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ZERO-WAITING TIME TO CONCEPTION IN HUMAN REPRODUCTION: FAILURE OF SURVIVAL MODELS AND DETERMINANTS BY LOGISTIC REGRESSION MODELS

N. Sharat Singh

Abstract

Some mothers have no menses between two consecutive live births leading to the duration of waiting time to conception to be zero resulting into the fecundability cannot be estimated with survival models. The phenomenon had first ever been termed as 'zero-waiting time to conception' in 2010. In this study, it was to explore the determinants of zero-waiting time to conception of women in the tribal dominated populations in Manipur, the internationally border with Myanmar. A cross-sectional community base study was conducted during July, 2014 to June, 2015 taking 1278 eligible mothers who were having at least two live births under cluster sampling technique. Some important independent variables of the phenomenon could be detected by using binary logistic regressions. With a prevalence rate of 32 per thousand, some of the determinants were observed to be age at marriage, age at delivery, and parity each at $P<0.01$ and tribal/ non-tribal differential and infant mortality ($P<0.05$). The findings might be baseline information for future researchers in maternal and child health development in India particularly in North East India.

Keywords:

Tribal,
age at marriage,
parity,
binary logistics,
odds ratios.

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1. Introduction

The first National Family Health Survey (NFHS) reports the significant inter-state variations in the unwanted fertility in India. Unplanned pregnancies are still relatively common and the unwanted fertility had risen from 22% in 1992-93 to 25% in 1998-99.

The unwanted fertility as per cent of Total Fertility Rate (TFR) declined in the low fertility southern states of Kerala, Tamil Nadu and Andhra Pradesh and rise up in most of the high fertility states like Bihar, Rajasthan, Uttar Pradesh, Madhya Pradesh, and Orissa over the same period. However, if the unwanted fertility component is taken care of or gets eliminated then the TFR would come down to replacement level of 2.1 or even below that in most parts of India. The NFHS-3 report also stresses that if all women were to have only the number of children they wanted, the TFR would be 1.9 instead of 2.7. Among births in the five years before the survey, 10% were wanted later and 11% were not wanted. In the report, 71% of adults want no more children, are already themselves sterilized, or have a spouse who is sterilized. Among those who do want another child, about half would like to want at least two children. Two-thirds of women and men consider the ideal family size to be 2 children or less. In the NFHS-4 (2015-16), more than 80% of the North East India's populations from Assam (2.2), Manipur (2.6), Meghalaya (3.0), Mizoram (2.3) and Nagaland (2.7) are lagging behind the national fertility goal (2.1) except those in three states viz. Sikkim (1.2), Tripura (1.7) and arunachal Pradesh (2.1). However, Meghalaya and Sikkim have equally reduced the TFR by 0.8 children during the last decade (2005-2015). Tripura also follows the reducing rate by 0.5 children. The two states – Assam and Manipur can reduce as little as 0.2 children in TFR during the decade. The rural-urban differential may also be one of the causes of variations in these fertility indicators. This differential in TFR is found to be highest (1.8), say 1.7 in urban and 3.5 in rural in Meghalaya which is followed by Manipur and Assam with rural-urban difference each of 0.8 children. The lowest difference of 0.1 children is found in Sikkim in the survey report. In their findings of Shekhar et al., (2014) considering the 15 States and 2 Union Territories in NFHS-4 (2015-16) also highlighted that urban fertility levels are at or below the replacement level (2.1 children) except Bihar (2.4 children).

As a new approach to study the complexity of fertility regulation, birth-intervals dynamics becomes paramount importance for population control. In fact, fertility depends on the duration of effective reproductive span and length of birth interval (Bongaarts and Potter 1983). There are the two types of birth interval viz. - complete birth interval and incomplete birth interval. The former is the interval between the two consecutive live births, generally known as closed birth interval or simply birth interval. Both the intervals - the time interval between marriage and first live birth and also the time interval between the last live birth and date of survey are termed as incomplete birth interval. The closed birth interval is taken into consideration in the present study. Its major components are post partum amenorrhoea (PPA), waiting time to conception and gestation period. The post partum amenorrhoea is the length of time between the termination of pregnancy and the first successive ovulation following of pregnancy during the reproductive span of a woman. In other words, it is the temporary sterility immediately following the termination of pregnancy during which conception usually does not occur. A susceptible state, in which a woman can conceive, of a fecund woman is termed as "waiting time to conception" or simply waiting time. In another sense, the interval between end of PAA and time of conception is known as waiting time. The third component, gestation is the period of pregnancy associated with later live birth. It may also be defined as the interval of time between the end of waiting time and the beginning of PPA. The second component "waiting time to conception" may also be defined to be the time interval between the resumption of menses after a pregnancy until the beginning of the next pregnancy. The

gestation is treated to be a constant duration in various studies while PPA is in fact a physiological process which varies in a complex fashion (Lantz et al. 1992). But the waiting time to conception is highly influenced by various socio economic, cultural, demographic and behavioural characters (Kathleen et al. 1989; Singh et al. 2007; Singh et al. 2011).

Zero-Waiting Time to Conception: In the present investigation, 41 out of 1278 eligible mothers have no menses between two consecutive live births. Most of them gave births with as much as a short time interval of two-year gap between babies without even having a period at all. In this biological phenomenon, the waiting time to conception can not quantitatively be defined to be a duration variable say an event history data. In this sense, the present researcher firstly termed it as 'zero-waiting time to conception'. It simply means that the value of the life time of waiting time to conception is used to be zero. A physiological idea of such phenomenon was highlighted by Maire (1982) in his book 'The breastfeeding book' – 'In some new mothers, ovulation occurs before menstruation so the mothers can be producing eggs and therefore the capable of conceiving even before they have had a period'.

Problem in survival analysis: For mothers having such phenomenon, fecundability can not be estimated therein despite its needs for statistical modeling. Obviously, in survival analysis, the waiting time to conception 'T' is considered to be continuous and non-negative valued random variable. The distribution of 'T' may be characterized by three equivalent functions viz., survival function (SF - S(t)), probability density function (p.d.f. - f(t)) and hazard function (HF- $\lambda(t)$). Taking SF, for instance, we have S(t) = P[T $\geq$ t]= P [that a woman will not conceive at least time t] = 1 - P[T < t] i.e., S(t) = 1- F(t) , where F(t) = P[T < t]= $\int_0^t f(t)dt$ = P [that a woman conceives before time t] is called cumulative distribution of T. It may be noted that S(t) is a non increasing function of *t* with the properties that S(t) = 1 for t = 0 and S(t) = 0 for t $\rightarrow \infty$ that is, the probability of not conceiving at least at the time zero is one and that of surviving an infinite time is zero. But, the present phenomenon contradicts the above condition as the event of conception occurs at time, t = 0. Though waiting time to conception is a duration data, the survival analysis is likely to be failed to such community based study rather clinical observations. Thus, the present study aims to investigate the prevalence and determinants of zero-waiting time to conception.

2. Research Method

A cross sectional as well as community based study of 1278 mothers was conducted during the period from July, 2014 to June, 2015 under cluster sampling technique in valley districts of Manipur – Imphal West, Imphal East, Thoubal, and Bisnupur. Some important independent variables of the phenomenon could be detected by using binary logistic regressions. The eligible mothers are taken into account after excluding the mother who did not fulfill the two criteria – firstly, she must have had at least two pregnancies in her life and secondly her most recent pregnancies must have resulted in two live births and hence, a sample size of 1278 eligible mothers is analysed here. To control recall error, last birth intervals of the eligible mothers are considered in the study. Tool of the survey was a pre-tested and semi-structural questionnaire and data

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was collected through personal interview method. The cluster with rural-urban areas under study is defined according to Population of Manipur: Social Statistical Indicator - 2006 (Directorate of Economics and statistics, Govt. of Manipur, 2007). The χ^2-test is used for testing the prevalence of zero-waiting time to conception according to some socio-demographic variables of interest. The determinants of the phenomenon, the response variable have been investigated through logistic regression models. The results of the regression analysis are interpreted by β - coefficients with their standard error (S.E), Wald-value, P-value and odds ratios (OR), Exp (β) with 95% confidence interval (CI).

Logistic Regression Model: The logistic or logit function is used to transform an S-shaped curve into an approximately straight line and to change the range of the proportion from 0 to 1 into $-\infty$ to $+\infty$. The logit function is defined as the natural logarithm (ln) of the odds of death (Kirkwood & Sterne, 2003). Here, the term death is meant for the phenomenon of zero-waiting time conception to a woman. That is,

$$Logit\,(P)=In\left[P/(1-P)\right]=\alpha+\beta x \qquad (1)$$

where P being the probability of death that is the probability that a woman bears the phenomenon of zero-waiting time and $1-P$ is defined as the complement of death that is the probability of a woman bears non-zero waiting time to conception , α is the constant; β standing for the regression coefficient, x 's being the independent covariates and the ratio $\left[P/(1-P)\right]$ being the odds that a woman bears the zero-waiting time. Equation (1) can be expressed as

$$\frac{P}{1-P}=e^{(\alpha+\beta x)}$$

$$\text{or} \qquad P=\frac{e^{(\alpha+\beta x)}}{1+e^{(\alpha+\beta x)}} \qquad (2)$$

When the explanatory variable increases by one unit from x to $x+1$ (0 to 1 for binary dummy variable), the odds that a woman bears the zero-waiting time change from

$$e^{\alpha}e^{\beta x} \text{ to } e^{\alpha}e^{\beta(x+1)}=e^{\alpha}e^{\beta x}e^{\beta}$$

The odds ratio (OR) that is the amount of risk for a woman bearing zero-waiting time to that of woman having non-zero-waiting time is therefore, $e^{\alpha}e^{\beta x}e^{\beta}\Big/e^{\alpha}e^{\beta x}=e^{\beta}$. Wald χ^2 statistics are used to test the significance of individual coefficients in the model and it is calculated as $\left(\frac{Coefficient}{SE\ Coefficient}\right)^2$. Each Wald statistic is compared with a χ^2 distribution with 1 degree of freedom.

3. Results and Analysis

To examine the prevalence of the zero-waiting time to conception, fifteen socio-demographic factors are considered. They are district, residence, family type, religion,

caste, education, income, age at menarche, age at marriage, age at delivery, sex of previous child, parity, infant mortality, type of feeding and duration of breastfeeding. Utilizing χ^2-test, only five factors are found to be significant in the variations on prevalence of zero-waiting time to conception. The factors are district ($P<0.05$), religion ($P<0.05$), age at marriage ($P<0.05$), duration of breastfeeding ($P<0.01$), and infant mortality ($P<0.05$) depicted in table 1. Apart from the nonexistence of statistical significance, visible differences in the prevalence of zero-waiting time to conception are come across the factors like place of residence, type of family, caste, age at menarche, income, age at delivery, type of feeding, parity etc. But the variations in the prevalence might have caused by the joint effects of various factors under consideration. However, the relative influences of the factors are examined through logistic regression analysis as quantified by OR. The prevalence of zero-waiting time to conception is observed to be 32 per 1000. The prevalence rate (PR) is visibly higher (35) in rural than that of urban (24). In the significant variation of PR ($P<0.05$) with respect to religion, Muslim women contributes the highest rate of 57 followed by Christian and other group, 50 and the lowest rate of only 24 by Hindu women. An approximate upward movement in the PR is observed with educational level with the lowest rate 14 associated with under matriculate mother. It is raising to 28 in matriculate mother and 62 in the mothers who completed intermediate level. Among the factors influencing the prevalence of zero-waiting time, women's age at marriage has an upward regular movement with significantly varied PR ($P<0.05$) ranging from about 14 in the women marrying at their age of below 20 year, 29 in those of 20-25 year, 56 in 25-30 year and the highest rate of 58 in the women marrying at 30 year and above. Notwithstanding, irregular changes ($P>0.05$) in the PR of zero-waiting time to conception is found according to age at delivery of the index birth.

Irrespective of the influences of other factors, an inverse relation is existed in the PR with duration of breastfeeding, observed to be highly significant ($P<0.001$). It is interestingly noted that the higher PR of 57 of zero-waiting time is associated with mothers who breastfed their baby for a short duration of below 6 month, followed by 38 in those of 6-12 month and the lowest rate of 9 is found in the mother who breastfed their babies at least one year duration. Also the significant difference in the PR of the phenomenon is observed according to infant death (death=100, survived=30; $P<0.05$) shown in Table-1. In the logistic regression, 12-factors are hypothesized to be influencing on the phenomenon of zero-waiting time to conception. They are residence (rural/ urban), community (tribal/non-tribal), religion (Hindu/Muslim/Christian and others), educational level (defined to be the number of completed year in education), age at menarche, age at marriage, age at delivery, parity, sex of index child, mortality status of infant (survived/ death) and duration of breast feeding. As advocated by their p-value of the Wald-test statistics, five adjusted coefficients are found to be significant of which the corresponding ORs are illustrated in Table-2. After adjusted the joint effects of others, the significant factors are age at marriage ($P<0.001$; OR= 1.22 with 95 per cent CI: 1.12-1.33), age at delivery of the index child ($P<0.001$; OR= 0.82), Parity ($P<0.05$; OR= 1.56), infant mortality ($P<0.05$; OR= 4.85) and Christian religion ($P<0.05$; OR= 3.56). When the effects of other variables are unadjusted, the five factors viz., age at marriage ($P<0.01$), infant mortality ($P<0.05$), duration of breast feeding ($P<0.001$), educational achievement ($P<0.01$), and hill-valley differential ($P<0.05$) have also been observed to have their

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significant impact on the zero-waiting time to conception. When the effects of other variables are controlled, the 22 per cent higher risk of being zero-waiting time can be assessed as one year increase in mother's marriage age. But the risk is decreased by 18 per cent at the advancement of one year in their delivery age. However, the risk of being zero-waiting time is increased by 56 per cent subject to monotonic advancement of parity. Besides, when the index child is died in infancy the risk of zero-waiting time is 4.85 times increased from the case when the infant is survived. Under adjustment of other factors, the women enjoying Christian religion have also higher risk of 3.56 times in the phenomenon of zero-waiting time than that of Hindu.

Table-1: Prevalence Rate (PR) of zero-waiting to conception according to some socio-demographic factors

Factors		No. of women with waiting time to conception			PR per 1000	P-value for χ^2
		Zero	Non-Zero	Total		
All		**41**	**1237**	**1278**	**32.08**	
Residence	Urban	7	286	293	23.89	0.365
	Rural	34	951	985	34.52	
Type of family	Nuclear	17	651	668	25.45	0.159
	Joint	24	586	610	39.34	
Religion	Hindu	22	895	917	23.99	0.031
	Islam	7	116	123	56.91	
	Christian & others	12	226	238	50.42	
Caste	General	21	826	847	24.79	0.109
	S.C	10	191	201	49.75	
	S.T	10	220	230	43.48	
Educational level	Under matriculate	4	278	282	14.18	0.065
	Matriculate	18	616	634	28.39	
	Intermediate	10	152	162	61.73	
	Graduate & above	9	191	200	45.00	
Monthly income (in '000Rs.)	< 5	17	322	339	50.15	0.814
	5-10	5	147	152	32.89	
	10-15	6	80	85	70.59	
	15+	7	127	134	52.24	
Age at menarche (yr)	<12	3	54	57	52.63	0.540
	12-14	23	646	669	34.38	
	14+	15	537	552	27.17	
Age at marriage (yr)	<15	0	21	21	0	0.030
	15-20	6	425	431	13.92	
	20-25	20	414	434	46.08	
	25-30	8	264	272	29.41	
	30+	7	113	120	58.33	
Age at	<25	6	101	107	56.07	

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delivery (yr)	25-30	13	216	229	56.77	0.136
	30-35	12	210	222	54.05	
	35+	3	149	152	19.74	
Type of feeding	Completely breastfed	35	1012	1047	33.43	0.561
	Otherwise	6	225	231	25.97	
Duration of breast feeding (mth)	<6	28	459	487	57.49	<0.001
	6-12	8	201	209	38.28	
	12+	5	577	582	8.59	
Sex of index child	Male	23	690	713	32.26	0.698
	Female	18	547	565	31.86	
Infant mortality	Death	3	27	30	100.00	0.030
	Survived	38	1210	1248	30.45	
Parity	0	15	290	305	49.18	0.143
	1	10	302	312	32.05	
	2	4	218	222	18.02	
	3	8	184	192	41.67	
	4+	4	243	247	16.19	

Applying the stepwise method in the binary logistic regression (Backward: Wald), the six factors are observed in 8th step to be determinants on the existence of zero-waiting time to conception (table-3). In one sense, the model is significant up to 8th step with the six explanatory variables. The factors are age at menarche (OR=0.82), age at marriage (P<0.001, OR=1.21 with 95 per cent CI: 1.12-1.32), age at delivery (P<0.001, OR=0.82 with 95 per cent CI: 0.75-0.90), parity (P<0.01, OR=1.54 with 95 per cent CI: 1.12-2.13), community (P<0.05, OR=0.22 with 95 per cent CI: 0.04-1.24) and Christian religion (P<0.05, OR=3.25 with 95 per cent CI: 1.23-7.15). As such, the six factors may be treated as the best set of determinants of zero-waiting time to conception in human reproduction in the study population. In this last model, we may assess that the mother has 12 per cent lower risk of zero-waiting time with one year increase in their age at menarche. After controlling the joint effect of other five factors (age at menarche, age at delivery, parity, community and religion), the mothers have at least 21 per cent higher risk (P< 0.001) of the phenomenon to one year advancement in their marriage age. But in the same model, a mother has 18% lower risk (P< 0.001) of the phenomenon as she could postpone her delivery one year. In this complex situation, the mothers of higher parity have also higher risk of zero-waiting time to conception quantifying 54 per cent to each increment of parity (Table-3).

Table-2: Odds Ratios (OR) of variables on zero-waiting time to conception under logistic regression

Factor		Unadjusted OR			Adjusted OR		
		OR	95%CI	P-value	OR	95%CI	P-value
Residence	Urban	1.00			1.00		
	Rural	1.46	0.64-3.33	0.368	0.94	0.24-3.63	0.930
Religion	Hindu	1.00			1.00		
	Islam	1.99	0.86-4.59	0.107	2.12	0.67-4.74	0.203
	Christian	1.85	0.93-3.68	0.079	3.56	1.17-4.55	0.032

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	& others						
Community	Non-tribal	1.00					
	Tribal	1.49	0.72-3.09	0.282	0.25	0.04-1.43	0.119
Educational level		1.09	1.02-1.17	0.008	1.07	0.97-1.17	0.186
Age at menarche		0.83	0.66-1.04	0.104	0.84	0.66-1.05	0.126
Age at marriage		1.09	1.03-1.15	0.004	1.22	1.12-1.33	<0.001
Age at delivery		0.95	0.89-1.01	0.111	0.82	0.74-0.91	<0.001
Parity		0.85	0.70-1.03	0.099	1.56	1.10-2.20	0.012
Sex of index child	Female	1.00			1.00		
	Male	1.01	0.54-1.90	0.968	0.92	0.44-1.92	0.817
Infant mortality	Survived	1.00			1.00		
	Death	3.54	1.03-8.17	0.045	4.85	1.37-7.19	0.015
Duration of breast feeding (mth)		0.87	0.82-0.93	<0.001	0.94	0.84-1.05	0.258

Table-3: Odds Ratios (OR) of most influencing factors on zero-waiting time to conception in last 8th-Step of stepwise logistic regression

Factor		OR by Stepwise method		
		OR	95%CI	P-value
Religion	Hindu	1.00		
	Christian & others	3.25	1.23-11.78	0.027
Community	Non-tribal	1.00		
	Tribal	0.22	0.04-1.24	0.036
Age at menarche		0.82	0.65-1.03	0.086
Age at marriage		1.212	1.117-1.316	<0.001
Age at delivery		0.823	0.749-0.904	<0.001
Parity		1.544	1.120-2.129	0.008

4. Discussion

Though the prevalence rate of zero-waiting time to conception varies in a complex fashion, it has first ever been detected to be 32 per 1000 eligible women. The prevalence is significantly higher in hill areas, Muslim and Christian religion, low breastfed mothers and high infant deaths. Notwithstanding, the present findings can not compare with the past results due to unavailability of literatures. Irrespective of other factors, the high prevalence of zero-waiting time may have a linkage with low education and short period of abstinence. In one sense, the possible causal factors like high infant mortality, religion of Muslim and Christian and hill areas are associated with low education. The high prevalence may also be thought to be caused by sexual contact during post partum period. So the status of abstinence may be low there. But the cause of significant difference detected by chi-square test in the prevalence rate with respect to age at marriage and duration of breast feeding can not be interpreted because of its complex variation in nature. As quantified by odds ratios in logistic regressions, the higher risk of being zero-waiting time is again observed to be associated with age at marriage, infant death, higher parity and

Christian religion. The lower risk of the phenomenon has a linkage with age at menarche, age at delivery of index child and the prolong breast feeding. In addition to the lack of education and short duration of abstinence, one possible cause may be psychological feeling of the couples when index child is death. Infant death may exert a psychological pressure on the parents to make up the loss as early as practicable neglecting cultural and traditional norms of abstinence. In other words, the behavior of child replacement effect involves a deliberate decision by the couples to compensate the death child leading to the phenomenon of zero-waiting time to conception. On the other hand, presence of infant and young child and strain of rearing the child may reduce the desire for sexual relations which may result in reducing coital frequency and hence leading to longer waiting time to conception. The similar view is supported by Linstrom (2000), Murphy (2001), Singh et al. (2007), Singh et al. (2011) and Singh et al. (2011). After adjusted the effects of other factors, the couples who marry late may have a tendency towards quick child-bearing and try to compensate their earlier lost reproductive period in order to have desire number of children. Consequent upon their short reproductive period the duration of waiting time to conception directly results into a short to be even zero too. The significantly short duration of waiting time to conception due to late marriage is also observed in the earlier studies of Clegg (2001), Singh et al. (2007) and Singh et al. (2011).

5. Conclusion

The zero-waiting time to conception has no agreement on the national goal for fertility reduction to replacement level of 2.1, specifically adoption of methods of contraception to space children. Factors influencing the hazardous phenomenon would provide a great opportunity for counseling new mothers and their husbands about of not only family planning and promotion of postpartum contraception, but also about child care practices including initiation and continuation of exclusive breastfeeding, reduction of infant mortality and management of child health. The present findings also suggest that new mothers especially from economically poor section of hill areas are of priority sector and are demanding maternal and child health related services from the public facilities.

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