INCOME INEQUALITY IN CHILD INJURY IN BANGLADESH- IMPLICATION FOR DEVELOPING COUNTRIES

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Introduction

In recent decades the overall child mortality rates have decreased globally. In Bangladesh, between the periods 1989-2004 infant mortality declined by 25 percent from 87 deaths per 1,000 live births to 65 deaths per 1,000 live births. Child and under five mortality have declined 52 and 34 percent respectively over the same period. Last five years child mortality declined only 20 percent[1]. Various immunization program and intervention program played important role in reducing the infectious and non-communicable deceased. However, injuries have been emerged as a leading cause of both morbidity and mortality for children[1-3]. In the infancy, the main causes of death were law birth weight, pneumonia and birth asphyxia. Whereas after the infancy the main leading cause of child death are injury[1]. It is now a public health issue in both developed and developing world[4-6]. World Health Organization reported that almost 6 million deaths due to injury [7]. Studies from Bangladesh revealed that 21% deaths among 1-4 years children due to injury [3]. It is also a major cause of disabilities and deaths of children[6, 8]. The problems of road traffic accident, drowning, fall, and burn have been an unnoticed public health disaster. It is expected that injury will be the rival of communicable disease as a cause of ill health and death by the first decade of the new millennium[9]. Non fatal injuries are the frequent cause of hospital admission and disabilities center and half of the hospital surgical beds are occupied by the injury patient [10].

Data from several populations suggest that socioeconomic disparities are strong predictors of childhood mortality[11-15]. Low maternal education, young age, and increased number of other children were strong predictors of injury mortality rate for children 0 through 4 years of age[11]. Although the recent decline in child mortality in Bangladesh is remarkable, death from causes other than infectious diseases and malnutrition remains an important component of child mortality. Death from injury of children can be expected to be a problem in Bangladesh given the geographical features of the country[16].

Globally, poorer bears a disproportionate burden of injury morbidity and mortality. The poor countries suffer more than the rich countries. Within the counties, poor people represented by pedestrians, passengers in buses and trucks, and cyclists suffer a higher burden of morbidity and mortality from traffic injuries.[17] Numerous studies have been demonstrated that lower socioeconomic classes have higher death rates than the upper socioeconomic classes and this difference have increased in the past decades[18-19,a]. But very few studies focus the equity in child injury mortality and morbidity. The aim of this study is to investigate the income inequality in injury morbidity and mortality among 1- 4 years children.

Materials and Methods

Data

The data for this study is derived from Bangladesh Health and Injury Survey[20] (BHIS) 2003. The aims of BHIS were to investigate information on cause of death and serious morbidity, pattern and characteristics of injury and overall risk factors and hazards for childhood injury. BHIS also investigated the information environmental risk and hazards around the households. This study conducted in Bangladesh between January and December 2003. BHIS is a large cross sectional data set that comparable across the countries. A multistage cluster sampling technique was conducted for this survey. Administratively, Bangladesh is divided into 6 divisions. These in turn consist of 64 districts, 12 of them randomly selected. In each district, one upazila (sub-district) out side from district head quarter was randomly selected. Two rural unions (the smallest administrative unit) from each upazila outside from head quarters were randomly selected. Each rural union had roughly 20,000 populations. From district head quarter 12 mahollus (urban smallest administrative unit) was selected randomly for urban sample. A sample of 132000 households from both rural and urban areas in Bangladesh was selected for collecting information.

In BHIS, respondents were asked to provide a complete history of each individual, including age, sex, death occurred preceding two years before survey, and illness occurred before 6 months of the survey. For who died, age and sex were recorded. Verbal autopsy was made for diagnosed the causes of death and illness with a specified structured questionnaire. Two independent panels of pediatricians checked the collected autopsy forms for find the exact cause of death. To collect information on characteristics of injuries, separate forms were used for each mechanism of injury.

Statistical analysis

This study used a proxy measure of economic status of each household in terms of assets or wealth (Poorest, Second, Middle, Fourth, Richest) rather than in terms of income or consumption. Information regarding the household items (i.e. television, radio, electricity, refrigerator or car) and ownership of house and cultivable land were assigned a weight or factor score generated through principle component analysis[19]. The resulting scores were distributed normally with mean zero and standard deviation one. Each household was assigned a standard score for each asset. Standard household score were added up for each household, and each child was assigned the total household asset score for its household. Children were ranked according to their total scores and divided five quintiles to understand health inequality. Inequalities by income in mortality and morbidity thereof are measured here using a concentration index[19]. Concentration index is a generalisation of the Gini coefficient. To measure income related inequality in health we plot the concentration curve, which graphs the cumulative proportion of health against the cumulative proportion of population ranked by income (see Figure-1). The numerical measure of inequality in mortality is measured by the *concentration index* denoted as C defined as twice the area between the concentration curve and the diagonal. The concentration index estimates reported in these study are calculated from grouped data using the following equation:

$$C = 2/\mu(\Sigma f_t \mu_t R_t) - 1 \qquad (1)$$

Where, μ represents the mean of the particular health indicator μ_t and f_t respectively represent the value of health indicator and population share for the tth socio-economic group. R_t is the relative rank of the tth socio-economic group, defined as $R_t = \sum f_\tau + 0.5 \; f_t$, which indicates the cumulative proportion of population up to midpoint of each interval group.

Analysis of the effects of socio-economic and demographic factors on child injury mortality and morbidity is based on the estimation of a primary model. The model examines the effects of maternal and other socio-demographic characteristics on the likelihood of the child being injured. In the analysis of the model, death or illness due to injury is measured as dichotomous variable coded 1 if the injured prior to the date of interview and 0 otherwise. Logistic regression model is used for the analysis. The coefficient in the analysis represents increase or decrease in the log odds of being occurrence of event (versus not occurrence) associated with a unit or category change in an independent variable.

Limitation and strength
Information regarding assets and households characteristics were collected from only 25% sample households i. e. 32,200 households. So the analysis mainly based on proportion of occurring injury .It is a large sample study. Asset score measured in this study is consistent with Bangladesh Demographic Health Survey (BDHS). Value of some quintiles is 0 (Zero) for specific causes of injury, so Concentration Index is not measured.

Results

Table 1 shows that the descriptive measures of the households' possession of durable goods. Results of this study show that only 27 percent household own a television, 32 percent own either a radio of a tape recorder, 3 percent had refrigerator. Almost 91% of the households had the television belongs to the richest and only 2.7% middle class household had the television. Only the 15 % of the rich quintiles' household had ownership of a refrigerator. About one-third (31 percent) of the households of the study sample had electricity connection. About 80 percent of households had own homestead. Only 37 percent of the households possessed cultivable land more than or equal 50 decimal. In the BHIS survey, respondents were asked their gross monthly income. Almost 50 percent of the household respondent mentioned that they earned more than 3000 BDT (Bangladeshi Taka) i.e. 50 USD.

Table 1: Percentage of household asset by each quintile

	Poorest	Second	Middle	Fourth	Richest	Total
Possession of television			2.7	46.8	90.5	26.8
Possession of radio/tape-recorder			26.5	56.9	80.4	31.8
Possession of motor-cycle			2.0	10.0	88.0	1.6
Possession refrigerator				0.6	14.9	2.8
Electricity connection			22.5	35.9	84.6	27.2
Land>=50 decimal		52.1	54.7	59.6	42.2	39.7
Income>3000 BDT		36.5	55.4	77.0	95.7	51.9
Ownership of House	94.2	92.5	87.5	75.9	41.2	80.4
Rent House			6.4	19.4	56.3	15.5

The ratio of mortality and morbidity proportion by different cause and by each quintile is given in table 2. Due to shortage of space two intermediate (second and fourth) quintiles are not shown in the table. The proportion of mortality for 1-4 year children of first, third and fifth quintiles (referred to low, middle and high economics status) asset index is shown in table 2.

**Table 2: Proportion of mortality and morbidity by quintile**

	Mortality							Morbidity						
	Q_1	Q_3	Q_5	Q_1/Q_5	CI	SE (CI)	t-value	Q_1	Q_3	Q_5	Q_1/Q_5	CI	SE (CI)	t-value
Infection	43.8	18.0	7.9	5.6	-.40***	.08	-5.0	21.8	17.8	18.3	1.2	-.03	.02	-1.5
NCD	39.3	21.4	7.1	5.5	-.32**	.13	-3.1	22.7	21.0	14.3	1.6	-.08**	.04	-2.2
Injury	40.0	21.7	6.7	6.0	-.26**	.06	-3.2	23.9	22.4	14.0	1.7	-.09**	.04	-2.2
Total	41.8	19.8	7.3	5.7	-.32**	.07	-4.2	22.5	19.3	16.8	1.4	-.05**	.018	-2.6

NCD=Non-communicable Disease; Q_1=Poorest quintile; Q_3=Middle quintile; Q_5=Richest quintile; CI=Concentration Index; SE=Standard Error; *<.10;**P<.05; ***P<.01

The overall mortality of 1-4 year children was consequently highest for those living in the poorest family (first quintile). For example, a poor-rich ratio 5.7 for children implies that mortality rate in the poorest quintile is about 5.7 times more than the rate of the richest quintile. The results of this study revealed that injury related mortality and morbidity was much more among the most disadvantaged group of Bangladeshi children other than the infectious and non-communicable diseases. The poorest-richest quintiles ratio due to injury mortality was 6.0 and 1.7 whereas this ratio was 5.6 and 5.5 for the infectious and non-communicable diseases. Similarly, the ratio of poorest-richest quintile in terms of illness, cause of injury was the highest ratio. The ratio of injury related illness of 1-4 years children between poor and rich was 1.7 whereas infectious and non-communicable disease was 1.2 and 1.6 respectively.

 The values of *Concentration Index (CI)* for the children mortality for the Infection, NCD and injury causes are –0.40, -0.32 and –0.26 respectively. All are significantly different from zero at conventional levels (the *t*-value are -5.0, -3.1 and -3.2 respectively). The absolute value of the CI of infectious disease 0.40 indicates the higher degree inequality in mortality. Similarly, among the morbidity concentration indices injury shows the significantly greater inequality.

Figure-1 Mortality and morbidity concentration curve
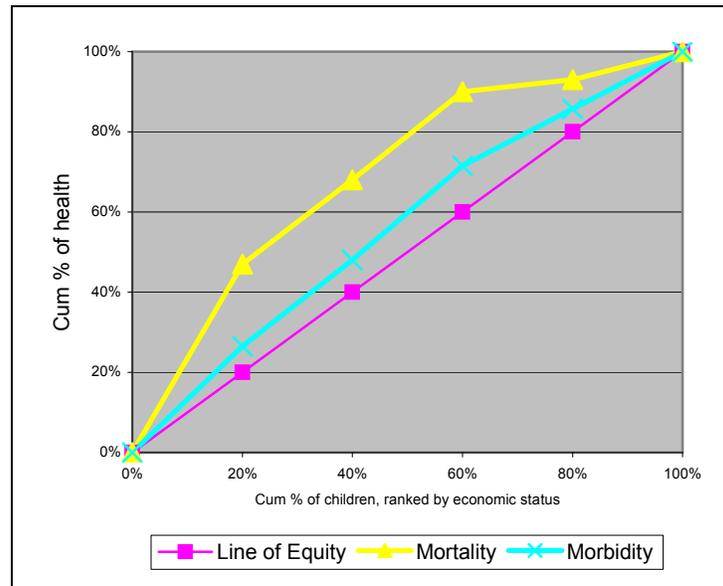
The curves in Figure 1 are mortality-morbidity concentration curve. It plots the cumulative proportion of deaths or illnesses (on the *y*-axis) against the cumulative proportion of children at risk (on the *x*-axis), ranked by income, beginning with the most disadvantaged child. If the curve coincides with the diagonal, all children, irrespective of their household income, enjoy the same mortality rates. The convention is that the index takes a negative value when the curve lies above the line of equality, indicating disproportionate concentration of the mortality among the poor, and a positive value when it lies below the line of equality. If the health variable is a 'bad' such as ill health, a negative value of the concentration index means ill health is higher among the poor. The further the curve lays from the diagonal, the greater the degree of inequality in mortality across quintiles of economic status. In Figure-1 the mortality concentration curve indicate the greater degree of inequality than the morbidity concentration curve. The absolute value of CI for mortality and morbidity are 0.32 and 0.05. Both are significantly different from zero ($p<.05$). This result is consistence with the concentration curve (Fig.-1).

The mortality concentration curves for deaths due to all causes lay above the line of equity (Fig-2). All the curves indicate that child mortality favour the better off. And the curve labeled infection lies everywhere further from diagonal than the curve NCD and injury. The curve for infection is said to dominate that for NCD and injury. Although infection labeled curve is dominating, still greater degree of inequality is appearing in mortality among the income groups for the NCD and injury labeled curve.

Figure 2 Mortality concentration curve by broad causes classification
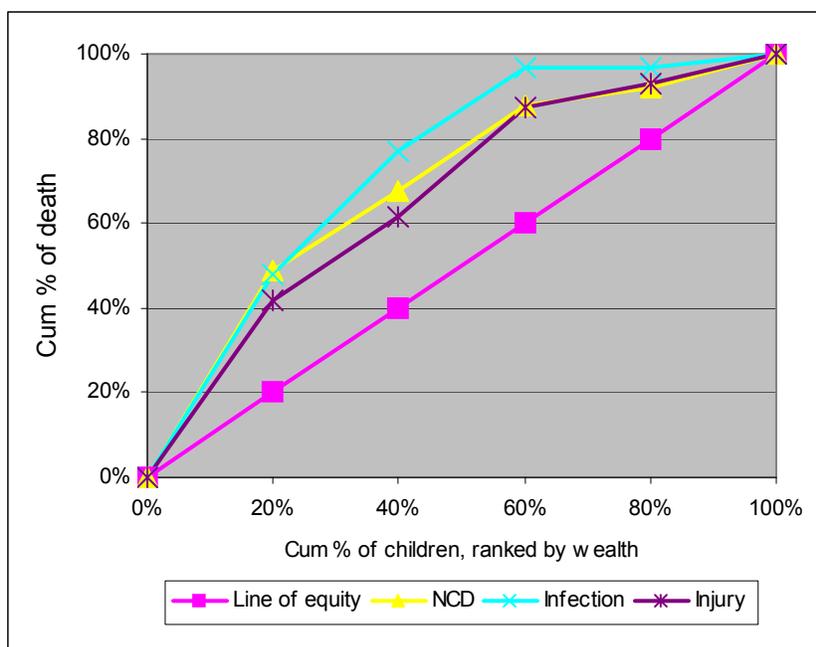
Bangladesh Health and Injury Survey found that pneumonia and diarrhoea are the top two leading causes of death of children between age 1 and 4. The study also found drowning is the third leading cause of childhood death. The mortality and morbidity inequality is highest for cause due to drowning (Table-3). The Poor-rich ratio for drowning, diarrhoea and pneumonia was 7, 5 and 6 respectively. Concentration indices and it's corresponding t-value reveal that there are significant inequalities among the income groups for these three leading cause of mortality. It is also found that cause of pneumonia has the greater degree of inequality.

Table 3: Inequality in leading cause of injury mortality and morbidity

Cause	Mortality							Morbidity						
	Q_1	Q_3	Q_5	Q_1/Q_5	CI	SE (CI)	t-value	Q_1	Q_3	Q_5	Q_1/Q_5	CI	SE (CI)	t-value
Pneumonia	50.0	11.1	8.3	6.0	-.34***	.07	-5.2	20.4	20.3	18.8	1.1	.00	.02	0.1
Diarrhoea	50.0	10.0	10.0	5.0	-.33**	.11	-3.0	29.0	14.5	13.5	2.1	-.13**	.05	-2.3
Drowning	39.6	22.6	5.7	7.0	-.28**	.11	-2.6	31.3	22.7	8.2	3.8	-.21**	.08	-2.7

Q_1=Poorest quintile; Q_3=Middle quintile; Q_5=Richest quintile; CI=Concentration Index; SE=Standard Error; *<.10;**P<.05; ***P<.01

In case of leading causes of morbidity, the poor-rich ratio for diarrhoea and pneumonia are 2.1 and 1.1 respectively. Drowning is another cause of childhood morbidity as well as mortality the ratio is 3.8. Concentration indices for pneumonia, Diarrhoea and drowning are 0 (zero), -0.13

6

and −0.21. Significant income inequality appears for the diarrhoeal and drowning causes of morbidity among the children (Table-3).

Among the children, burn and unintentional poisoning injuries morbidity were 3.2 and 1.5 time more for most disadvantaged than the better off (table-4). Diarrhoea and pneumonia were 2.1 and 1.1 times more for the poorest than the richest quintiles (table 5). Electrocution was another cause of childhood morbidity as well as mortality.

Table 4: Inequality in external cause of injury morbidity

	Q_1	Q_3	Q_5	Q_1/Q_5
RTA	15.2	20.7	23.9	0.6
Fall	13.3	19.8	22.8	0.6
Cut Injury	25.0	8.1	16.9	1.5
Burn	29.5	24.5	9.9	3.0
Drowning	31.3	22.7	8.2	3.8
Poison	23.1	23.1	15.4	1.5
Machine	23.1	46.2	7.7	3.0
Electrocution	21.6	29.4	2.0	11.0
Others	35.7	21.4	21.4	1.7

Table 5: Multiple logistic regression model for risk of injury mortality and morbidity

		Mortality		Morbidity	
		OR	95% CI	OR	95% CI
Child age in year		0.9	.68-1.1	1.6**	1.5-1.6
Child's Sex	Male	1.0		1.0	
	Female	1.6*	.95-2.7	.85**	0.8-.9
Economic status	Richest	1.0		1.00	
	Poorest	2.8**	1.1 −7.9	1.30**	1.0-1.6
Mother's age	<25 years	1.0		1.0	
	>=25 years	0.9	0.4-2.0	0.80*	0.7-0.9
Mother's Education	None	1.00		1.00	
	10 yr+	0.2	0.02-2.03	0.91	0.7-1.15
No of living children	1	1.00		1.00	
	2	1.30	0.4-3.6	1.10	0.9-1.3
	3	1.56	0.4-5.0	1.21	0.9-1.5
	4+	4.14**	1.4-11.8	1.15	1.0-1.4
Constant		-5.69		-2.25	
Model chi-square		41.3		322.8	
-2loglikelihood		610.9		6676.6	

OR =Odd ratio; *<.10; **P<.05; ***P<.01

The logistic regression analyses are provided in table 5. Analysis revealed that female children had significant higher likelihood of injury death as compared to male children. The analysis also reveals that the households with many living children have greater chance of occurring injury

deaths. Children with poor had 2.8-times more likely to have injury mortality adjusting the other factors. It is statistically significant. It is also observed that likelihood of morbidity due to injury is 1.3 times higher among children of poor families as compared to the children of rich families. Control for the other characteristics the occurrence of injury morbidity is increased with the child age. The likelihood of injury morbidity is significantly lower among the females as cmpared to the males. Children with the older age mother had 20 percent less likely to have injury morbidity than the children with younger age (<25 year) mother. The odd ratio occurring an injury related morbidity for poorest quintiles than the richest was 1.3 (95% CI=1.04-1.62). However, the odd ratio of occurring an injury related death for poorest quintiles than the richest was 2.8 (95% CI=1.1-7.9).

Discussion

This study investigated the inequality in mortality and morbidity for one to four year children especially by cause of injury. In this study, quintiles are used to measure the economic status in terms of household's goods that developed by World Bank [19]. The concentration indices show that injury related death was higher among the poor as compare to rich. The study found that inequalities also appeared in mortality due to infectious and non-communicable disease. The children of poorest family suffered more in injury morbidity than the children of rich family. Income inequality is significantly visible in both leading causes of mortality and morbidity. Greater degree inequality exists in drowning related illness among 1-4 years children. The multivariate logistic regression analysis found that female injury mortality was higher but the illness became lower than males. These might be the cause of gender discrimination. In south Asia however, female mortality at many ages especially during the childhood periods[21]. Excess female mortality at child hood period in Bangladesh and other south Asian countries is believed to result from son preference, which leads to differentials treatment of sons and daughters in terms of foods allocation, prevention of disease and accident, and treatment of illness[22]. In south Asia different studies revealed the evidence of sons' preference and discrimination in caring for son and daughters[23]. The study shows significant association between income inequality and mortality among children after adjustment of other factors. The study stated that income distribution affect on child mortality due to infectious and non-communicable disease while this may true in injury mortality. This analysis shows after infancy age to be an important mediator of relationship between income inequality and injury mortality and morbidity. Due to existing socioeconomic situation in Bangladesh, the poor children are more vulnerable to injury morbidity and mortality the percentage of disabled are much higher in this group as compare to rich group.

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