ORIGINAL ARTICLE

Velocity and Elasticity of Pregnancy Wastage and Caesarian Deliveries in Bangladesh

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ABSTRACT

The aim in this paper is to investigate the effect of age factor of mother as a cause of pregnancy wastage and delivery types. Using the information from 2967 mothers of Rajshahi District within the reproductive span (15-49 years), we have found that the proportion of pregnancy wastage to live birth in two edges of reproductive span is tremendously dodgy whereas in other age groups between 20 and 35 these are comparatively benign. Further, 6717 births were accounted to investigate the flow of caesarian deliveries over the ages. We found 359 caesarian deliveries against 6358 natural (vaginal) deliveries. Some statistical tools were used and the velocity and elasticity curves were drawn to analyze the risk of pregnancy wastage and caesarian deliveries. Our result shows that the risk of caesarian delivery increases with the increased age and this risk moves faster than the age.
Keywords: Pregnancy wastage, Caesarian delivery, Vaginal delivery, Velocity curve,.

INTRODUCTION

Pregnancy is the state of female that is produced due to the implantation of the fertilized ovum in the uterine endometrium and ultimately giving rise to a foetus and pregnancy wastage is the loss of product of conception normally or therapeutically (Jeffcoate, 1975). Pregnancy wastage can be classified as intra-uterine foetal death, abortion, and menstrual regulation (Jeffcoate, 1975; and Shaw, Soutter and Stanton 2003). In our study, we have dealt with the normal pregnancy wastage that is not therapeutical.

Every year about eight million women suffer from pregnancy related complications and over half a million die. About 99% of them are in developing countries (WHO, 2004). Most of these deaths can be averted even where resources are limited. The poor reproductive health of women, in third world countries, is an outcome of the general neglect of health and nutrition in childhood and adolescence, which affects their future well being (De silva, 1998). In 1987 Ardebili, Kamali, Pouranssari and Komarizadeh studied on the reproductive behavior of 1525 pregnant women. The type of pregnancy termination that resulted in live birth or abortion has significant relation to the age of mother. Again, the highest percentage of abortion was observed in (15-19) age group and the highest number of natural deliveries was observed in the age group (20-29).

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Khandait et al (2000) examined complications of the reproductive health of married women and envisaged the age factor as a cause of still birth accumulating with other factors. Yasakawa and Tayahashi (1990) observed that the age-specific maternal mortality was rising with age. They also investigated that the pregnant women aged over 35 faced more pregnancy complications with high risk. Another study by Breart, Blondel, and Maillard (1987) acclaimed with the risks of late pregnancy for mothers and their births indicated that there was excess risk for mothers over age 35 but the difference is decreasing relatively to the general population (mothers of before 35). They also found that the risk of mothers over 34 was 3.6 times higher in 1975 and 2.6 times higher in 1983 than for the general population. Study on scheduled caste women of Punjab experienced the least number of abortion and still births in the age group (25-29) and the risk of pregnancy wastage increases with age (Sidhu and Sidhu, 1988). Similar results by Banerjee and Hazra (2004) showed that the rates of pregnancy wastage in two extreme age groups (<20 and 35+) are relatively higher. These evidences indicate that there exists an age-specific relationship of pregnancy wastage and mothers' age.

Further, Kim, Byun, and Lee (1991) studied over 2874 mothers and observed 342 caesarian deliveries against 2532 vaginal deliveries. They included several factors like, education, occupation, residence (big cities, urban, and rural) and age of mother at birth to explain the delivery status. As to the mothers age at delivery they found that 10.4% C-section (caesarian section) were under age 24, 12.1% were in (25-29), and 14.1% were over 30. Thus, there is an

increasing trend of C-section over the age. But, the exact relationship of pregnancy wastage and caesarian deliveries with respect to their flows over the age of mother is still unknown. In this paper, an attempt has been made to investigate the age-specific flow of pregnancy wastage and caesarian delivery.

DATA AND METHODS

Data: The data were collected from a field survey conducted in the district of Rajshahi of Bangladesh. We collected information from 2967 mothers by preparing an open ended questionnaire. Also, the delivery statuses of 6717 births were under investigation and our data confront only the delivery types (caesarian and vaginal).

Methods: In this paper we have used the logic of equilibrium level of satisfaction, velocity and elasticity curves. The logic of equilibrium has been extensively using in the field of economics especially in demand analyses. The concept of velocity has a greater share in physical sciences and recently it has been using in human biology. On the other hand, elasticity of goods, demand and income elasticity explain the speed of relative change and replacement (Varian, 2003; Chakravarty, 1997 and Dewett and Chand, 1999).

Equilibrium level of satisfaction: Equilibrium level of satisfaction leads intersection of two curves at a particular point. When one curve is downward sloping and the other is going upward from the origin then both the curves intersect each other at a particular point. At that point values on both the curves are equal. For example, if we consider a demand and a supply curve. Then the equilibrium level of demand and supply attains at the point of their intersection (Varian, 2003, Chakravarty, 1997 and Dewett and Chand, 1999).

Velocity curve

To draw the velocity and elasticity curves we fit the polynomial regression models. The velocity curve is just the first derivative of the fitted polynomial regression line with respect to age (Gasser et al., 1984; Ali and Ohtsuki, 2001; Islam et al., 2003). The polynomial regression model of order 'p' (Gujarati, 1995 and Montegomery and Peck, 1982) is of the form:

$$y = f(x) = \varphi_0 + \varphi_1 x + \varphi_2 x^2 + \ldots\ldots\ldots\ldots + \varphi_p x^p + u$$

where all the parameters (φ_i) and the error terms (u) follow the usual assumptions. Now, the velocity curve is just the first derivative of the above equation and so we get

$$\frac{dy}{dx} = f'(x) = \varphi_1 + 2\varphi_2 x + 3\varphi_2 x^2 + \ldots\ldots\ldots\ldots + p\varphi_p x^{p-1}$$

Elasticity curve

The elasticity can be computed using the formula mentioned by Dewett and Chand (1999), Chakravarty (1997) and Varian (2003) as

$$\varepsilon = \frac{d\log y}{d\log x} = \frac{x}{y}\frac{dy}{dx} = \frac{x}{y} f'(x)$$

We can comment on the speed of relative change or replacement using the following criterion:

(a) if $-1 < \varepsilon < +1$ then the overall process is inelastic,

(b) if $\varepsilon < -1$ then the process is elastic and the speed of relative change is negative, that is, speed of change of y is slower than x,

(c) if $\varepsilon > +1$ then the process is elastic and the speed of relative change is positive, that is, the values of y increases faster than x,

(d) if $\varepsilon = 1$ then the relative change is proportionate to each other and in this case both the factors change equally likely.

Cross validity predictive power

The cross validity predictive power has been used to examine the rigidity of the fitted polynomial regression models. The cross validity predictive power due to Stevens (1996) and Khan and Ali (2003) is

$$\rho^2_{rcv} = \begin{cases} 1 - w(1 - R^2); & R^2 \geq 1 - w^{-1},\ w = \dfrac{(n-1)(n-2)(n+1)}{n(n-k-1)(n-k-2)},\ n > k+2 \\ 0; & otherwise. \end{cases}$$

where R^2 is the coefficient of multiple determination, n is the sample size, k is the number of regressors used in the model. Further, the stability of R^2 (Stevens, 1996, Khan and Ali, 2003, Islam et al., 2003) can be computed as $\eta = R^2 - \rho^2_{rcv}$.

Numerical Results

First of all, we simply present the observed values, computed proportions (Table 1) and smoothed proportions (Table 2) both for urban and rural areas. The proportion of pregnancy wastage to live birth is calculated by dividing the number of pregnancy wastage by the number of live birth in a specific age group. Similarly, proportion of pregnancy wastage to mother and that of caesarian deliveries to vaginal deliveries (Table 1) have been computed. Our aim is to know the age-specific flow of pregnancy wastage and caesarian deliveries. So, we have used smoothing techniques, "*4253H, twice*" from Minitab window 12.0 to obtain the smoothed values (Table 2).

Table 1: Pregnancy wastage to mother and live birth

	Urban					Rural					Urban & rural		
	Observed Values					Observed Values					Observed Values		
Age	Birth	Pw	M	PwLb	PwM	Birth	Pw	M	PwLb	PwM	V	C	Cv
15-20	21	2	45	0.095238	0.044444	72	8	149	0.111111	0.053691	2062	51	0.024733
20-25	203	12	202	0.059113	0.059406	341	22	319	0.064516	0.068966	2297	132	0.057466
25-30	388	23	324	0.059278	0.070988	601	28	351	0.046589	0.079772	1296	94	0.072531
30-35	523	32	324	0.061185	0.098765	566	30	261	0.053004	0.114943	481	49	0.101871
35-40	519	34	277	0.065511	0.122744	598	21	229	0.035117	0.091703	164	24	0.146341
40-45	446	29	191	0.065022	0.151832	404	17	141	0.042079	0.120567	54	8	0.148148
45-49	268	17	107	0.063433	0.158879	170	7	47	0.041176	0.148936	4	1	0.25
Total	2368	149	1470			2752	133	1497			6358	359	

Here Pw, M, PwLb, PwM, V, C, and Cv indicate Pregnancy wastage, Mother, Proportion of pregnancy wastage to live birth, Proportion of pregnancy wastage to mother, Vaginal delivery, Caesarian delivery, and Proportion of caesarian delivery to vaginal delivery, respectively.

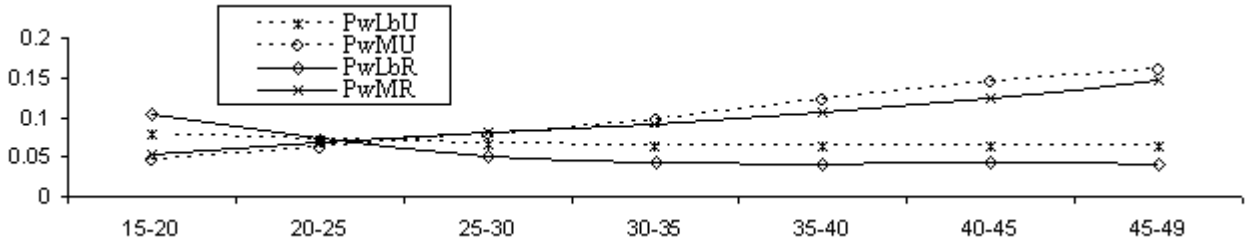
Table 2: Smoothed proportion

	Urban		Rural		Urban & rural	Urban & rural
AGE	PwLb	PwM	PwLb	PwM	PwLb	Caesarian to vaginal
15-20	0.078165	0.044444	0.105083	0.053691	0.091624	0.024733
20-25	0.069348	0.059143	0.071963	0.067360	0.070656	0.051604
25-30	0.064310	0.076591	0.051199	0.080151	0.057755	0.077014
30-35	0.063146	0.098643	0.042820	0.093503	0.052983	0.10428
35-40	0.063337	0.123023	0.041145	0.108585	0.052241	0.135726
40-45	0.063433	0.143879	0.041347	0.126115	0.05239	0.180715
45-49	0.063433	0.158879	0.041176	0.147056	0.052304	0.246312

Notations are explained in Table 1.

Plotted smoothed proportions (Fig.1) intersect each other at a certain point and at this point equilibrium status is achieved. We observe that for rural areas pregnancy wastage to live birth and to mother is equal at age 23. But, in urban areas this is at age 25. At these points proportion of pregnancy wastage to live birth and to mother are equal, that is, number of live birth equals number of mother. In other word, at that point every mother yields a live birth with minor risk of pregnancy wastage.

Fig. 1: Smoothed proportion of pregnancy wastage to live birth and to mother.



Here PwLbU and PwLbR represent pregnancy wastage to live birth for urban and rural areas; PwMUand PwMR refer to pregnancy wastage to mother both for urban and rural areas, respectively.

A matter of regret that for delivery status much data for different age groups especially last two age groups are not available for urban and rural areas separately. Thus, we were compelled to conduct our study combining urban and rural areas altogether. In that case, we have nested our focus on equilibrium level for proportion of pregnancy wastage to live birth and proportion of caesarian deliveries to vaginal deliveries. At age 25 this equilibrium level is achieved. Thus, at 25 years of mother $\frac{Pw}{Lb} = \frac{Cd}{Vd}$, that is, for non-zero pregnancy wastage (Pw), Live birth (Lb), and Vaginal delivery (Vd) we have caesarian delivery $Cd = \frac{Pw \times Vd}{Lb}$ that explains the minor risk of pregnancy wastage and live birth reduces the risk of caesarian deliveries. Elaborately, we can say that live birth and vaginal deliveries are

fixed at certain non-zero level then increase (or minor risk) of pregnancy wastage yield increase (or minor risk) of caesarian delivery. Similarly, if pregnancy wastage and vaginal delivery is fixed at certain non-zero levels then the increase of live birth substantially reduce the risk of caesarian delivery. Moreover, we can say that if a woman gives a live birth through vagina then the risk of caesarian delivery for the next birth is very low. Here it is mentionable that these comments are valid only if such equilibrium condition is achieved. Thus, our findings elucidate that the women at age 25 in Bangladesh bears low risk for child bearing with respect to less risk of both pregnancy wastage and caesarian deliveries. To check the liability of our results we had formed a control group that includes all the respondents of age 25 years. Then we had performed a study over every single year. One caveat that we faced was availability of data in every single year; especially the information on birth and delivery types for respondents after 35 years of age was really shaky. However, we did it for those single year's respondents to whom data were available. To accumulate the joint effect of both factors (pregnancy wastage and caesarian delivery) we added the proportion of pregnancy wastage to live birth and proportion of caesarian delivery to vaginal delivery for every single year. We found that this was the lowest at the single age year 25 and was 0.0524. Thus, we may assure that our results related to the equilibrium level of age (25 year) are true.

Thereafter, we have fitted statistical models to those smoothed proportions and have found that third order polynomial regression model better explains the age-specific flow of both pregnancy wastage and caesarian deliveries. Our fitted models are highly stable (Table 3). Further, the velocity and elasticity of caesarian deliveries and pregnancy wastage (Table 4) have been computed.

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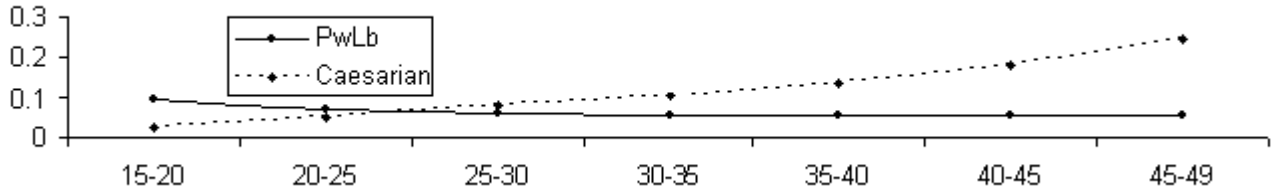
Fig. 2: Equilibrium level of pregnancy wastage and caesarian deliveries.



Here PwLb & caesarian represent proportion of pregnancy wastage to live birth and that of caesarian deliveries to vaginal deliveries, respectively.

Table 3: Fitted models

Variables		Fitted Models	R^2	CVPP	Stability
Urban	Pregnancy wastage to live birth	$\hat{Y} = 0.162602 - 0.007868X + 0.000204X^2 - 0.00000174X^3$	0.9998	0.9988	0.0010
	Pregnancy wastage to mother	$\hat{Y} = 0.087904 - 0.007856X + 0.000374X^2 - 0.00000372X^3$	0.9997	0.9983	0.0014
Rural	Pregnancy wastage to live birth	$\hat{Y} = 0.394198 - 0.026097X + 0.000638X^2 - 0.00000516X^3$	0.9997	0.9983	0.0014
	Pregnancy wastage to mother	$\hat{Y} = -0.012650 + 0.005186X - 0.000104X^2 + 0.00000137X^3$	0.9999	0.9994	0.0005
Both	Caesarian deliveries to live birth	$\hat{Y} = -0.188978 + 0.020187X - 0.000589X^2 + 0.0000075X^3$	0.9998	0.9988	0.0010

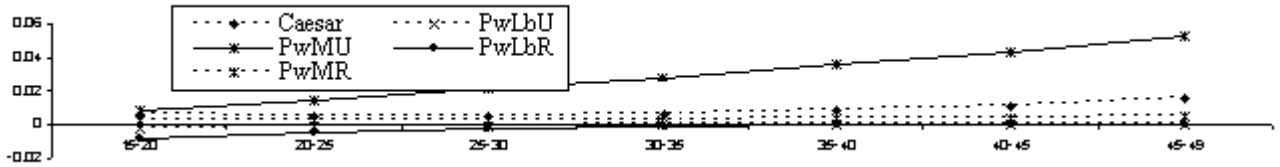
Table 4: Velocity and elasticity of pregnancy wastage and caesarian delivery

Age	Velocity			Elasticity		
	PwLb		Cv	PwLb		Cv
	Rural	Urban	Urban & Rural	Rural	Urban	Urban and Rural
15-20	-0.00851	-0.002327	0.006463	-1.4141	-0.52079	4.665101
20-25	-0.00522	-0.001331	0.005073	-1.64836	-0.43254	2.165553
25-30	-0.00271	-0.000596	0.004808	-1.44058	-0.25358	1.715809
30-35	-0.00098	-0.000122	0.005668	-0.74046	-0.06274	1.789762
35-40	-1.57E-05	9.14E-05	0.007653	-0.01449	0.054272	2.111322
40-45	0.000172	4.34E-05	0.010763	0.176498	0.028944	2.517524
45-49	-0.00041	-0.000266	0.014998	-0.47722	-0.19916	2.897614

Notations are explained in Table 1.

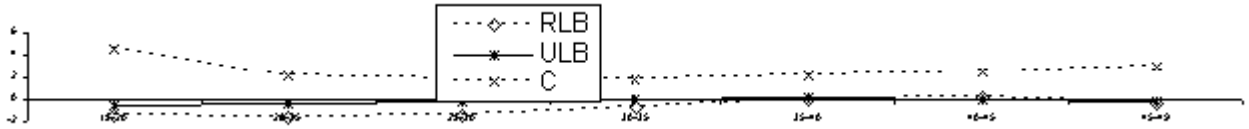
Velocity curves in Fig. 3 show that velocity of pregnancy wastage to live birth both in urban and rural areas yield negative magnitude but that of caesarian deliveries yield positive magnitude. Thus, we can say that the pregnancy wastage decreases over ages where as caesarian delivery increases. Elasticity of pregnancy wastage to live birth is less than unity up to the age 30 and thereafter these values lie between –1 and +1, that is, up to age 30 the system is elastic and inelastic thereafter (Table 4). In other word, the risk of pregnancy wastage decreases with the increase of age and the speed is faster than the speed of age. However, the pregnancy wastage to live birth in urban areas is almost inelastic (Fig.4). But, for caesarian deliveries the elasticity is always greater than one and so the risk of caesarian deliveries increase with the increase of age (Fig.4). Furthermore, the risk of caesarian delivery (speed) increases faster than the increase of age.

Fig. 3: Velocity of pregnancy wastage and caesarian deliveries.



Here Caesar indicates caesarian deliveries. All other notations are same as in Fig.1.

Fig.4: Elasticity of pregnancy wastage and caesarian deliveries



Here RLB, and ULB indicate elasticity of pregnancy wastage to live birth in rural and urban areas, and C stands for elasticity of caesarian deliveries in total (urban and rural) areas.

Here Caesar indicates caesarian deliveries. All other notations are same as in Fig.1.

CONCLUSION

Risk of pregnancy wastage and caesarian deliveries are changed over ages. Increased age increase the risk of caesarian delivery but decrease the risk of pregnancy wastage. However, in the extreme age groups pregnancy wastages are observed substantially larger. Equilibrium condition for risk of pregnancy wastage and caesarian delivery yields 25 year as an ideal age of child bearing for Bangladeshi women as both the risks are in tolerable situations. Therefore, no pregnancy before 25 and only one birth at this age can avail of acceptable risks of pregnancy wastage and caesarian delivery in Bangladesh. Different country and regional difference may draw different risks and age structure for pregnancy wastage and caesarian deliveries. Early marriage (before 18 years) and teenage motherhood is a stark reality behind the plight of women health hazard in Bangladesh. A proper policy towards the safe motherhood (no birth before 25 years) may be helpful to overcome the pregnancy related deficiencies as well as to control the population growth in a large extent.

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