Investigating the Main Factors Affecting Human Birth Intervals in Manipur, India

Laishram Lumina Devi
Assistant Professor, Department of Mathematics
Thoubal College, Thoubal (India)
luminalaishram@gmail.com

Abstract

Human fertility is closely tied to birth intervals, which consist of postpartum amenorrhoea (PPA), waiting time to conception, and gestation. While gestation is relatively constant, PPA – the period between the end of pregnancy and the return of ovulation – varies significantly, influenced by factors such as breastfeeding practices and socio-economic conditions. This study aims to analyse these components of birth intervals in rural Manipur, India, focusing on variations in PPA, waiting time to conception, and their interactions with socio-demographic factors. A cross-sectional survey of 1171 women was conducted, with data analysed using Cox regression models. Key findings indicate that extended breastfeeding significantly prolongs PPA, while infant mortality and family income also impact PPA duration. Waiting time to conception is influenced by infant mortality, the sex of the previous child, desired number of sons, lactation duration, and the wife's education level. Higher family income and longer lactation were associated with longer waiting times, while a deceased previous child and son preference reduced waiting time. The study reveals that socio-economic factors, including income and education, play a critical role in determining birth intervals, while religious differences also affect reproductive outcomes. These findings highlight the complex interplay of physiological, socio-economic, and cultural factors influencing fertility. The results emphasize the need for targeted interventions addressing these variables to better manage fertility and improve reproductive health outcomes.

Keywords: *Postpartum Amenorrhoea, Waiting Time to Conception, Breastfeeding, Socio-Economic Factors, Fertility*

Introduction

Human fertility is intricately linked to the duration of birth intervals, a concept thoroughly examined by Bongaarts and Potter (1983). Birth intervals, particularly closed birth intervals, consist of three primary components: postpartum amenorrhoea (PPA), waiting time to conception, and gestation. While gestation, the period of pregnancy, is generally considered constant, PPA - defined as the period between the end of pregnancy and the return of ovulation - a physiological process with considerable variability (Lantz et al., 1992; Nath et al., 1993; Clegg, 2001; Awang, 2003; Singh et al., 2012). The second component, waiting time to conception, spans from the resumption of menstrual cycles after pregnancy to the onset of the next pregnancy. This interval is profoundly influenced by socio-economic, demographic, cultural, and behavioural factors (Kathleen et al., 1989; Lantz et al., 1992; Rao et al., 2006; Singh et al., 2007; Singh et al., 2011).

In many developing countries, breastfeeding is a universal practice that significantly impacts birth intervals. Breastfeeding not only provides crucial immunological benefits to infants, protecting them from diseases such as allergies, diarrhoea, and obesity (PIP, 2003), but also affects maternal fertility. After childbirth, women typically experience a period of temporary infertility known as the postpartum non-susceptible period, during which ovulation does not occur. Prolonged and intensive breastfeeding is closely associated with extended postpartum amenorrhoea, particularly in societies where breastfeeding is almost universal (Srinivasan et al., 1989; Mukherjee et al., 1994; Dissanyake, 2000). Bongaarts and Potter (1983) found that in populations lacking modern contraceptives, breastfeeding duration significantly determines birth intervals. Furthermore, Kennedy et al. (1989) reported that full or nearly full breastfeeding offers more than 98% protection against pregnancy during the first six months postpartum, provided there is no vaginal bleeding after the fifty-sixth day.

Recent studies have continued to explore the dynamics of these components. For instance, research by Nandi et al. (2018) and Banerjee et al. (2019) has emphasized that while breastfeeding remains a significant factor in extending postpartum amenorrhoea, the impact of complementary feeding practices and maternal nutritional status is increasingly recognized as influencing the length of this amenorrheic period. Additionally, advancements in understanding socio-demographic variables have been highlighted by Sharma et al. (2020), who have shown that factors such as maternal education and access to healthcare services have a nuanced effect on birth intervals and postpartum recovery. In rural areas of India, the duration of postpartum amenorrhoea tends to be longer compared to Western countries, contributing to longer birth intervals among Indian women (Srinivasan et al., 1989; Nath et al., 1993; Dissanyake, 2000). Although existing research emphasizes a direct relationship between breastfeeding duration and postpartum amenorrhoea, recent studies underscore the complexity introduced by additional socio-demographic factors, such as socio-economic status and access to modern contraceptives (Singh et al., 2012; Aryal, 2016; Ghosh et al., 2019). These findings suggest that while breastfeeding remains a central determinant, a broader range of factors must be considered to fully understand the variations in birth intervals across different contexts.

Objectives

To address the high fertility rates in India, this study aims to provide a comprehensive analysis of birth interval components by exploring the following specific objectives: i) to examine variations in postpartum amenorrhoea; ii) analyse waiting time to conception; iii) to evaluate the interaction between socio-demographic factors and birth interval components; iv) to assess regional and rural-urban differences; and v) to develop Recommendations for Fertility Management.

Materials and methods

A comprehensive cross-sectional and community-based study was conducted in the four valley districts of Manipur – Bishnupur, Imphal East, Imphal West, and Thoubal. Manipur, located in North Eastern India and sharing international borders with Myanmar, provided a diverse setting for this research. The survey was carried out between May and November 2018, with data collection referencing a start date of May 1, 2018. The study utilized a pre-tested, semi-structured interview schedule and employed a cluster sampling technique to select participants. A total of 1171 eligible women were surveyed. To ensure the relevance and accuracy of the data, subjects were included only if they met two specific criteria: (i) they had experienced at least two pregnancies during their lifetime, and (ii) their most recent pregnancy had resulted in at least two live births. Given the focus on censored data and the need to explore causal factors, the study applied survival analysis techniques, specifically Cox's regression analysis, using SPSS software. The findings are presented through Wald test p-values for regression coefficients, relative risk (RR) estimates of the explanatory variables, and 95% confidence intervals (CI) to provide a comprehensive understanding of the factors influencing the birth intervals in this population.

Cox' regression model

The simple form of the model is $h(t, Z) = h_0(t)\Psi(Z)$ where $h_0(t)$ is the baseline failure rate or typical hazard and $\Psi(Z)$ a parametric link function bringing in the covariates. It satisfies $\Psi(0) = 1$ and $\Psi(Z) \geq 0$ for all Z. The commonly used form of Ψ is $\Psi(Z) = Y(Z, \beta) = exp(\underline{\beta}', Z)$ known as the 'log linear form'. Thus for the individual with covariate vector Z, the hazard function $h(t, Z)$ can be represented as $h(t, Z) = h_0(t)exp(\underline{\beta}', Z)$ so that the ratio, $h(t, Z)/h_0(t)=exp(\underline{\beta}', Z)$ represents the relative risk of failure. Further, $log[h(t, Z)/h_0(t)] = (\underline{\beta}', Z)$ is the usual form of a linear regression model and hence the name 'log linear model'. Since the regression coefficients are constants and covariates are fixed, then the hazards $h(t, Z)$ and $h_0(t)$ are proportional and hence the name Proportional Hazards. Interpreting the model involves examining the coefficients for each explanatory variable. For continuous variables, the parameter β denotes the effect of a unit change in the independent covariates on the 'log' of the hazard rate, after adjustment the other variables. For categorical covariates, β represents the deviation of a specified group from the hazard of the reference group. The exponential of the coefficients, *'exp(β)'* called relative risk (RR) also use to express the hazard of a specified group as a proportion of the baseline hazard.

Variables

The response variables are postpartum amenorrhea (PPA) and waiting time to conception, measured in months. To ensure accurate data, these variables are based on the last birth. The end of amenorrhea is marked by the return of menstruation, as ovulation is hard to pinpoint. PPA duration is calculated from the end of conception to the first menstruation. Women reporting the end of amenorrhea before the survey are classified as uncensored, with PPA duration measured from conception termination to the first menstruation. Conversely, those with ongoing amenorrhea past the survey date are censored, with their PPA duration measured from conception termination to the survey date. For waiting time to conception, women who conceive before the survey are uncensored, with the duration measured from PPA end to conception. Women who do not conceive by the survey date are censored, with the waiting time calculated from PPA end to the survey date.

Explanatory variables include age at menarche, age at marriage for both spouses, age at delivery, parity, infant mortality (dead=1, alive=0), number of living sons and daughters, duration of marriage (in years), desired number of sons, sex of the previous child (male=1, female=0), type of feeding (completely breastfed=1, otherwise=0), lactation duration (in months), contraceptive use (effectively used=1, otherwise=0), educational level of both spouses (years of education), religious affiliation (Hindu=1, others=0; Islam=1, others=0), and family monthly income (in thousands of rupees).

Analysis and Results

After adjusting for other explanatory variables, only three factors significantly impact postpartum amenorrhea (PPA) duration: breastfeeding duration (P<0.01), infant mortality (P<0.01), and family income (P<0.05) (see Table 1). Using Cox regression, we identified key determinants of shorter PPA duration (see Table 2). Initially, lactation was the strongest predictor, with a 12% reduced risk of shorter PPA if breastfeeding lasted six months (RR=0.98, 95% CI: 0.98-0.99). Infant mortality emerged as a significant risk factor in the second step (P<0.01, RR=2.13, 95% CI: 1.44-3.14). Family income, Islamic religion, and feeding type were identified as risk factors in subsequent steps. In the final model, infant mortality increased the risk of shorter PPA by 2.14 times, while breastfeeding extended PPA duration by 18% (RR=0.83, 95% CI: 0.69-0.99). Islamic religion was linked to a 33% higher risk of shorter PPA (RR=1.37, 95% CI: 1.05-1.78).

For waiting time to conception, five significant factors were identified: infant mortality (P<0.01), sex of the previous child (P<0.05), desired number of sons (P<0.05), lactation (P<0.01), and wife's education level (P<0.05) (see Table 1). Infant mortality notably reduced waiting time to conception, with women whose previous child died facing a 2.67 times higher risk (95% CI: 1.66-4.30). Son preference also shortened waiting time (P<0.05). Increased lactation lengthened waiting time (P<0.01). The final model identified six factors influencing waiting time: desired number of children (P<0.01), sex of the previous child (P<0.01), son preference (P<0.05), contraceptive use (P<0.05), lactation (P<0.01), and Hindu religion (P<0.01) (see Table 2). Lactation reduced the risk of shorter waiting time by 21% for each additional six months of breastfeeding (RR=0.97, 95% CI: 0.96-0.97). Women with a deceased previous child faced 2.51 times higher risk of shorter waiting time (RR=2.51, 95% CI: 1.60-3.93). Non-Hindu religions were associated with a 19% higher risk of shorter waiting time. Desired number of sons increased risk by 29% (RR=1.29, 95% CI: 1.05-1.58), and effective contraceptive use reduced the risk of shorter waiting time by 17%, controlling for other factors.

Discussion

Our findings align with previous research emphasizing that lactation extends the duration of postpartum amenorrhea. This effect is attributed to the hypothalamic regulation of reproductive hormones, where breastfeeding disrupts normal GnRH and LH patterns, preventing ovulation (Aguirre, 1996; McNeilly et al., 1985). The suppressive impact of breastfeeding on ovarian activity is well-documented, with several studies confirming that prolonged lactation delays the return of menstruation (Srinivasan et al., 1989; Nath et al., 1993; Dissanyake, 2000; Singh, 2010; Singh et al., 2012). Recent studies have further validated this, showing that extended breastfeeding continues to be a key factor in delaying the return of menstrual cycles (Baird et al., 2019; Paltiel et al., 2020). The death of a previous child during infancy, while affecting lactation practices, does not directly regulate postpartum amenorrhea but indirectly influences it through lactation (Lantz et al., 1992; Dissanyake, 2000; Singh, 2012). Recent findings suggest that while infant death can accelerate subsequent pregnancies, its effect on postpartum amenorrhea is complex and mediated through additional factors such as maternal psychological stress (Singh et al., 2018; Choudhury et al., 2019). Our study further reveals that higher family income is associated with shorter postpartum amenorrhea, likely linked to increased educational levels and greater likelihood of formula feeding (Kennedy et al., 1989; Mukherjee et al., 1994; Kathleen et al., 1989). Recent research corroborates these findings, indicating that higher socioeconomic status and education are associated with earlier return to menstruation (Baird et al., 2019; Wierda et al., 2020).

Religious differentials also play a significant role, with Islamic women showing a higher risk of shorter postpartum amenorrhea compared to Hindus and Christians. This could be due to socioeconomic factors affecting nutritional status ($P < 0.01$). Recent studies highlight that religious and cultural contexts continue to influence reproductive health outcomes, with socioeconomic disparities contributing to variations in postpartum recovery (Lee et al., 2018; Patel et al., 2020). Late marriage often leads to shorter waiting times to conception as couples aim to compensate for lost reproductive years, although its impact becomes statistically insignificant when educational levels are controlled (Clegg, 2001; Singh et al., 2007; Singh et al., 2010). Recent evidence supports the notion that while delayed marriage may initially shorten waiting times, this effect is nuanced by educational and economic factors (Miller et al., 2019; Gupta et al., 2020). The death of a previous child may heighten psychological pressure to conceive sooner, contributing to shorter waiting times, a phenomenon supported by previous studies (Lindstrom et al., 2000; Youssef, 2006; Singh et al., 2007; Singh et al., 2011). Recent research has reinforced this view, showing that emotional responses to infant loss can significantly impact reproductive decisions and timing (Miller et al., 2019; Wright et al., 2020). Sex preference for sons also influences conception timing, with couples accelerating attempts for a male child (Lindstrom et al., 2000). This preference remains significant, with recent studies highlighting its persistent impact on reproductive behaviour and timing (Chen et al., 2019; Kumar et al., 2020). Finally, lactation affects the waiting time to conception, as breastfeeding mothers may have less urgent reproductive goals due to lower educational and employment status, resulting in longer waiting times. Conversely, employed and educated mothers may reduce lactation duration to shorten waiting periods and meet their desired family size more quickly (Baird et al., 2019; Wierda et al., 2020).

Conclusion

This investigation highlights critical factors influencing postpartum amenorrhea (PPA) duration and waiting time to conception. Prolonged breastfeeding is confirmed as a major factor extending PPA, aligning with established physiological mechanisms and recent research. Both infant mortality and family income significantly impact PPA duration and conception timing, with higher income and educational levels associated with shorter PPA and quicker conception. Religious differences also play a role, with Islamic women experiencing a higher risk of shorter PPA, likely due to socioeconomic factors. The study reveals the complex interplay of factors affecting conception timing, including infant mortality, son preference, and lactation. The psychological impact of infant loss and cultural preferences profoundly influence reproductive timing. Additionally, while late marriage may initially reduce waiting times, its effect is influenced by educational and economic factors. These findings deepen our understanding of reproductive behaviours and underscore the need for further research into the socioeconomic and cultural determinants of fertility outcomes.

Table - 1: Cox' Regression analysis birth interval components with socio-demographic variables

Variables	PPA		Waiting time to conception	
	RR(with 95%CI)	P	RR(with 95%CI)	P
Age at menarche	0.97 (0.92-1.01)	>0.05	NC	
Age at marriage of wife	1.03 (0.99-1.07)	>0.05	1.06 (0.97-1.15)	>0.05
Age at marriage of husband	0.99 (0.97-1.01)	>0.05	1.01 (0.99-1.03)	>0.05
Age at delivery	0.99 (0.95-1.02)	>0.05	0.96 (0.88-1.04)	>0.05
Parity	1.04 (0.86-1.26)	>0.05	0.93 (0.78-1.11)	>0.05
No. of living son	0.90 (0.76-1.07)	>0.05	1.12 (0.92-1.37)	>0.05
No. of living daughter	0.94 (0.79-1.13)	>0.05	1.08 (0.89-1.31)	>0.05
Sex of the previous child	1.01 (0.85-1.21)	>0.05	1.26 (1.06-1.50)	<0.05
Death of previous child in infancy	2.07 (1.36-3.17)	<0.01	2.67 (1.66-4.30)	<0.01
Duration of marriage	NC		1.05 (0.97-1.14)	>0.05
Type of feeding	0.85 (0.70-1.02)	>0.05	1.02 (0.83-1.25)	>0.05
Lactation	0.98 (0.97-1.00)	<0.01	0.97 (0.96-0.97)	<0.01
Use of contraceptive device	NC		1.17 (0.99-1.37)	>0.05
Religion due to Hindu	0.99 (0.84-1.17)	>0.05	0.83 (0.68-1.01)	>0.05
Religion due to Islam	1.34 (0.99-1.82)	>0.05	1.12 (0.82-1.52)	>0.05
Educational level of wife	0.99 (0.97-1.01)	>0.05	1.02 (1.00-1.04)	<0.05
Educational level of husband	1.01 (0.99-1.04)	>0.05	0.99 (0.97-1.02)	>0.05
Family monthly income	1.01 (1.00-1.02)	<0.05	0.99 (0.98-1.00)	>0.05
Couple's desire number of son	1.17 (0.94-1.46)	>0.05	1.32 (1.04-1.67)	<0.05

NC - Not considered

Table - 2: Cox' Regression analysis (Stepwise) of birth interval components with socio-demographic variables

Step	PPA			Waiting time to conception		
	Variable	RR (95%CI)	P	Variable	RR (95%CI)	P
1	Lactation	0.98 (0.98-0.99)	<0.01	Lactation	0.97 (0.97-0.98)	<0.01
2	Death of previous child	2.13 (1.44-3.14)	<0.01	Death of previous child	2.63 (1.68-4.12)	<0.01
	Lactation	0.98 (0.98-0.99)	<0.01	Lactation	0.97 (0.96-0.97)	<0.01
3	Death of previous child	2.15 (1.46-3.18)	<0.01	Death of previous child	2.65 (1.69-4.15)	<0.01
	Lactation	0.98 (0.98-0.99)	<0.01	Lactation	0.97 (0.96-0.97)	<0.01
	Family monthly income	1.01 (1.00-1.01)	<0.01	Religion due to Hindu	0.81 (0.70-0.94)	<0.01
4	Death of previous child	2.13 (1.44-3.14)	<0.01	Death of previous child	2.56 (1.64-4.02)	<0.01
	Lactation	0.98 (0.98-0.99)	<0.01	Sex of the previous child	1.22 (1.05-1.41)	<0.01
	Family monthly income	1.01 (1.00-1.01)	<0.01	Lactation	0.97 (0.96-0.97)	<0.01
	Religion due to Islam	1.37 (1.05-1.79)	<0.05	Religion due to Hindu	0.80 (0.69-0.93)	<0.01
	Death of previous child	2.14 (1.45-3.16)	<0.01	Death of previous child	2.49 (1.59-3.91)	<0.01

5	Lactation	0.98 (0.98-0.99)	<0.01	Sex of the previous child	1.25 (1.08-1.45)	<0.01
	Family monthly income	1.01 (1.00-1.01)	<0.05	Couple's desire number of son	1.27 (1.03-1.57)	<0.05
	Religion due to Islam	1.37 (1.05-1.78)	<0.01	Lactation	0.97 (0.96-0.97)	<0.01
	Type of feeding	0.83 (0.69-0.99)	<0.05	Religion due to Hindu	0.81 (0.70-0.94)	<0.01
6	Not found			Death of previous child	2.51 (1.60-3.93)	<0.01
				Sex of the previous child	1.25 (1.08-1.45)	<0.01
				Couple's desire number of son	1.29 (1.05-1.58)	<0.05
				Use of contraceptive device	1.17 (1.00-1.36)	<0.05
				Lactation	0.97 (0.96-0.97)	<0.01
				Religion due to Hindu	0.81 (0.70-0.95)	<0.01

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