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Factors Influencing Foetal Wastage—A Case Study of Anand Town

Introduction

CHILD which survives longer, grows into a full man and becomes a citizen and makes his/her country progress further. Unfortunately, in India, it has been observed that there are a large number of foetal wastages and early neonatal deaths. There are various factors attributable to this natural calamity. In this paper, we examine some of the factors which influence foetal wastage.

Some of the studies which are relevant to the problem, are made by Morris and Heady (1955); Heady, Daly and Morris (1955); Daly, Heady and Morris (1955); Marchal (1972); Freedman, Whelpton and Champbell (1959); Shapiro, Jones and Densen (1962); Freedman, Combs and Friedman (1966); Potter, Wyon and Gordon (1965); Jain (1969); Carlos *et al.* (1969) and Gandotraet *al* (1975).

In the above studies, it has been noted that though the causes of still birth and abortion are many, the importance of each of these causes is not implicitly determined. The present paper, on the one hand examines the crude impact of the factors viz., Sex, Maternal age and Gravida on still birth rate, and on the other hand, the relative effect of each of these factors individually, in the absence of the influence of other factors. Similarly, on the one hand the crude impact of the factors viz., Maternal age and gravida on the risk of spontaneous abortion, and on the other hand, the relative effect of each of these factors individually, in the absence of the influence of other factors.

It is extremely difficult to collect complete and accurate information about pregnancy losses in any retrospective study. The problems of detecting early miscarriages, memory lapses, unwillingness to divulage information on abortions and still births, lack of knowledge in distinguishing a still birth from the death of a new born infants etc. are well known and make accurate assessement of pregnancy wastage difficult. To over-come such difficulties data are collected from the case-card records of mothers registered for delivery, during the period 1978-80 in Anand Municipal Hospital, Anand, India. During that period 3431 pregnancies are reported to have been recorded with complete information as per proforma. And out of these, 196 are found to have ended in abortions and 185 in still births.

Methodology

To study the influence of each of the factors under investigation on still birth rate and abortion, a binary variable multiple regression method described by Feldstein (1966) and later used by Shah (1971) is adopted. This method is helpful in simultaneous adjustment of large number of variables and uses directly the classificatory data. Another major advantage of this technique is that qualitative variables could also be analysed with it. However, the use of some continuous variables like maternal age and infant birth weight, as discrete variables may weaken the analysis slightly.

In this study, still birth rate is assumed to have the impact of the following three factors : (1) Maternal age (2) Gravida (3) Sex of the infant. The risk of abortion is assumed to have the impact of the following two factors : (1) Maternal age (2) Gravida. Each factor is then divided into following subclasses.

(1) *Maternal Age.* Mothers included in this study are divided into 5 sub-groups with regard to their age : (i) less than 20 years (ii) 20-24 (iii) 25-29 (iv) 30-34 and (v) 35 years and above. Four binary variables X_i X_2, X_3, X_t, are used to denote these subclasses.

(2) *Gravida.* It determines the order of present pregnancy. Four categories are made : (i) First order (ii) Second order (iii) 3-5 (iv) 6 and higher order pregnancies. Three binary variables X_5, X_6, X_7 are used to denote these subclasses.

(3) *Sex.* Still births are divided into two categories according to their sex : (i) Male (ii) Female. One binary variable X_8 is used to denote these subclasses.

For the purpose of Multiple regression analysis, all the variables are considered as binary taking the value 0 or 1. And each subclass of the variable is considered here as separate regressor (Feldstein, 1966). For the study of abortion, the method is modified by deleting the variable X_8 (Sex). The regression equation between the still birth rate and the independent variables mentioned above is given as follows :

$$y = \beta_0 X_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \varepsilon_t \quad (2.1)$$

where $y = 1$ if it is a still birth
$= 0$ otherwise.
$x_0 = 1$ Dummy variable (Always)

(X_1, X_2, X_3, X_4)	$= (1, 0, 0, 0)$	if the still birth belongs to mother with age less than 20 years.
	$= (0, 1, 0, 0)$	if the still birth belongs to mother with age 20-24 years.
	$= (0, 0, 1, 0)$	if the still birth belongs to mother with age 25-29 years.
	$= (0, 0, 0, 1)$	if the still birth belongs to mother with age 30-34 years.
	$= (0, 0, 0, 0)$	if the still birth belongs to mother with age 35 years and above.
(X_5, X_6, X_7)	$= (1, 0, 0)$	if the order of present pregnancy of mother is one.
	$= (0, 1, 0)$	if the order of present pregnancy of mother is two.
	$= (0, 0, 1)$	if the order of present pregnancy of mother is 3-5.
	$= (0, 0, 0)$	if the order of present pregnancy of mother is 6 and above.
(X_8)	$= 1$	if the still birth is male
	$= 0$	if the still birth is female

ε_t = Error component such that $E(\varepsilon_t = 0)$ and $E\,(x_{it}, \varepsilon_t + \theta) = 0$ for all i, t and θ. Since the interest in this study is to measure the average effect of each factor on the still birth rate, rather than its prediction we have not assumed interactions between the effects of the three different factors in the above model.

The above regression model can be rewritten as follows :

$$E(y) = X\beta \qquad (2.2)$$

where y is the vector of N observations, X is the $N \times 9$ matrix $(X_0, X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8)$ of zeros and ones and β is 9×1 vector of regression coefficients $(\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8)$. Using the standard procedure, the least square estimates of regression coefficients are obtained as

$$\hat{\beta} = (X'X)^{-1} X'y \qquad (2.3)$$

one can easily verify that

$$X'X = \begin{bmatrix} N & n_1 & n_2 & n_3 & n_4 & n_5 & n_6 & n_7 & n_8 \\ n_1 & n_1 & 0 & 0 & 0 & n_{15} & n_{16} & n_{17} & n_{18} \\ n_2 & 0 & n_2 & 0 & 0 & n_{25} & n_{26} & n_{27} & n_{28} \\ n_3 & 0 & 0 & n_3 & 0 & n_{35} & n_{36} & n_{37} & n_{38} \\ n_4 & 0 & 0 & 0 & n_4 & n_{45} & n_{46} & n_{47} & n_{48} \\ n_5 & n_{15} & n_{25} & n_{35} & n_{45} & n_5 & 0 & 0 & n_{58} \\ n_6 & n_{16} & n_{26} & n_{36} & n_{46} & 0 & n_6 & 0 & n_{68} \\ n_7 & n_{17} & n_{27} & n_{37} & n_{47} & 0 & 0 & n_7 & n_{78} \\ n_8 & n_{18} & n_{28} & n_{38} & n_{48} & n_{58} & n_{68} & n_{78} & n_8 \end{bmatrix} \tag{2.4}$$

n_{ij} = The number of live births in the sample.

n_i = The number of live births in the subclass i.

$$'y = \begin{bmatrix} D_0 \\ D_1 \\ \cdot \\ \cdot \\ \cdot \\ D_8 \end{bmatrix} \tag{2.5}$$

where D_i = No. of still births in the class i.

$$D_0 = \sum_{j=1}^{8} D_i = \text{Total no. of still births.}$$

The estimated regression equation is given by

$$\hat{y} = X\hat{\beta}. \tag{2.6}$$

Let $\bar{Y} = \frac{D_0}{N} \times 1000$ = observed still birth rate defined as the number of still births per 1000 live births in a year.

The estimated $\hat{\bar{y}}$ is given by

$$\hat{\bar{y}} = 1000 \times \frac{\Sigma \hat{y}}{N}$$

$$= 1000 \times \left(\hat{\beta}_0 + \frac{1}{N} \sum_{i=1}^{8} \hat{\beta}_i n_i\right). \tag{2.7}$$

The deviation from the average risk associated with being in a particular subclass of a variable is given by

$$d_i = \hat{\beta}_i - \frac{1}{N} \sum_{j=1}^{r-1} \hat{\beta}_j n_j, \; i = 1,2, \ldots, r \qquad (2.8)$$

where $\hat{\beta}_j$ = estimate of a coefficient for the subclass j of a variable
r = number of subclass of the variable.
n_j = number of births in the subclass j.
N = Total no. of births.

The above equation (2.8) can also be written as

$$d_i = \hat{\beta}_i \left(1 - \frac{n_i}{N}\right) - \sum_{j \neq i}^{r-1} \frac{\hat{\beta}_j n_j}{N}$$
$$= w_i' \hat{\beta}$$

where w_i' is a row vector

$$\left[-\frac{n_1}{N}, -\frac{n_2}{N}, \ldots (1 - \frac{n_i}{N}) \ldots - \frac{n_{r-1}}{N} \right]$$

and $\hat{\beta}' = (\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3, \ldots, \hat{\beta}_{r-1})$. The second term on the right hand side of the equation (2.8) measures the average risk of still birth for the variable under consideration. The percentage deviation from average risk of still birth is given by $d_i / \bar{Y} \times 100$.

Now

$$\begin{aligned} \text{var}(d_i) &= \text{var}(w_i' \hat{\beta}) \\ &= w_i' \,\text{var}(\hat{\beta})\, w_i \\ &= w_i' \sigma^2 V (w_i) \\ &= \sigma^2 w_i' V w_i \end{aligned} \qquad (2.9)$$

Now σ^2 is estimated by

$$\hat{\sigma}^2 = S^2 = \frac{y'y - \hat{\beta} X'y}{N - h - 1}, \; h = \sum_{j=1}^{m} (r_j - 1)$$

$$= \frac{D_0 - \sum_{i=0}^{8} \hat{\beta}_i D_i}{N - 9} \qquad (2.10)$$

V is the relevant submatrix of $(X'X)^{-1}$.

$$S\,E\left(\frac{d_i}{\bar{Y}} \times 100\right) = \frac{100}{\bar{Y}} \times S\,E\,(d_i) = \frac{100}{\bar{Y}} \times S\sqrt{w_i'\,Vw_i}\ . \qquad (2.11)$$

To obtain the estimate of standard error associated with percent deviation, the mean of the dependent variable ($\bar{Y}$) is treated as constant. Because of the large sample size (3431) it is expected that this will introduce little error.

If the percentage deviation is less than two times standard error, it implies that the variable has little or no impact on still birth. If the percentage deviation is more than two times standard error, the impact of the variable is taken as significant. The percentage deviation with plus sign is interpreted as the higher risk of still birth than that of the average. The percentage deviation with negative sign indicates the lower risk of still birth than that of the average.

Results and Discussion (Still Birth Rate)

In the overall population of Anand Municipal Hospital, the rate of foetal wastage is found to be 111 per 1000 pregnancies. Of these 53 per 1000 pregnancies are classified as terminated in abortion and 58 per 1000 pregnancies in still birth. The level of foetal wastage in eleven villages of Punjab is estimated to be 136 per 1000 pregnancies (Potter *et al.*, 1965). This rate of the Khanna Study (1965) is considered lower than the actual rate. The foetal wastage in Baroda is estimated 162 per 1000 pregnancies (Gandotra, 1972).

Comparing the findings of the other studies, the foetal wastage eastimate of 111 for the present study appears to be a lower estimate. However, the still birth rate of 58 per 1000 is more than the rates reported in other studies. In contrast, the abortion rate of 53 per 1000 seems to be lower than the rate of spontaneous abortion. The cases are registered in the Hospital just at the time of delivery and do not avail the facilities of ante-natal care which the hospital provides. At the same time, there are less chances for these cases to report early miscarriages.

The unadjusted percent deviations from the average risk of still birth is obtained for each variable (i.e. Maternal Age, Order of Gravida, Sex) in the absence of the effect of all other variables. The adjusted percent deviations from the average risk of still birth is obtained in the presence of the effect of all variables. The regression equation taking all the variables is as follows :

$$y = .0900 - .0431\,X_1 + .0066\,X_2 - .0067\,X_3 - .0030\,X_4 - .0298\,X_5 - .0565\,X_6 - .0463\,X_7 + .0215\,X_8.$$

Factors Related to Still Births

MATERNAL AGE. The regression equation of still birth on maternal age is as follows :

$$y = .0744 - .0469\ X_1 - .0073\ X_2 - .0248\ X_3 - .0153\ X_t.$$

Table 1 indicates the percentage deviations from average risk of still birth by Maternal Age.

It is clear from the unadjusted deviations shown in Table 1, that the risk of still birth is higher than average for those babies whose mothers are of age 20 years and above except the age group 25-29 years. After considering the effect of all other variables, it is clear from the adjusted deviations that the babies whose mothers are of age 30 years and above have greater risk of still birth than the babies of the younger mothers (less than 24 years).

TABLE 1-DEVIATIONS FROM AVERAGE RISK OF STILL BIRTH BY MATERNAL AGE

Age Group	y_i	*Unadjusted*		*Adjusted*	
		deviations	*standard error*	*deviations*	*standard error*
<20	5	—54.9075	29.9018	—71.6945	31.5706
20-24	91	14.3389	8.3410	- 8.0438	16.0001
25-29	47	—16,2624	11.3137	- - 1.5738	11.5935
30-34	26	.3497	18.4307	15.2132	20.2144
35 and above	16	27.1040	26.7543	3.6721	30.7063

As the unadjusted percentage deviations are less than two times standard error, the risk of still birth from average for Maternal Age (< 20, 20-24, 25-29, 30-34, 35 and above) is found to be statistically insignificant. Similarly the adjusted percentage deviations, are less than two times standard error except in the case of materal age < 20 years. So the risk of still birth from average for maternal age (20-24, 25-29, 30-34, 35 and above) is found to be statistically insignificant while it is found to be statistically significant in the case of maternal age less than 20 years.

ORDER OF GRAVIDA. The regression equation of still birth on gravida is as follows :

$$y = .0990 — .0305\ X_1 — .0537\ X_2 — .0461\ X_3.$$

Table 2 indicates the percentage deviations from average risk of still births by Gravida.

TABLE 2—DEVIATIONS FROM AVERAGE RISK OF STILL BIRTHS BY GRAVIDA

Gravida	*Yi*	*Unadjusted*		*Adjusted*	
		deviations	*standard error*	*deviations*	*standard error*
1	68	16.4372	10.4394	18.7105	13.2722
2	35	—24.1314	12.7476	—27.9783	13.0099
3-5	62	—10.8416	9.5651	— 10.1421	10.2470
6 and above	20	69.7711	27.8035	70.8203	31.9653

It is clear from the unadjusted deviations shown in Table 2, that mothers belonging to the lowest gravida one and highest gravida 6 and above have higher risk of still births than that of average. And mothers in the intermediate gravidas 2 to 5 have lower risk of still birth than that of the average. The trend of unadjusted deviations from average risk of still births by gravida seems to follow a U-shaped pattern. This trend is same, even after the adjustment is made.

After considering the effect of all other variables, it is clear from the adjusted deviations that mothers belonging to the lowest gravida one and higher gravida 6 and above have higher risk of still birth than that of average. The comparison of unadjusted and adjusted percentage deviations indicates that the influence of gravida on still births is increased to some extent.

The unadjusted percentage deviations are less than two times standard error except in the case of Gravida 6 and above. So the risk of still birth from average for gravida 1, 2, 3-5 is found to be statistically insignificant, while it is found to be statistically significant in the case of gravida 6 and above. The adjusted percentage deviations are less than two times standard error in the case of gravida 1 and 3-5. So the risk of still birth from average for gravida 1 and 3-5 is found to be statistically insignificant. The adjusted percentage deviations are greater than two times standard error in the case of gravida 2 and 6 and above. So the risk of still birth from average for gravida 2 and 6 and above is found to be statistically significant.

SEX. The regression equation of still birth on sex is as follows:

$$y = .0477 + .0206 X_1$$

Table 3 indicates the percentage deviations from average risk of still births by sex.

It is clear from the unadjusted deviations shown in Table 3, male babies had risk of still birth 16.61 percent above average. After considering the effect of

TABLE 3—DEVIATIONS FROM AVERAGE RISK OF STILL BIRTHS BY SEX

Sex	y_i	*Unadjusted*		*Adjusted*	
		deviations	*standard error*	*deviations*	*standard error*
Male	116	16.6121	6.8197	17.3116	6.8197
Female	69	—19.4049	7.8689	20.2843	7.8089

all other variables, it is clear from the adjusted deviations, that the risk of still birth, in the case of males is slightly increased to 17.31 percent above the average. Similarly from the unadjusted deviations, shown in the above table, it is clear that female babies have risk of still birth 19.40 percent below the average. After considering the effect of all other variables the risk of still birth decreased to 20.28 percent below the average. The unadjusted and adjusted percentage deviations are greater than two times standard error. Hence the risk of still birth from average, for males and females is found to be statistically significant. This shows that sex plays an important role in explaining the risk of still birth.

Results and Discussions for Abortions

The regression equation taking all the variables is as follows :

$$y = .0480 + .0185\ X_1 + .0038\ X_2 — .0183\ X_z — .0235\ X_4 + .0212\ X_5 + .0176\ X_7 + .0238\ X_s.$$

Maternal Age. The regression equation of Abortion on maternal age is as follows :

$$y = .0613 + .0263\ X_1 + .0112\ X_2, — .0107\ X_3 — .0174\ X_4$$

Table 4 indicates the percentage deviations from average risk of abortion by maternal age.

TABLE 4-DEVIATIONS FROM AVERAGE RISK OF ABORTION BY MATERNAL AGE

Age group	y_t	*Unadjusted*		*Adjusted*	
		deviations	*standard error*	*deviations*	*standard error*
<20	17	42.5623	27.7069	40.2437	29.9923
20-24	99	17.5548	7.3531	15.8987	9.1252
25-29	48	—18.7142	8.9761	—20.7015	9.9532
30-34	19	-29.8102	17.5052	—29.3133	19.4759
35 and above	13	— 0.9937	24.1131	9.6055	25.4546

It is clear from the unadjusted deviations shown in Table 4, that the risk of abortion is higher than average for mothers of age < 24 years. After considering the effect of all other variables, it is clear from the adjusted deviations that mothers of age 24 years and below have greater risk of abortion than the mothers who are aged 25 years and above. It is also clear from the unadjusted and adjusted percentage deviations that the abortion rate decreases with the increase in the age of mother.

As the unadjusted percentage deviations are less than two times standard error, the risk of abortion from average for maternal age (< 20, 30-34 and 35 and above) is found to be statistically insignificant. The risk of abortion from average for maternal age (20-24 and 25-29) is found to be statistically significant. The adjusted percentage deviations arc less than two times standard error, the risk of abortion from average, for maternal age (< 20, 20-24, 30-34, 35 and above) is found to be statistically insignificant. While the risk of abortion from average for maternal age 25-29 is found to be statistically significant.

Gravida The regression equation of Abortion on gravida is as follows :

$$y = .0372 + .0348\ X_1. + .0226\ X_2 + .0219\ X_3.$$

Table 5 indicates the percentage deviations from average risk of abortion by gravida.

TABLE 5- DEVIATIONS FROM AVERAGE RISK OF ABORTION BY GRAVIDA

Gravida	y_i	*Unadjusted*		*Adjusted*	
		deviations	*standard error*	*deviations*	*standard error*
1	72	16.5612	10.5163	2.1529	12.2553
2	47	— 3.6434	12.1559	—3.8091	12.3546
3-5	69	— 4.8027	8,9596	6.4588	10.0361
6 and above	8	—41.078	27.7566	—32.9568	31.9797

It is clear from the unadjusted deviations shown in Table 5, that mothers belonging to the lowest gravida 1, have higher risk of abortion than that of the average. And mothers having gravida 2 and above have lower risk of abortion than that of the average. After considering the effect of all other variables, it is clear from the adjusted deviations that mothers belonging to the lowest gravida 1 and gravida 3-5 have higher risk of abortion than that of average, while mothers having gravida 2 and gravida 6 and above have lower risk of abortion than that of the average.

As the unadjusted percentage deviations,~are less than two times standard error, the risk of abortion from average for all gravidas is found to be statistically insignificant. Even after the adjustment is made, the pattern remains same.

Conclusions

(1) The risk of still birth is higher than average for those babies whose mothers are of age 20 years and above. But after considering the effect of all other variables, the risk of still birth is higher than average for those babies whose mothers are of age 30 years and more.

(2) The babies whose mothers belong to the lowest gravida 1 and highest gravida 6 and above have higher risk of still birth than that of the average.

(3) Male babies have higher risk of still birth than female babies.

(4) The risk of abortion is higher than average for mothers who are of age less than 24 years. But after considering the effect of all other variables the risk of abortion is higher than average for mothers of age less than 24 years and 35 years and above.

(5) The mothers belonging to the lowest gravida one have higher risk of abortion than that of average.

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