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Graduating Age at First Caesarean Delivery of Female

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Abstract: The caesarean delivery is a mode of delivery appears, as an uncommon practice in present scenario in developed as well as developing societies. Also this mode of delivery of children is observed increasing over the time in both developed and developing society. Caesarean birth has increased noticeably over the last years especially in countries with high or middle income. The present study is based on analysis of data taken from National Family Health Survey-III (2005-06). Finding suggests that cubic and inverse cubic model are appropriate to graduate the age of female at marriage and at first birth in case of first caesarean delivery, but these curves have some shortcomings thus a mix type curve has been employed for getting better fitting.

Keywords: Caesarean Section, Age at marriage, Age at first birth, Restricted cross validity predictive power (RCVPP), Shrinkage-test.

1 Introduction

Caesarean delivery was introduced in clinical practice as a life saving procedure both for the mother and the baby. As other procedures of some complexity, its use follows the health care inequity pattern of the world; this is in under use in low income settings, and adequate or even unnecessary use in middle and high income settings (Althabe & Belizan, 2006 and Belizan et al., 1999). Caesarean delivery rates have been increasing worldwide raising the question of the appropriateness of the selection of cases for the procedure and growing access to gynecological and obstetric care as well (Mishra & Ramanathan, 2002). It is observed that the first delivery is observed more caesarean deliveries than vaginal deliveries. World Health Organization (WHO) stated: There is no justification for any region to have caesarean deliveries rates higher than 10-15% and according to its modified guidelines, the caesarean birth rate in any population group should range between 5% and 15% (WHO, 1985). It is suggested that no additional benefit accrues to the children or to the mothers when the rates exceed this level. However, currently the caesarean birth rates in many developed and developing countries far exceed the tolerable limit specified by the WHO and indicate an unnecessary use of this intervention.

Caesarean deliveries have other serious implications for the health of females. Therefore the performance of caesarean deliveries is justified only when obstetric risks outweigh the risks of the procedure itself. There are numerous factors such medical, socio-demographic and institutional factors associated with caesarean birth rates. The important among them includes rising maternal age, breech presentation of the baby and the size of the child at birth (Keeler & Brodie, 1993), previous caesarean deliveries, obstetric complications (low birth weight, preterm delivery, prenatal death etc), as institutional factors. Among socio-demographic factors some are high level of maternal education, maternal wish (Ash & Okah, 1997) and high income level of social class (Mossialos et al. 2005). The previous literature suggests that the advanced maternal age is itself may be an independent risk factor for caesarean delivery, due to physicians and patients concern over pregnancy outcome for an older women (Gordon et al., 1991; Taffel, 1994; Irwin et al., 1996 and Mc Closky, 1988). The pattern of age of female at marriage and at first birth especially in relation to caesarean delivery may be an emerging issue to understand the mechanism for the demographers. For the lack of data at national level as well as lack of interest among the social scientists and demographers, no early study has been carried out to examine the curve estimation on the age distribution of caesarian delivery of first birth in association with age at marriage and at birth. Therefore, this

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study is important to get a clear picture of the pattern of maternal age in relation to caesarean delivery which may be helpful in some policy implications. To know the pattern of age at marriage and age at first delivery especially in relation to first order of birth by caesarean cases is of our interest in the present study.

2 Objective

The pattern of age at marriage and age at first delivery especially in relation to caesarean mode is of recent interest by the demographers. It is obvious that the required distribution of age of female when first delivery is caesarean section has a typical shape. The standard shape depicting the age pattern is increasing till a point and after reaching at peak it is getting slower down. This shape is following some non-linear pattern, which one must try to observe and the literature suggests non-linear regression models come in all shape and size.

Some well-known families of models are polynomial models, exponential family, power family and yield-density models. To best capture the age pattern of females, we have used polynomial models due to other models cannot adequately describe the pattern. Islam (2009) used polynomial Model approach to graduate age specific marital fertility rates and suggested a simple third degree polynomial to justify the current fertility pattern of Bangladesh population. The polynomial models have also been preferred in some instance Brown & Newman (2002), Newman et al. (2004) and Markovic & Sekalic (2006) to graduate the age pattern. Using the scattered plot of the pattern of age at marriage and age at first birth in case of caesarean delivery for first birth in Uttar Pradesh, it is observed the pattern can be fitted by polynomial model with respect to different ages in year. Therefore, an nth degree polynomial model is considered.

3 Data and Methodology

In order to examine the pattern of age at marriage and age at first birth in caesarean cases of first birth, we fit several mathematical models including both linear and non-linear models for the empirical data. Various types of models were tested and among these, the best fitted models have been considered here. For non-linear models polynomials have been considered and a polynomial is briefly discussed as an expression of the form given below;

$$Y = \alpha + \sum_{i=1}^{n} \beta_i x^i \quad ; \beta_i \neq 0 \ \& \ i = 1, 2, \cdots, n \tag{1}$$

Where α is the constant, $\beta_i' s$;(i=1,2,$\cdots$, n) are the regression coefficient of $X_i s$ and X is the independent variable i.e. the age at marriage and age at first birth in caesarean delivery case and n is the positive integer, is called a polynomial of degree n. If $n = 0$ it becomes constant function. If $n = 1$ then it is a polynomial of degree 1 i.e. simple linear function. If $n = 2$ then it is a polynomial of degree 2 i.e. quadratic polynomial. If $n = 3$ then it is polynomial of degree 3 i.e. cubic polynomial etc., the inverse cubic (i.e. the cubic polynomial of reciprocal of X) equation has been applied to the data also but all these models have some shortcomings such as that they provide negative outputs for some explanatory variable. Thus a mix type mathematical curve has been used and this curve provides equally good results and appropriate output for every value of explanatory variable. The models used can be expressed as follows;
Linear model: $Y = \alpha + \beta X; \ \ \beta \neq 0$
Quadratic model: $Y = \alpha + \beta_1 X + \beta_2 X^2; \ \ \beta_1, \beta_2 \neq 0;$
Cubic model: $Y = \alpha + \beta_1 X + \beta_2 X^2 + \beta_3 X^3; \ \ \beta_1, \beta_2, \beta_3 \neq 0$
Inverse Cubic model: $Y = \alpha + \frac{\beta_1}{X} + \frac{\beta_2}{X^2} + \frac{\beta_3}{X^3}; \ \ \beta_1, \beta_2, \beta_3 \neq 0$
The explanation of various parameters (coefficients) of the models is that if there is a unit change in X we obtain a change in Y equal to the value of respective coefficients.

4 Test-Statistics

One wants to estimate how accurately a predictive model will perform in practice or to know how much the proposed model is stable over population, an appropriate technique known as cross validity prediction power (CVPP) given by Herzberg (1969). So, for validity of the models cross validity predictive power (CVPP) and restricted cross validity predictive power (RCVPP) Stevens (1996) has been used. The cross validity predictive power (CVPP) is defined as;

$$\rho_{cv}^2 = 1 - w(1 - R^2) \tag{2}$$

And the restricted cross validity predictive power (RCVPP) is;

$$\rho_{rcv}^2 = \begin{cases} 1 - w(1 - R^2) & ; R^2 \geq 1 - w^{-1}, n \geq (k+2) \\ 0 & ; Otherwise \end{cases} \tag{3}$$

where, $w = \dfrac{(n-1)(n-2)(n+1)}{n(n-k-1)(n-k-2)}$ and R^2 is the coefficient of multiple determination, n is the sample size, k is the number of predictors used in the model, and $\dfrac{n+1}{n} \leq w \leq \dfrac{(n-1)(n-2)(n+1)}{2n}$.

Further, the shrinkage of R^2 in computing RCVPP has been computed from the absolute difference between RCVPP and R^2 (Steven, 1996) that is,

$$\eta = |\rho_{cv}^2 - R^2| = |1 - w(1 - R^2) - R^2| \tag{4}$$

Now, $\rho_{rcv}^2 = 0.95$ indicates that if we fit the same model to some other data from the same population then the fitted model will be able to explain 95% variation of the dependent variable. Further, $\eta = 0.01$ indicates that over the population the fitted model is 99% stable.

5 Application and Interpretation

The observed distribution of females according to age at marriage and age at first birth in cases where the first delivery is caesarean is provided in table 1 and 3 respectively. And their fitted equations due to several models are given in table 2 and 4 respectively. One can easily observed that the all curves provide some negative values except mix type curve in both tables. Linear equation also gives positive value but the coefficient of determination indicates poor fit among all for this. The fitted trend equations to age at marriage and age at first birth along with the value of coefficient of determination (R^2) are given in table 2 and table 4 respectively. It is obvious that the coefficient of determination for age at marriage and age at first birth on caesarean cases are increasing as the degree of polynomial is increases. Figure 1 and figure 2 shows the different curves fitted to observe data of caesarean cases corresponding to age at marriage and age at first birth. The linear and quadratic curves are a bit over estimated at their starting points and conversely under estimated at the end points.

Although the cubic curve shows the less over estimate as compared to other two in the beginning. It provided a closer and best fit to observe data among all. It is found that the cubic model i.e. the third order polynomial gives the most appropriate model for explaining the trend in number of caesarean cases for those with first birth by caesarean delivery corresponding to age at marriage and age at first birth and the results has been also supported by the value of coefficient of determination (R^2) as well as the figure 1 and 2. In order to get a better coefficient of determination the inverse cubic model is used which provide better relation among the age at marriage and age at first delivery.

Further, observing the data it can be noted that every model is giving somewhere the negative values which is quite clear by the figures also. So getting an improved trend we go for the mix type of polynomial which is giving us the appropriate fitting without providing negative values. The validation of the fitted model which is here done by Restricted cross validity predictive powers (RCVPP) is also supported by the value of and shrinkage (η). So it can be stated that over the population cubic model is 93.60% stable in case of age at marriage as the value of is 0.816 and η is 6.40 and 87.03% stable when the age at first birth has been taken as consideration as the value of is 0.627 and η is 12.97 and as we go for inverse cubic model, we get 94.61% stability in case of age at marriage as the value of is 0.845 and η is 5.39 and 86.50% stability when the age at first birth has been taken as consideration as the value of is 0.612 and η is 13.51. The last fitted model was the mix type which is providing us 92.90% stability to the data of age at marriage as the value of is 0.796 and η is 7.10 and 90.71% stability when the age at first birth has been taken as consideration as the value of is 0.733 and η is 9.29.

6 Conclusion

The present study attempts to show the graduation of trend in the caesarean delivery of childbirths according to the age of female at marriage and first birth in Uttar Pradesh. The exact cause of these remains unknown but it could be age factor of the mother, obstetric risks, mothers or their family members demand i.e. CDMR (Caesarean delivery on mothers request) due to fear of pain in labour or fear of foetal loss during labour. But overall it can be said that the important reason for medical intervention at childbirth is to attempt to save the lives of mother and child. One fourth of the total female used caesarean delivery up to 18 year of their age due to premature pregnancy. The mix type equation works well to graduate phenomenon than other equation considered in the present study. This provides positive estimates throughout the age but others provided negative estimates somewhere. The present study used only one data set so that the suitability and reliability of the proposed methodology should be checked with the other data set over the period of time and place.

Table 1: Distribution of age of females at first birth when first birth is caesarean

Age at marriage	Observed females	Computed through				
		Linear	Quadratic	Cubic	Inverse cubic	Mix type
14	2	20.49	14.22	5.87	1.72	7.43
15	14	19.42	15.23	12.45	14.27	12.38
16	21	18.35	16.01	17.15	20.44	17.29
17	23	17.27	16.54	20.18	22.78	21.03
18	18	16.2	16.82	21.73	22.85	22.92
19	26	15.13	16.85	22.01	21.61	22.89
20	19	14.06	16.64	21.22	19.66	21.29
21	18	12.99	16.18	19.58	17.38	18.7
22	12	11.91	15.48	17.28	15.01	15.69
23	15	10.84	14.53	14.53	12.68	12.67
24	17	9.77	13.34	11.54	10.47	9.92
25	7	8.7	11.9	8.5	8.44	7.57
26	3	7.63	10.21	5.63	6.61	5.66
27	6	6.55	8.28	3.12	4.97	4.16
28	0	5.48	6.1	1.19	3.54	3.02
29	0	4.41	3.67	0.03	2.31	2.17
30	2	3.34	1	***-0.14***	1.25	1.54
31	2	2.27	***-1.92***	0.87	0.37	1.09
32	1	1.19	***-5.08***	3.27	***-0.36***	0.76

Table 2: Fitted equation for age of females at marriage when first birth is caesarean

Type of Curve	Fitted Equation	R^2	Adj. R^2	ρ^2_{rcv}	η in %
Linear	$Y=35.497-1.071X$	0.473	0.443	0.376	9.71 (90.29)
Quadratic	$Y= -25.895+4.587X-0.123X^2$	0.622	0.575	0.493	12.93 (87.07)
Cubic	$Y= -398.623+56.874X-2.476X^2+0.034X^3$	0.88	0.857	0.816	6.41 (93.59)
Inverse cubic	$Y=82.552-\frac{7643.958}{X}+\frac{213005.399}{X^2}-\frac{1705652.253}{X^3}$	0.899	0.878	0.845	5.39 (94.61)
Mix type	$Y = Exp(108.480-\frac{496.821}{X}-26.899\ln(X))$	0.867	0.845	0.796	7.10 (92.90)

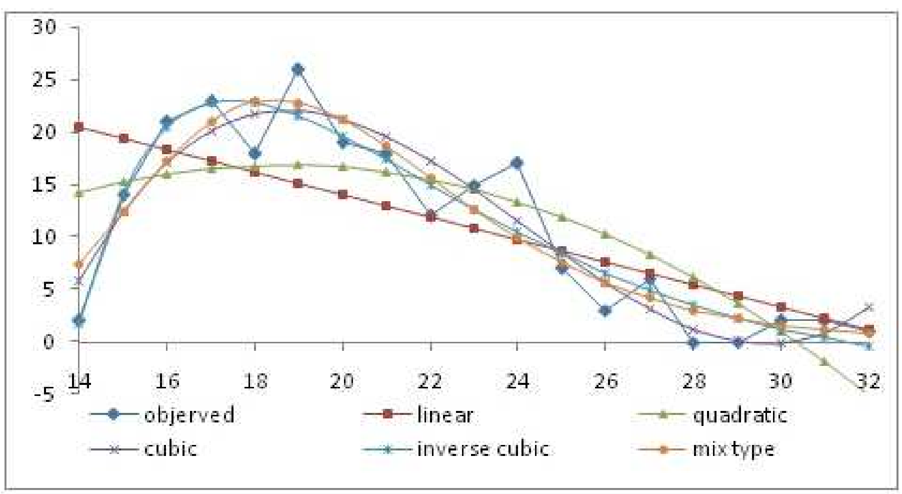

Fig. 1: Age of females at marriage when first birth is caesarean

Table 3: Distribution of age of females at first birth when first birth is caesarean

Age at FB	Observed females	Computed through				
		Linear	Quadratic	Cubic	Inverse cubic	Mix type
14	0	13.86	0.01	***-5.48***	***-2.86***	0.58
15	1	13.52	4.29	2.46	2.53	1.99
16	2	13.19	8.03	8.78	7.75	4.92
17	13	12.85	11.22	13.62	12.21	9.46
18	14	12.52	13.87	17.11	15.7	14.88
19	22	12.18	15.98	19.38	18.16	19.87
20	18	11.85	17.55	20.57	19.66	23.24
21	25	11.51	18.57	20.81	20.29	24.37
22	33	11.18	19.05	20.24	20.16	23.35
23	11	10.84	18.99	18.99	19.37	20.77
24	18	10.51	18.38	17.19	18.04	17.37
25	17	10.17	17.23	14.99	16.24	13.8
26	8	9.84	15.54	12.52	14.06	10.5
27	6	9.5	13.3	9.91	11.56	7.7
28	9	9.17	10.52	7.29	8.81	5.48
29	5	8.83	7.2	4.8	5.86	3.81
30	3	8.5	3.34	2.58	2.75	2.59
31	1	8.16	***-1.07***	0.76	***-0.48***	1.73
32	0	7.83	***-6.02***	***-0.52***	***-3.81***	1.14

Table 4: Fitted equation for age of females at first birth when birth is caesarean

Type of Curve	Fitted Equation	R^2	Adj. R^2	ρ^2_{rcv}	η in %
Linear	Y=18.549-0.335X	0.04	0	-0.138	17.70 (82.30)
Quadratic	Y= -116.923+12.153X-0.272X^2	0.661	0.619	0.545	11.60 (88.40)
Cubic	Y= -362.332+46.579X-1.820X^2+0.023X^3	0.758	0.709	0.627	12.97 (87.03)
Inverse cubic	Y=-297.985+$\frac{16832.045}{X}$-$\frac{283733.047}{X^2}$+$\frac{1483010.418}{X^3}$	0.747	0.696	0.612	13.51 (86.50)
Mix type	Y = Exp(163.014-$\frac{829.677}{X} - 39.518\ln(X)$)	0.826	0.804	0.733	9.29 (90.71)

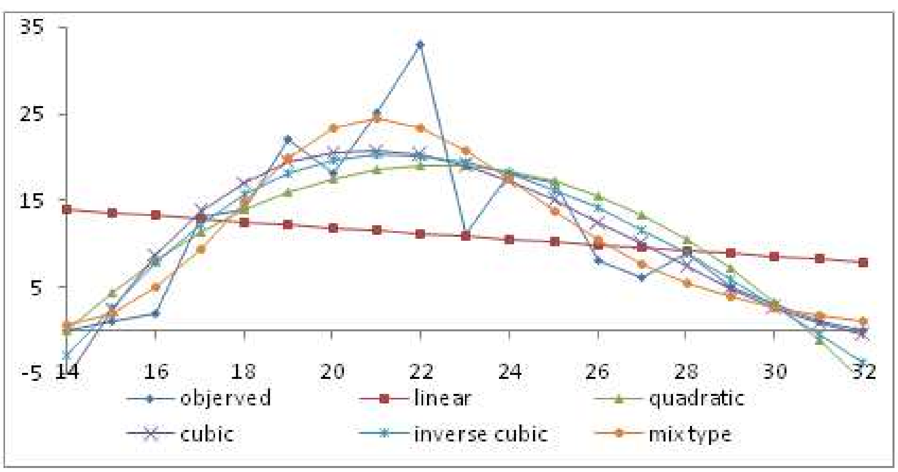

Fig. 2: Age of females at first birth when birth is caesarean

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