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INDIRECT ESTIMATION OF CHILDHOOD MORTALITY IN BANGLADESH

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ABSTRACT

Childhood mortality is one of the sensitive indices of health as well as development which often reflect the standard of living of a country. Moreover, it is considered as an interesting topic for researcher in Bangladesh because of high childhood mortality. The purpose of this study is to estimate the childhood mortality through Brass, Sullivan and Trussel techniques using the data extracted from Bangladesh Demographic and Health Survey (BDHS)-2004 when data are classified by age of mothers. Moreover, it is to fit some models to age specific average parities per woman. In case of Brass technique, the probabilities of dying ($_nq_x$) are increasing with increasing age of mothers. In Sullivan method, the same patterns are followed except for male and both sexes of urban level of Bangladesh. The probability of dying is low in the age group 20-24 for male of national and rural level and in the age group 25-29 of urban level when it is calculated by Trussel method. But, in all cases, the probabilities of dying ($_nq_x$) for male are greater than that of females excepting some ages. It is investigated that age specific average parities per woman for three cases follow simple regression model with explaining more than 99% variation.

Keywords: Cross validity prediction power (CVPP), Childhood mortality.

1. INTRODUCTION

In any nation, childhood mortality is a reflection of the nation's health as well as the care, health and nutritional status of children which also indicates the social, cultural and economic progress. During the last five decades, childhood mortality rates especially infant mortality rate (IMR) in developed countries are rapidly declining but still a problem in developing countries like Bangladesh. An estimated 29000 children die in every day before completing their age of five in the world (Tadesse *et al.*, 2009). UNICEF (2009) reported that in 2007, 9.2 million children born alive across the world died before reaching the age of five. But, one year later, it has been decreased to 8.8 million (Black *et al.*, 2010; You *et al.*, 2010), of which, 41% of deaths occurred in neonates (You *et al.*, 2010). According to PRB (2011), IMR is 44, 5 and 76 per 1000 live births in the world, more developed and less developed countries respectively. Despite decreasing childhood mortality, it still remains high in some vulnerable groups and areas. You *et al.* (2010) had reported that the highest rates of under-five mortality continue to occur in Sub-Saharan Africa and South Asia have the second highest rate in the world. Moreover, most of these children lived in these regions and died from a disease or a combination of diseases or illness (Srinivasan and Prabhu, 2006). However, many countries are not on track to meet the target of Millennium Development Goal-4 (MDG-4) (You *et al.*, 2010), but Bangladesh is currently one of the very few countries in the world especially in South Asia and Sub-Saharan Africa, which is on target for achieving the MDG-4 relating to child mortality. The target for Bangladesh related to the MDGs is to reduce under five mortality from 151 per 1000 live births in 1990 to 50 in 2015 (Arifeen, 2008). Recently, several studies reported that IMR is 45 per 1000 live births (PRB, 2011) and under five mortality is 71 (UNESCAP, 2009) and 65 (Mitra and Associates, 2007) in this country, which clarify that Bangladesh is on the track to meet MDG-4. Although the recent decline in childhood mortality is remarkable (Ahmed *et al.*, 1999), but it still remains high in Bangladesh due to the high prevalence of malnutrition, childhood diseases and other socio-demographic factors. UNICEF (2008) has reported that the child mortality in the poorest households and in hard to reach areas is approximately 50% higher than those in the wealthiest areas and one neonate dies in every three to four minutes, making 14 neonatal deaths every hour in Bangladesh. Most of deaths occur in the neonatal period (Habib *et al.,* 2009). So, it has long been a topic of interest to population expert, health researchers and academicians assess the causes and levels of mortality in Bangladesh. But, due to insufficient information, it is not possible to know the exact mortality level and their causes. Moreover, the causal relationship and differentials between under-five mortality and its socio-economic and other covariates is not well established; in this context, the objective of this study is to estimate the childhood mortality in Bangladesh through various indirect techniques.

2. METHOD AND MATERIALS

2.1 DATA

The data classified by age of mothers is taken from Bangladesh Demographic and Health Survey (BDHS) 2004 (Mitra and Associates, 2004), for the ten year period preceding the survey, having an eligible woman (ever married and aged 10-49) with at least one or more children (with a total sample size 8721, of whom 5840 from rural and 2881 from urban areas), which was conducted by Mitra and Associates under the authority of the National Institute of Population Research and Training (NIPORT), Ministry of Health and Family Welfare, Bangladesh.

2.2 EMPIRICAL METHODS

2.2.1 BRASS, SULLIVAN AND TRUSSEL TECHNIQUE

The most well-known and widely used estimation techniques such as Brass's technique, Sullivan's technique and Trussel's technique are developed by Brass (1964), Sullivan (1972) and Trussel (1975) respectively. These have been employed to estimate the childhood mortality for national level, rural level and urban level of Bangladesh separately when the data are classified by age of mothers in Bangladesh. Brass (1964) was the first to develop a procedure for converting proportions dead of CEB reported by women in age groups 15-19, 20-24 etc. into estimates of the probability of dying before attaining certain exact childhood ages. Brass found that the relation between the proportion of children dead (D_i) and a life-table mortality measure (${}_nq_x$) is primarily influenced by the age pattern of fertility because it is this pattern that determines the distribution of the children of a group of women by length of exposure to the risk of dying. An important assumption made in the development of this method is that the risk of dying of a child is a function only of the age of the child and not of other factors, such as mother's age or the child's birth order. Trying to increase the flexibility of Brass's original method, Sullivan (1972) computed another set of multipliers by using least-squares regression to fit equation to data generated from observed fertility schedules and the Coale and Demeny Regional Model Life Tables (1966). Trussell (1975) estimated a third set of multipliers by the same means but using data generated from the Model Fertility Schedules developed by Coale and Trussell (1974).

2.3 MODEL FITTING

If age specific average parities per woman are plotted in the graph paper, then, it appears from the Fig. 4 to Fig. 6 that these are linearly distributed. So, in this case, linear regression model is identified and the structure of this model is $y = a_0 + a_1 x + u$ (Montgomery and Peck, 1982). In which, x represents the mid value of age in years, y represents age specific average parities per woman, a_0 is the constant; a_1 is the coefficient of x and u is the error term of the model. It is to be noted that these models are built using the software STATISTICA.

2.4 MODEL VALIDATION PROCEDURE

To check the legitimacy of these models, the CVPP, ρ^2_{cv}, is employed at this juncture. The mathematical formula for CVPP is specified below:

$$\rho^2_{cv} = 1 - \frac{(n-1)(n-2)(n+1)}{n(n-k-1)(n-k-2)}(1-R^2)$$

Wherein, n is the number of classes, k is the number of explanatory variables in the fitted model and the cross-validated R is the correlation between observed and predicted values of the dependent variable (Stevens, 1996). The shrinkage of the model is the absolute value of (ρ^2_{cv} - R^2); where ρ^2_{cv} is CVPP and R^2 is the proportion of variation of the fitted model. Furthermore, the stability of R^2 of the model is (1-shrinkage). The estimated CVPP corresponding to their R^2 and information on model fittings are summarized in Table 2. It was informed that CVPP was also employed by Islam (2006), Islam et al. (2003) and Khan and Ali (2004) as model validation method.

To identify the overall assessment of significant level of the formulated model as well as the significance of R^2, the F-test is employed in this paper. The formula for F-test is given as

$$F = \frac{R^2 / (p-1)}{(1-R^2)/(n-p)}$$

with (p-1, n-p) degrees of freedom (d.f.).

Wherein, p = the number of parameters is to be estimated in the fitted model, n is the number of cases and R^2 is the coefficient of determination of the model (Gujarati, 1998).

3. RESULTS AND DISCUSSION

3.1 ESTIMATION OF CHILD MORTALITY FOR NATIONAL LEVEL OF BANGLADESH

After classifying the data on children ever born (CEB) by sex, a quick check of the consistency of the data is ascertained by computing the sex ratios of CEB by age of mother. Hence the complete sets of these sex ratios are enumerated and shown in Table 1. Ideally, these sex ratios should not vary systematically with age and their values should be between 1.02 and 1.07 (United Nations, 1983). It is revealed that the sex ratios fluctuate somewhat by age of mother but show no systematic trend and the overall sex ratio is acceptably close to the expected values of 1.05. Furthermore, since some variation of the sex ratios by age is expected because of the small sample being considered, therefore, it is concluded that this test shows no clear deficiency in the data.

Table 1. Children Ever Born and Children Surviving for National, Rural and Urban Level of Bangladesh, 2004

Age group (in years)	Total women	Male		Female		Sex ratio of CEB
		CEB	Dead	CEB	Dead	
National level						
(1)	(2)	(3)	(4)	(5)	(6)	(7)
15-19	1703	553	53	552	34	1.00181
20-24	2198	1908	163	1716	139	1.11189
25-29	1912	2581	291	2545	247	1.01415
30-34	1445	2628	333	2671	281	0.98390
35-39	857	2015	329	2048	310	0.98389
40-44	413	1141	227	1216	215	0.93832
45-49	193	648	133	703	140	0.92176
Total	8721	11474	1529	11451	1366	1.00201
Rural level						
(1)	(2)	(3)	(4)	(5)	(6)	(7)
15-19	1205	391	37	398	26	0.98241
20-24	1455	1325	106	1201	97	1.10325
25-29	1226	1767	217	1729	173	1.02198
30-34	935	1803	245	1843	212	0.97830
35-39	571	1446	243	1422	245	1.01688
40-44	296	858	171	905	154	0.94807
45-49	152	530	106	582	108	0.91065
Total	5840	8120	1125	8080	1015	1.00495
Urban level						
(1)	(2)	(3)	(4)	(5)	(6)	(7)
15-19	498	162	16	154	8	1.05195
20-24	743	583	57	515	42	1.13204
25-29	686	814	74	816	74	0.99755
30-34	510	825	88	828	69	0.99638
35-39	286	569	86	626	65	0.90895
40-44	117	283	56	311	61	0.90997
45-49	41	118	27	121	32	0.97521
Total	2881	3354	404	3371	351	0.99496

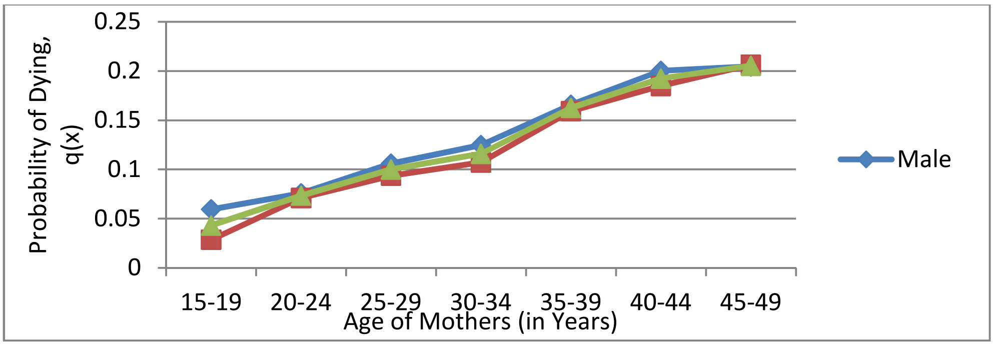
Note: 10-14 age group is included in 15-19 age group

The average parities per woman and the proportion of children dead (D_i) are presented in Table 2. It is seen that the values of D_i have slightly increased between age group 25-29 and 30-34 for male, female and both sexes. These values are almost higher among women of age 35 and above than all other ages of women, probably because the newborn to women aged 35 and above are, in fact, subject to higher mortality risk both mother and their newborn.

The multipliers (k_i), required to adjust the reported proportion dead (D_i) for the effects of the age pattern of childbearing are calculated from the ratios P_1/P_2 and P_2/P_3 and the coefficients are obtained from West Family of Model Life Tables in the Coale-Demeny system. It is assumed that the West Family of Model Life Tables is an adequate representation of mortality in Bangladesh.

In case of Brass technique, the estimated values of the probabilities of dying ($_nq_x$) are calculated by multiplying the k_i values appearing in Table 2 by the corresponding value of D_i, given in that Table. A complete set of q_x estimates of Brass, Sullivan and Trussell methods for each sex and both sexes combined are presented in Table 2. The results indicate that the estimates of ${}_nq_x$ increase with the increase of the age of mother for male, female and both sexes that are represented in Figure 1.

Figure 1. Patterns of child mortality using the Brass technique for the national level of Bangladesh



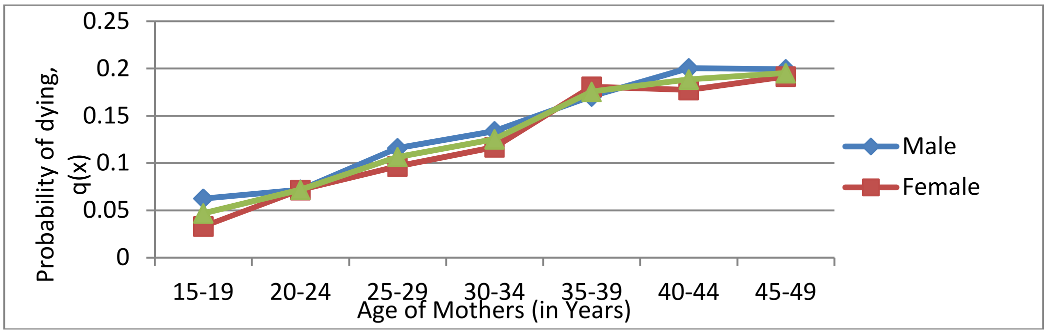


Figure 2. Patterns of child mortality using Brass technique for rural level of Bangladesh

3.2 ESTIMATION OF CHILD MORTALITY FOR RURAL LEVEL OF BANGLADESH

In the rural areas of Bangladesh, the complete sets of P_i values for male, female and both sexes are shown in Table 3. The results indicate that the average parities per woman i.e. the mean number of male CEB are higher than the female CEB. It is also observed from the results that average parity is increasing with the increase of age of the mother. The proportion of children dead (D_i) and ki values are estimated and shown in the same table.

In case of Brass technique, the estimated values of the probabilities of dying (${}_nq_x$) are given in that Table. A complete set of ${}_nq_x$ estimates of Brass, Sullivan and Trussell are presented in Table 3 for each sex and both sexes combined. The results indicate that the estimates of ${}_nq_x$ increase with the increase of the age of mother of male, female and both sexes that are represented in Figure 2.

3.3 ESTIMATION OF CHILD MORTALITY FOR URBAN LEVEL OF BANGLADESH

The complete sets of P_i values for male, female and both sexes are shown in Table 4. The results indicate that the average parities per woman i.e. the mean number of male CEB are higher than the female CEB. It is also observed from the results that average parities are increasing due to the age of the mother. The proportion of children dead (D_i) and ki values are estimated and shown in the table. A complete set of probabilities of dying (${}_nq_x$) estimates of Brass, Sullivan and Trussell are presented in Table 4 for each sex and both sexes combined. The results indicate that the estimates of ${}_nq_x$ increase with the increase of age of mother for male, female and both sexes that are represented in Figure 3.

Table 2. Estimates of Probabilities of Dying and Surviving by Sex, Derived from Child Survival Data Classified by Age of Mother, West Model, National Level of Bangladesh, 2004

Sex	Age group (in years)	Average parities per woman P_i	Proportion of children dead D_i	Multipliers k_i	Exact age	Estimates of ${}_nq_x$			Probability of surviving l_x		
						Brass	Sullivan	Trussell	Brass	Sullivan	Trussell
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Male	15-19	0.32472	0.09584	0.62164	1	0.05958	-	0.10946	0.94042	-	0.89054
	20-24	0.86806	0.08543	0.88543	2	0.07564	0.08139	0.08672	0.92436	0.91861	0.91328
	25-29	1.34990	0.11275	0.94017	3	0.10600	0.10292	0.11445	0.89400	0.89708	0.88555
	30-34	1.81869	0.12671	0.98486	5	0.12479	0.11629	0.13097	0.87521	0.88371	0.86903
	35-39	2.35123	0.16328	1.01543	10	0.16580	-	0.16641	0.83420	-	0.83359
	40-44	2.76271	0.19895	1.00681	15	0.20030	-	-	0.79970	-	-
	45-49	3.35751	0.20525	0.99803	20	0.20485	-	-	0.79515	-	-
		P_1/P_2				0.37408	-	0.37408			
		P_2/P_3				0.64306	0.64306	0.64306			
Female	15-19	0.32413	0.06159	0.46707	1	0.02877	-	0.07011	0.97123	-	0.92989
	20-24	0.78071	0.08100	0.87822	2	0.07114	0.07965	0.08195	0.92886	0.92035	0.91805
	25-29	1.33107	0.09705	0.96639	3	0.09379	0.09078	0.10028	0.90621	0.90922	0.89972
	30-34	1.84844	0.10520	1.01863	5	0.10716	0.09851	0.11264	0.89284	0.90149	0.88736
	35-39	2.38973	0.15137	1.05325	10	0.15943	-	0.16183	0.84057	-	0.83817
	40-44	2.94431	0.17681	1.04608	15	0.18496	-	-	0.81504	-	-
	45-49	3.64249	0.19915	1.03622	20	0.20636	-	-	0.79364	-	-
		P_1/P_2				0.41518	-	0.41518			
		P_2/P_3				0.58653	0.58653	0.58653			
Both sexes	15-19	0.64885	0.07873	0.54745	1	0.04310	-	0.08978	0.95690	-	0.91022
	20-24	1.64877	0.08333	0.88236	2	0.07353	0.08066	0.08446	0.92647	0.91934	0.91554
	25-29	2.68096	0.10496	0.95313	3	0.10004	0.09698	0.10749	0.89996	0.90302	0.89251
	30-34	3.66713	0.11587	1.00140	5	0.11603	0.10742	0.12189	0.88397	0.89258	0.87811
	35-39	4.74096	0.15727	1.03392	10	0.16260	-	0.16416	0.8374		0.83584
	40-44	5.70702	0.18753	1.02600	15	0.19241	-	-	0.80759	-	-
	45-49	7.00000	0.20207	1.01669	20	0.20544	-	-	0.79456	-	-
		P_1/P_2				0.39354	-	0.39354			
		P_2/P_3				0.61499	0.61499	0.61499			

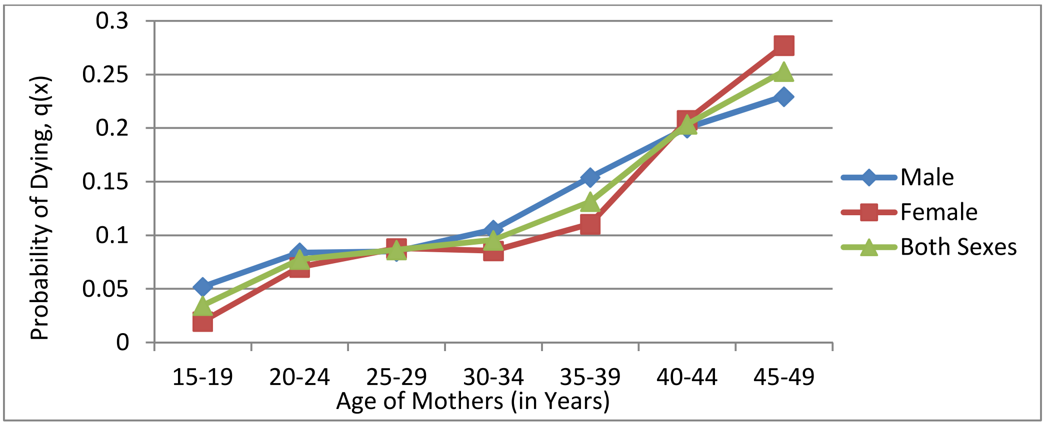


Figure 3. Patterns of child mortality using the Brass technique for urban level of Bangladesh

Table 3. Estimates of Probabilities of Dying and Surviving by Sex, Derived from Child Survival Data Classified by Age of Mother, West Model, Rural Level of Bangladesh, 2004

Sex	Age group (in years)	Average parities per woman P_i	Proportion of children dead D_i	Multipliers k_i	Exact age	Estimates of $_nq_x$			Probability of surviving l_x		
						Brass	Sullivan	Trussell	Brass	Sullivan	Trussell
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Male	15-19	0.32448	0.09463	0.66112	1	0.06256	-	0.10827	0.93744	-	0.89173
	20-24	0.91065	0.08000	0.89795	2	0.07184	0.07670	0.08156	0.92816	0.92330	0.91844
	25-29	1.44127	0.12281	0.94374	3	0.11590	0.11265	0.12518	0.88410	0.88735	0.87482
	30-34	1.92834	0.13588	0.98549	5	0.13391	0.12521	0.14106	0.86609	0.87479	0.85894
	35-39	2.53240	0.16805	1.01495	10	0.17056	-	0.17210	0.82944	-	0.82790
	40-44	2.89865	0.19930	1.00602	15	0.20050	-	-	0.79950	-	-
	45-49	3.48684	0.20000	0.99735	20	0.19947	-	-	0.80053	-	-
		P_1/P_2				0.35632	-	0.35632			
		P_2/P_3				0.63184	0.63184	0.63184			
Female	15-19	0.33029	0.06533	0.50684	1	0.03311	-	0.07447	0.96689	-	0.92553
	20-24	0.82543	0.08077	0.88664	2	0.07161	0.07947	0.08196	0.92839	0.92053	0.91804
	25-29	1.41028	0.10006	0.96595	3	0.09665	0.09364	0.10347	0.90335	0.90636	0.89653
	30-34	1.97112	0.11503	1.01563	5	0.11683	0.10777	0.12306	0.88317	0.89223	0.87694
	35-39	2.49037	0.17229	1.04917	10	0.18076	-	0.18385	0.81924	-	0.81615
	40-44	3.05743	0.17017	1.04166	15	0.17726	-	-	0.82274	-	-
	45-49	3.82895	0.18557	1.03196	20	0.19150	-	-	0.80850	-	-
		P_1/P_2				0.40014	-	0.40014			
		P_2/P_3				0.58530	0.58530	0.58530			
Both sexes	15-19	0.65477	0.07985	0.58709	1	0.04688	-	0.09120	0.95312	-	0.90880
	20-24	1.73608	0.08036	0.89281	2	0.07175	0.07805	0.08175	0.92825	0.92195	0.91825
	25-29	2.85155	0.11156	0.95467	3	0.10650	0.10336	0.11453	0.89350	0.89664	0.88547
	30-34	3.89947	0.12534	1.00020	5	0.12537	0.11645	0.13207	0.87463	0.88355	0.86793
	35-39	5.02277	0.17015	1.03162	10	0.17553	-	0.17784	0.82447	-	0.82216
	40-44	5.95608	0.18434	1.02337	15	0.18865	-	-	0.81135	-	-
	45-49	7.31579	0.19245	1.01420	20	0.19518	-	-	0.80482	-	-
		P_1/P_2				0.37715	-	0.37715			
		P_2/P_3				0.60882	0.60882	0.60882			

Table 4. Estimates of Probabilities of Dying and Surviving by Sex, Derived from Child Survival Data Classified by Age of Mother, West Model, Urban Level of Bangladesh, 2004

Sex	Age group (in years)	Average parities per woman P_i	Proportion of children dead D_i	Multipliers k_i	Exact age	Estimates of $_nq_x$			Probability of surviving l_x		
						Brass	Sullivan	Trussell	Brass	Sullivan	Trussell
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Male	15-19	0.32530	0.09877	0.52596	1	0.05195	-	0.11237	0.94805	-	0.88763
	20-24	0.78466	0.09777	0.85884	2	0.08397	0.09219	0.09832	0.91603	0.90781	0.90168
	25-29	1.18659	0.09091	0.93513	3	0.08501	0.08232	0.09163	0.91499	0.91768	0.90837
	30-34	1.61765	0.10667	0.98656	5	0.10524	0.09726	0.10961	0.89476	0.90274	0.89039
	35-39	1.98951	0.15114	1.01979	10	0.15413	-	0.15318	0.84587	-	0.84682
	40-44	2.41880	0.19788	1.01197	15	0.20025	-	-	0.79975	-	-
	45-49	2.87805	0.22881	1.00288	20	0.22947	-	-	0.77053	-	-
		P_1/P_2				0.41458	-	0.41458			
		P_2/P_3				0.66127	0.66127	0.66127			
Female	15-19	0.30924	0.05195	0.38033	1	0.01976	-	0.05897	0.98024	-	0.94103
	20-24	0.69314	0.08155	0.86257	2	0.07034	0.08035	0.08204	0.92966	0.91965	0.91796
	25-29	1.18950	0.09069	0.96994	3	0.08796	0.08497	0.09376	0.91204	0.91503	0.90624
	30-34	1.62353	0.08333	1.02751	5	0.08562	0.07814	0.08969	0.91438	0.92186	0.91031
	35-39	2.18881	0.10383	1.06449	10	0.11053	-	0.11192	0.88947	-	0.88808
	40-44	2.65812	0.19614	1.05808	15	0.20753	-	-	0.79247	-	-
	45-49	2.95122	0.26446	1.04779	20	0.27710	-	-	0.72290	-	-
		P_1/P_2				0.44614	-	0.44614			
		P_2/P_3				0.58271	0.58271	0.58271			
Both sexes	15-19	0.63454	0.07595	0.45576	1	0.03461	-	0.08631	0.96539	-	0.91369
	20-24	1.47779	0.09016	0.86125	2	0.07765	0.08693	0.09070	0.92235	0.91307	0.90930
	25-29	2.37609	0.09080	0.95250	3	0.08649	0.08365	0.09270	0.91351	0.91635	0.90730
	30-34	3.24118	0.09498	1.00683	5	0.09563	0.08783	0.09991	0.90437	0.91217	0.90009
	35-39	4.17832	0.12636	1.04186	10	0.13165	-	0.13212	0.86835	-	0.86788
	40-44	5.07692	0.19697	1.03472	15	0.20381	-	-	0.79619	-	-
	45-49	5.82927	0.24686	1.02504	20	0.25304	-	-	0.74696	-	-
		P_1/P_2				0.42938	-	0.42938			
		P_2/P_3				0.62194	0.62194	0.62194			

4. RESULTS OF MODEL FITTINGS

The simple regression model is assumed to fit to age specific average parities per woman for Bangladesh, rural and urban areas and these fitted models are presented below:

- For Bangladesh, y=-3.05785+0.20879x
- For Rural, y=-3.18274+0.21853x
- For Urban, y=-2.44800+0.17560x

The estimated CVPP and results on model fittings for these models are shown in Table 5 and Table 6 respectively. It seems from this table that the fitted models (1) - (3) are highly cross- validated and their shrinkages are shown in the same table. These imply that the fitted models (1) - (3) will be stable more than 99% and these are demonstrated in the Table 5. Besides, it is found the parameters of these fitted models are highly significant with more than 99% of variance explained and the stability for R^2 of these models is more than 99%. The calculated values of F statistic, that is, analysis of variance (ANOVA) for these fitted models are displayed in the Table 6 in which from these statistics it is concluded that F-test is highly significant and hence, these models are highly statistically significant. Therefore, the fit of these models is well.

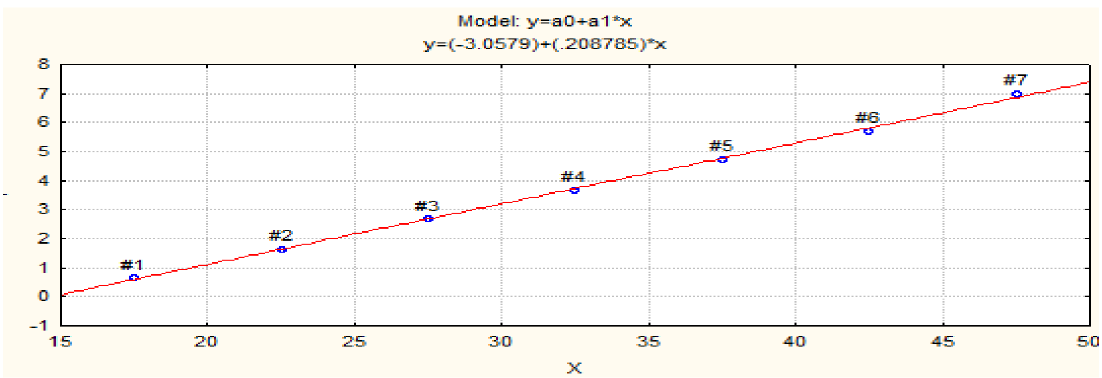
Table 5. The Results of CVPP

Models	n	K	R^2 (%)	ρ_{cv}^2	Shrinkage	Stability of R^2
Bangladesh	7	2	99.87	0.996286	0.002414286	0.997586
Rural	7	2	99.89	0.996857	0.002042857	0.997957
Urban	7	5	99.95	0.998571	0.000928571	0.999071

Table 6. Information on Model Fittings

Models	R^2	Para meters	Estimate	Standard	t-value	p-level	Lower Conf.	Upper Conf.	Calculated F with d.f (p-value)
Bangladesh	99.87	a0	-3.05785	0.113542	-26.9315	0.000001	-3.34972	-2.76599	3909.67 with d.f (1, 5) (0.000)
		a1	0.20879	0.003339	62.5274	0.000000	0.20020	0.21737	
Rural	99.89	a0	-3.18274	0.111191	-28.6241	0.000001	-3.46857	-2.89692	4466.20 with d.f (1, 5) (0.000)
		a1	0.21853	0.003270	66.8296	0.000000	0.21012	0.22694	
Urban	99.95	a0	-2.44800	0.059374	-41.2304	0.000000	-2.60062	-2.29537	10114.34 with d.f (1, 5) (0.000)
		a1	0.17560	0.001746	100.5701	0.000000	0.17112	0.18009	

Fig. 4. Observed and fitted age specific average parities per woman for Bangladesh. X axis represents age group and Y axis represents age specific average parities per woman.



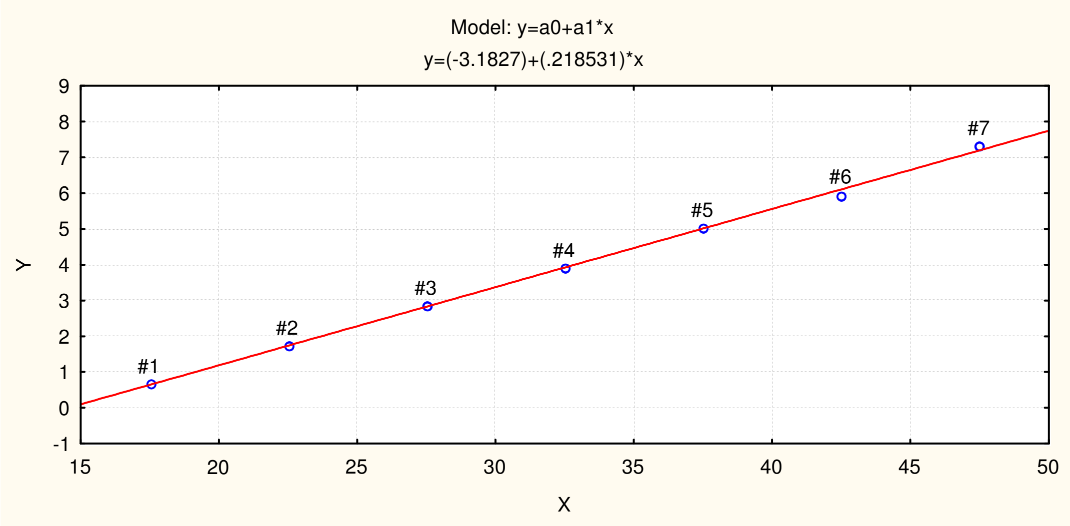


Fig. 5. Observed and fitted age specific average parities per woman for Rural level of Bangladesh. X axis represents age group and Y axis represents age specific average parities per woman.

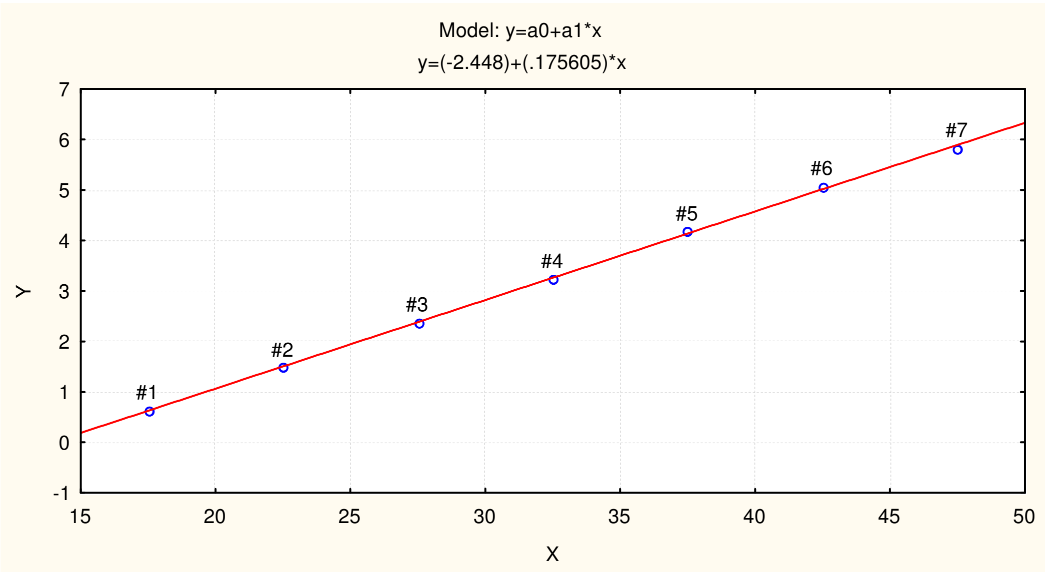


Fig. 6. Observed and fitted age specific average parities per woman for Urban level of Bangladesh. X axis represents age group and Y axis represents age specific average parities per woman.

5. CONCLUSION

It is found that the average parities and the proportions of dead children reported by women of each age group increase rapidly with age of the mother, especially from ages 30-34 to ages 45-49. The very rapid increase in the proportions of dead with age of mother suggests that a combination of effects is in operation, that is, there is an increasingly longer average exposure to the risk of dying of the children and considerably higher child mortality from ten years before the survey. In case of Brass method, the probabilities of dying are increasing with the increasing of age of mothers. In Sullivan method, the same patterns are followed except for male and both sexes of urban level of Bangladesh. The probability of dying is low in the age group 20-24 for male of national and rural level and in the age group 25-29 of urban level when it is calculated through Trussel method. It is investigated that age specific average parities per woman for three cases follow the simple linear regression model with explaining large proportion of variance.

Hope this study for measuring the childhood mortality would be helpful for policy makers, program designers and/or planners to design or redesign program(s) or existing program(s) for reducing under-five mortality as well as national development and for achieving the Millennium Development Goal-4 (MDGs-4) in terms of child mortality. Furthermore, for the estimation of adult mortality, the probability of surviving estimated in this research might be utilized for the applications of Widowhood method or any other adult mortality estimation methods.

REFERENCES

Ahmed, M. K., Rahman, M. & Ginneken, J. V. (1999). Epidemiology of Child Deaths Due to Drowning in Matlab, Bangladesh. *International Journal of Epidemiology* 28, 306-311.

Arifeen, S. E. (2008). Child Health and Mortality. *Journal of Health, Population and Nutrition* 26(3), 273-279.

Black, R. E., Cousens, S., Johnson. H. L., Lawn, J. E., Rudan, I., Bassani, D. G., Jha, P., Campbell, H., Walker, C. F., Cibulskis, R., Eisele, T., Liu, L., Mathers, C. *et al.* (2010). Global, Regional, and National Causes of Child Mortality in 2008: A Systematic Analysis. *Lancet* 375, 1969–87.

Brass, W. (1964). Uses of Census or Survey Data for the Estimation of Vital Rates (E/CN.14/CAS.4/V57), Paper Preparcd for the African Seminar on Vital Statistics, Addis Ababa. 14- 19, December 1964.

Gujarati, Damodar N. (1998). Basic Econometrics, Third Edition, McGraw Hill, Inc., New York.

Habib, H., Lohani, M., Khan, H. & Khan, M. H. (2009). Infant Morbidity Leading to Infant Mortality. *Gomal Journal of Medical Sciences* 7(2), 121-123.

Islam, Md. Rafiqul, Islam, Md. Nurul, Ali, Md. Ayub & Mostofa, Md. Golam. (2003). Construction of Male Life Table from Female Widowed Information ofBangl adesh, International Journal of Statistical Sciences, Dept. of Statistics, University of Rajshahi, Bangladesh, Vol. 2: 69-82.

Islam, Md. Rafiqul (2006). Construction of Abridged Life Tables and Indirect Estimation of Some Mortality Measures of Bangladesh in 2005, Journal of Population, Indonesia, Vol.11 (2):117-130.

Khan, Md. Atikur Rahman and Ali, Md. Ayub (2004). Dynamics of Mean Age at Marriage, TFR and NRR in Bangladesh, International J. of Statistical Sciences, Dept. of Statistics, University of Rajshahi, Vol. 3 (Special Issue): 297-309.

Mitra, S. N. & Associates (2004). Bangladesh Demographic and Health Survey 2004, National Institute of Population Research and Training (NIPORT), Dhaka, Bangladesh.

Mitra, S. N. & Associates (2007). Bangladesh Demographic and Health Survey 2007, National Institute of Population Research and Training (NIPORT), Dhaka, Bangladesh.

PRB (2011). World Population Data Sheet of the Population Reference Bureau. Demographic Data and Estimate for the Countries and Religion of the World, Washington, DC.

Srinivasan, K. & Prabhu, G. R. (2006). A Study of the Morbidity Status of Children in Social Welfare Hostels in Tirupati Town. *Indian Journal of Community Medicine* 31(3), 170-172.

Stevens, J. (1996). Applied Multivariate Statistics for the Social Sciences, Third Edition, Lawrence Erlbaum Associates, Inc., Publishers, New Jersey

Sullivan, J. M. (1972). Models for the Estimation of the Probability of Dying between Exact Ages of Early Childhood, *Population Studies,* Vol. XXVI, No. 1 (March 1972), pp. 79-97.

Tadesse, H., Deribew, A. & Woldie, M. (2009). Predictors of Defaulting from Completion of Child Immunization in South Ethiopia, May 2008 – A Case Control Study. *BMC Public Health* 9, 150.

Trussell, T. J. (1975). A Re-estimation of the Multiplying Factors for the Brass Technique for Determining Childhood Survivorship Rates. *Population Studies*, Vol. XXIX, No. 1 (March 1975), pp. 97-108.

UNESCAP (2009). United Nation Economic and Social Commission for Asia Pacific.

UNICEF (2008). Child Survival in Bangladesh, United Nations Children's Fund (UNICEF), New York, USA.

UNICEF (2009). Millennium Development Goals, United Nations Children's Emergency Fund.

United Nations (1983). Manual X: Indirect Techniques for Demographic Estimation. Department of International and Social Affairs, Population Studies, No. 81, New York: United Nations.

You, D., Wardlaw, T., Salama, P. & Jones, G. (2010). Levels and Trends in Under-5 Mortality, 1990–2008. *Lancet* 375, 100–03.