morbidity when examined in the univariate model. In the multivariate model, that includes the two demographic variables and toilet facility (Model 1), toilet facility retained its negative significant effect and reduces the risk of diarrhea by 26%. However, the addition of the environmental and socio-economic variables in the model (Models 2 to 5) tends to push the estimated toilet facility effect away from the null value, suggesting that the protective effect (negative effect) of toilet facility shown in the univariate model or in Model 1 of Table 2 could be attributed to the other variables. Particularly, the 39% excess risk associated with toilet facility in Model 5 is largely due to greater confounding with place of residence. A statistically significant negative association between type of floor and diarrhea prevalence is observed in the univariate model. This significant difference is retained even when all the other variables are introduced into the model.

As far as the socio-economic variables is considered, all of them are statistically significant when the relationships with diarrhoeal morbidity are examined independently. But, when the effects of other variables are held constant only household economic status and place of residence retained their statistical significance. Household economic status is significantly associated with diarrhoeal prevalence. It should, however, be pointed out that it is only the medium economic group that is significantly associated with diarrhea when other variables are held constant. Place of current residence emerged as a strong predictor of diarrhoeal disease. Children living in urban areas compared to those in rural areas are less likely to have diarrhea. This holds true in the univariate model as well as in the multivariate model. This persistent effect of rural-urban residence on diarrhoeal morbidity after controlling for the other variables may indicate the difference in diarrhoeal morbidity between rural and urban areas that cannot be explained by the factors included in the model.

In conclusion, the most strong explanatory covariates for variation in the level of diarrhoeal morbidity are the age of the child, number of children in the house, type of floor material and place of residence. These covariates, especially the last encompass many different elements, ranging from the attitudes of mothers to availability of basic health services and clean household environment, few of which are easily accessible to interventions. This may include the fundamental impact of basic personal and domestic hygiene, particularly in the preparation of children's food, feeding practices (e.g., breastfeeding) and the importance of conveying these ideas to mothers.

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## **Annex**

### **Description and Categorization of variables**

For the purpose of this analysis, whether a child had had diarrhea in the two weeks before the survey is used as a dichotomous dependent variable (ill or not ill during the two weeks prior to the survey). Explanatory variables included in the analysis can be categorized under the following classes: (1) Demographic variables, (2) household environmental variables, and (3) socio-economic variables. The demographic variables are age of child and number of children living in the house. The environmental variables considered are availability of toilet facilities in the house and whether the floor material of the house is dirt or non-dirt. Finally, the socio-economic variables include education of the mother, household economic status and rural-urban residence. The description and categorization of each of these variables is given below.

**Age of child.** Age is one of the most important factors in morbidity analysis because both feeding and disease incidence are largely dependent on it. The level of exposure of children to disease organisms and the type of immune response to infections vary with the age of the child. Infectious diseases such as diarrhea, are less frequent when the child is small because of the immunity acquired and the level of care and breast milk it receives from the mother as well as the less exposure to contaminated agents. When the child has lost inborn immunity and becomes more vulnerable to different infections the prevalence of diarrhea becomes high. Thus, assessing the prevalence of diarrhea by age of the child will give an important information about the age pattern of diarrhoeal prevalence. The age of child is categorized as 0-5, 6-11, 12-23, and 24-35 months.

**Number of children living in the house.** Number of children in the house may have some impacts on the incidence of child diarrhea. A large number of children in a household may be more likely of having diarrhea because of crowding and competition for mother's time and attention and other resources. Thus, number of

children living in the house is included as an indicator of crowding. Three categories are distinguished according to the number of children living in the house; less than 3, 3-5 and 6 or more children.

**Availability of toilet facility.** Respondents were asked whether the dwelling had some kind of toilet facilities. Responses to question on current excreta disposal are divided into two: no toilet facility and toilet facility.

**Type of floor material.** Another indicator of environmental contamination is whether the floor material of the house where the child lives in is dirt or non-dirt. Since dirt floors cannot be washed they are more likely to provide a breeding ground for various diarrhea-causing agents than non-dirt floors (Tagoe, 1995). The materials of which the dwelling's floor is constructed is classified into two categories. The first classification is 'dirt' where a floor is composed of soft floor - earth, sand or dung. The second group, 'non-dirt', has a hard floor - concrete or cement.

**Maternal education.** The EDHS collected information on the highest educational level of respondents at the time of the interview. The six categories identified by the EDHS are no education, primary incomplete, primary complete, secondary incomplete, secondary complete, and higher education. The distribution of mothers over these six levels were respectively 77.6, 13.3, 1.4, 5.5, 1.7, and 0.5%. Given the small numbers of mothers who had been to school, in this analysis education was measured as a simple dichotomy: none or some education.

**Household economic status.** Most surveys do not collect direct information on parental income but seek information on the number of consumer durables possessed by households (such as a radio, bicycle, etc.). Like most DHS surveys, the EDHS did not attempt to collect information about income directly. Instead, respondents were asked about ownership of household goods such as radio, bicycle, television, car, and the like. Ownership of radio, bicycle, and car are here regarded as a proxy for general household wealth, which may affect infant and childhood health but for which information was not directly available. These items are used to construct a new household economic status variable with three categories which is defined as (1) 'low'

if the household does not own any of the items (radio, bicycle, or car), (2) 'medium' if the household owns only a radio, and (3) 'high' if the household owns a bicycle or a car or both. This variable avoids the problem of income measurement in rural areas and might be a reasonable indicator of relative economic status.

**Rural-urban residence.** Whether a mother resides in an urban or rural locality may affect her exposure to education and the extent to which proper sanitation, clean water and health-care facilities are available. It may therefore be expected that children in urban areas where proper sanitation and health facilities are available as well as where modern treatment is more frequent, will have lower prevalence of diarrhoea. Thus, a distinction is made between rural and urban areas in this study.

Unfortunately, there are some other factors which may influence diarrhoeal morbidity which we are not able to take into account in our analysis. Perhaps the most important ones are water supply and breast feeding practices.

The health benefits of improved water supply have been established in several previous studies (Esrey and Habicht, 1986). Clean water prevents the spread of water-related diseases, such as diarrheas and cholera (Bateman and Smith, 1991). However, since piped water is only limited to urban areas, we are unable to consider this variable in our analysis.

Breastmilk has a protective effect on various infections. Some studies suggest that the anti-infective and protective effects of breastmilk are reflected in milder illnesses from various infections and lower risks of death (palloni and Tienda, 1986; Butz, et al., 1984). Exclusive breast-fed babies are much less likely to get diarrhea or to die from it than babies who are not breast-fed or are partially breast-fed (WHO, 1990). However, there are some problems in the breast feeding data in the EDHS. First, there are severe heapings of reported durations of breast feeding. Most of the reported durations fall on 6 month multiples, especially on 12, 18, and 24 months. Another problem is that we are unable to distinguish periods in which the child is in the process of being weaned. The introduction of supplementation with other liquids or foods marks the beginning of a child's exposure to possibly contaminated foods and liquids.