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Determinants of Postpartum Amenorrhoea in Rural Manipur Valley: A Cox Proportional Hazards Analysis

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Abstract

Postpartum amenorrhoea (PPA), defined as the interval between childbirth and the return of menstruation, is a key determinant of fertility and birth spacing, particularly in populations with limited access to modern contraceptive methods. This study examines the duration and determinants of PPA among currently married women in tribal-dominated rural areas of the Manipur Valley. Drawing upon the theoretical framework of Bongaarts and Potter, the study adopts a multivariate approach to assess the combined influence of biological, behavioural, and socio-economic factors on postpartum fertility regulation. A community-based cross-sectional design was employed, covering 779 women surveyed between January and July 2021 using cluster sampling techniques. Data were collected through structured interviews capturing reproductive history, breastfeeding practices, and socio-cultural characteristics. The Cox Proportional Hazards Model was applied to estimate the adjusted effects of explanatory variables on the timing of menstruation resumption. The findings reveal that behavioural factors, particularly lactation, play a dominant role in prolonging PPA. Duration of breastfeeding showed a strong and statistically significant negative association with the hazard of menstruation resumption ($p<0.001$), confirming its critical role in extending postpartum infecundability. Child survival status emerged as another significant determinant, with women experiencing infant loss showing more than twice the risk of early return of menses ($p<0.01$). Socio-economic factors such as family income were positively associated with earlier resumption of menstruation ($p<0.05$), while type of feeding and tribal affiliation showed moderate effects. In contrast, biological variables including age at menarche, age at delivery, and parity were not statistically significant after adjustment ($p>0.05$). Stepwise regression further identified lactation, infant mortality, income, cultural affiliation, and feeding practices as key predictors. The study concludes that PPA is shaped by a complex interplay of behavioural and socio-cultural factors, with breastfeeding and child survival exerting the most substantial influence. These findings highlight the importance of promoting optimal breastfeeding practices and integrating socio-cultural considerations into postpartum family planning programs.

Keywords: *Postpartum amenorrhoea, Breastfeeding, Fertility, Cox Proportional Hazards Model, Manipur*

Introduction

Postpartum amenorrhoea (PPA), defined as the interval between childbirth and the resumption of menstruation, is a crucial determinant of fertility and birth spacing, particularly in populations with limited use of modern contraception. It represents a natural phase of temporary infecundability that plays a significant role in regulating population growth and reproductive behaviour. The seminal work of John Bongaarts and Robert G. Potter (1983) established PPA as one of the key proximate determinants of fertility, demonstrating its direct influence on birth intervals and total fertility rates. Earlier, Aryal (2001, 2006) conceptualised

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PPA as a period of post-pregnancy infecundability following live births, stillbirths, or abortions, highlighting its demographic significance in natural fertility populations. In traditional societies, where prolonged breastfeeding is common, PPA serves as an effective biological mechanism for spacing births. Despite its importance, early research largely focused on isolated determinants, whereas more recent pre-2021 studies emphasize the need for integrated, multivariate approaches to capture the combined effects of biological, behavioural, and socio-cultural factors influencing PPA duration.

Among the various determinants, lactation has been consistently identified as the most influential factor affecting the length of PPA. Studies such as those by Aguirre (1996) demonstrated that increased frequency and duration of breastfeeding significantly delay the return of menstruation, thereby extending the amenorrhoeic period. This relationship is supported by physiological mechanisms whereby sustained suckling suppresses ovulation through hormonal pathways. However, PPA is not solely governed by biological processes; it is also shaped by a range of socio-demographic and cultural factors. Research by Karim and Hajian (2002), as well as Singh et al. (2012), highlighted the influence of maternal age, parity, and child survival on the duration of amenorrhoea. In particular, infant mortality has been shown to shorten PPA due to the early cessation of breastfeeding. These findings underscore the complex interaction between biological and socio-cultural factors. In regions such as Manipur, where traditional breastfeeding practices coexist with evolving socio-economic conditions, understanding these interactions becomes especially important. Therefore, the application of advanced statistical techniques such as the Cox Proportional Hazards Model enables a more precise estimation of the independent effects of multiple determinants, providing deeper insights into postpartum fertility behaviour.

Literature Review

Postpartum amenorrhoea (PPA), the temporary cessation of menstruation following childbirth, has long been recognized as a critical determinant of fertility and birth spacing. Early demographic insights can be traced to Corrado Gini (1920s), whose work on population dynamics laid the groundwork for studying birth intervals. The theoretical framework was later strengthened by Kingsley Davis and Judith Blake (1956), who identified proximate determinants linking social factors to fertility outcomes. This framework was refined by Louis Henry (1961, 1979), who emphasized postpartum infecundability as a key mechanism affecting fertility variation. Building on this, John Bongaarts (1978, 1983) developed a comprehensive model identifying postpartum amenorrhoea as one of the principal proximate determinants of fertility, highlighting the central role of breastfeeding in delaying ovulation. Subsequent empirical studies, such as those by Aguirre (1996) and John Cleland (1987), demonstrated that both the duration and intensity of breastfeeding significantly prolong amenorrhoea. Physiological research by Alan S. McNeilly (1994) further clarified the hormonal mechanisms, showing that sustained suckling elevates prolactin levels and suppresses ovulation. Later studies, including Mary Ann Labbok (2001) and Peter T. Ellison (2003), reinforced the view that lactation is both a biological and culturally mediated process influencing fertility. Collectively, these studies establish breastfeeding as the most powerful determinant of PPA, operating through both hormonal pathways and behavioural practices.

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Beyond lactation, a broad range of socio-economic, demographic, and cultural factors have been identified as influencing the duration of PPA. Studies by Karim and Hajian (2002) highlighted the roles of maternal age, parity, and nutritional status, while Singh et al. (2012) emphasized the critical impact of child survival, noting that infant mortality often shortens PPA due to early cessation of breastfeeding. Research using large-scale surveys, such as that by Peng (1998), demonstrated the influence of socio-economic conditions and maternal nutrition. Earlier contributions by William Brass (1978) and James Trussell (1986) underscored the importance of behavioural and demographic factors in shaping fertility patterns. The framework of Samuel Mosley and Lincoln Chen (1984) further linked maternal and child health behaviours with reproductive outcomes. Additional studies by Thomas W. Pullum (2004), John B. Casterline (2001), and Sarah L. Huffman (1991) emphasized the influence of socio-economic status, maternal workload, and cultural norms on breastfeeding practices and PPA duration. These studies collectively reveal that while biological mechanisms form the foundation of postpartum amenorrhoea, its actual duration is shaped by a complex interaction of behavioural practices, socio-economic conditions, and cultural contexts. Consequently, multivariate and interdisciplinary approaches have become essential for disentangling these interrelated influences and for developing a comprehensive understanding of postpartum fertility dynamics.

Objectives

The primary objective of the present study is to examine the duration and determinants of postpartum amenorrhoea (PPA) among currently married women in tribal-dominated rural areas of the Manipur Valley. Specifically, the study aims to analyse the time interval between childbirth and the resumption of menstruation as an important indicator of postpartum fertility regulation and birth spacing. In doing so, the study seeks to identify the independent effects of a range of biological, demographic, behavioural, and socio-economic factors influencing PPA. A key objective is to assess the role of breastfeeding practices, particularly the duration and type of lactation, in prolonging amenorrhoea, in line with the theoretical framework proposed by John Bongaarts and Robert G. Potter. Additionally, the study aims to evaluate the impact of child survival, parity, maternal age, and family composition on the timing of menstrual resumption. Another important objective is to examine how socio-economic factors such as education, income, and cultural affiliation shape postpartum reproductive behaviour. By applying the Cox Proportional Hazards Model, the study further intends to estimate the adjusted effects of these variables and identify the most significant predictors of PPA. Thus, the present research aims to provide a comprehensive understanding of the interplay between biological and socio-cultural determinants of postpartum amenorrhoea in a region characterized by diverse traditions and evolving socio-economic conditions.

Materials and Methods

A community-based cross-sectional study was conducted in tribal-dominated rural areas of the Manipur Valley to investigate the duration and determinants of postpartum amenorrhoea (PPA). The study encompassed rural regions of four valley districts viz., Imphal

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East, Imphal West, Bishnupur, and Thoubal where distinct socio-cultural practices and limited access to healthcare services may influence postpartum reproductive patterns. The study population included currently married women of reproductive age who had experienced at least one live birth. Using December 1, 2020 as the reference date, a total sample of 779 eligible women was surveyed during January to July 2021. In the absence of a formal sampling frame, a cluster sampling technique was employed, with villages serving as clusters. These clusters were selected through simple random sampling without replacement, and the sample was proportionally distributed across districts and their respective sub-divisions. Data were collected through face-to-face interviews using a pre-tested semi-structured interview schedule covering socio-demographic characteristics, reproductive history, breastfeeding behaviour, health-seeking practices, and cultural norms. Interviews were conducted in local languages to ensure better comprehension and accurate responses. Eligible respondents were identified within selected clusters, and informed consent was obtained prior to participation, ensuring confidentiality and voluntariness. Rapport was established with participants to enhance data reliability. Rural areas were defined according to official classifications, excluding urban administrative units, thereby ensuring consistency with state statistical records.

Model and Variables

The determinants of postpartum amenorrhoea (PPA) were analysed using the Cox Proportional Hazards Model, where the hazard function is expressed as $h(t,Z) = h_0(t)\exp(\beta' Z)$. Here, $h_0(t)$ denotes the baseline hazard, and $\exp(\beta' Z)$ represents the effect of covariates. The model assumes proportional hazards, implying that covariates multiplicatively shift the baseline hazard over time. Regression coefficients (β) indicate the effect of explanatory variables on the log hazard; their exponentials provide hazard ratios, measuring relative risk. Continuous variables reflect the change in hazard per unit increase, while categorical variables indicate deviations from a reference category. The response variable is the duration of PPA, defined as the time (in months) from childbirth to the return of menstruation. Explanatory variables include biological and demographic factors (age at menarche, age at delivery, parity), behavioural factors (duration and type of breastfeeding), and socio-economic characteristics (education, religion, and family income). Additional variables such as child survival status, sex composition, and desired number of children capture family dynamics and reproductive preferences. Together, these variables comprehensively explain variations in PPA duration.

Analysis and Results

The adjusted Cox Proportional Hazards Model was applied to evaluate the independent effects of socio-demographic, biological, behavioural, and cultural factors on the duration of postpartum amenorrhoea (PPA). The model estimates relative risks (RR), where RR < 1 indicates prolonged amenorrhoea and RR > 1 indicates earlier resumption of menstruation. After adjustment, biological variables such as age at menarche, age at marriage, age at delivery, and parity were not statistically significant ($p > 0.05$), although

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weak directional trends were observed. Age at menarche and age at delivery showed slight inverse associations with the hazard, suggesting marginally longer PPA, while parity exhibited a weak positive relationship, indicating shorter PPA when behavioural factors were controlled. These results imply that biological characteristics alone do not significantly determine PPA duration once socio-economic and behavioural variables are taken into account. Child survival status remained a strong and significant predictor of PPA. Women who experienced the death of their previous child had more than twice the risk of early menstruation resumption (RR ≈ 2.1, $p = 0.001$), indicating significantly shorter PPA duration (Table 1). This reflects both physiological mechanisms, such as cessation of breastfeeding and reduced prolactin levels, and behavioural responses related to replacement fertility. In contrast, variables related to gender composition, including number of sons, daughters, and sex of the previous child were not statistically significant ($p > 0.05$), suggesting their effects are indirect. Similarly, fertility preferences for sons or daughters did not show independent significance, although minor tendencies were observed. These findings indicate that socio-cultural preferences influence PPA primarily through behavioural pathways rather than direct biological effects.

Behavioural factors, particularly lactation, exerted the most significant influence on PPA. Duration of breastfeeding showed a strong negative association with the hazard of menstruation resumption (RR ≈ 0.987, $p < 0.001$), confirming its critical role in prolonging postpartum infertility and supporting the Lactational Amenorrhea Hypothesis. Type of feeding also showed a modest protective effect (RR ≈ 0.842, $p = 0.084$), indicating longer PPA among exclusively breastfeeding mothers, though the effect was marginally significant. Among socio-economic variables, family income had a small but significant positive effect (RR ≈ 1.004, $p = 0.031$), suggesting shorter PPA among higher-income households. Education of both husband and wife was not significant ($p > 0.05$), while tribal affiliation showed a near-significant positive association (RR ≈ 1.354, $p = 0.057$), indicating shorter PPA. The stepwise analysis further identified a concise set of robust predictors. Lactation remained highly significant across all models ($p < 0.001$), followed by death of the previous child ($p < 0.001$), family income ($p = 0.005$), tribal affiliation ($p = 0.020$–0.021), and type of feeding ($p = 0.040$) manifested in Table 2. The consistency of these variables across model steps highlights their independent contributions. Lactation emerged as the dominant protective factor, while infant mortality significantly accelerated the return of menstruation. Income and cultural affiliation acted as contextual modifiers, and feeding practices contributed additional explanatory power. Overall, the results demonstrate that PPA is governed by a complex interaction of biological, behavioural, and socio-economic factors, with breastfeeding and infant survival playing central roles.

Discussion

The findings of the present study strongly reinforce the theoretical and empirical understanding of postpartum amenorrhoea (PPA) as a multifactorial phenomenon, while at the same time highlighting the predominance of behavioural determinants, particularly lactation. The highly significant inverse association between duration of breastfeeding and the hazard of menstruation resumption confirms the central role of lactation in prolonging

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postpartum infecundability. This result is in close agreement with the classical framework proposed by John Bongaarts and Robert G. Potter (1983), who identified postpartum infecundability as a key proximate determinant of fertility. It also corroborates the findings of Aguirre (1996), who demonstrated through hazard models that increased frequency and duration of suckling significantly delay the return of menses. The physiological basis of this relationship, as explained by McNeilly (1994), lies in the suppression of ovulation through prolactin-mediated hormonal pathways. The present study further supports the view of Labbok (2001) and Ellison (2003) that breastfeeding is both a biological and culturally regulated behaviour, explaining why its impact remains robust even after controlling for socio-economic and demographic variables. The marginal effect of type of feeding also aligns with earlier observations that exclusive breastfeeding enhances the duration of amenorrhoea compared to mixed feeding practices.

Another important finding of the study is the significant effect of child survival on PPA duration. Women who experienced the death of their previous child had more than twice the risk of early return of menstruation, indicating a substantially shorter amenorrhoeic period. This observation is consistent with the findings of Singh et al. (2012), who emphasized that infant mortality leads to early cessation of breastfeeding, thereby shortening PPA. It also supports the broader behavioural framework suggested by Mosley and Chen (1984), where child survival and maternal health behaviours are closely interlinked. In contrast, biological variables such as age at menarche, age at delivery, and parity were not statistically significant, suggesting that their effects are largely mediated through behavioural and socio-economic pathways. This finding aligns with the observations of Karim and Hajian (2002) and Casterline (2001), who noted that once breastfeeding and socio-economic factors are controlled, the independent influence of biological characteristics tends to diminish. The positive and significant association of family income with earlier resumption of menstruation indicates that higher socio-economic status may be linked to reduced breastfeeding intensity or early supplementation, a pattern also observed in studies by Huffman (1991) and Pullum (2004). Similarly, the near-significant effect of tribal affiliation suggests the influence of cultural practices on breastfeeding behaviour and postpartum fertility. Overall, the study underscores that while biological factors provide the underlying framework, it is the interaction of behavioural practices, socio-economic conditions, and cultural contexts that ultimately shapes the duration of postpartum amenorrhoea, thereby reaffirming the importance of multivariate analytical approaches in reproductive health research.

Conclusion

The present study provides a comprehensive understanding of postpartum amenorrhoea (PPA) as a multifaceted determinant of fertility and birth spacing in the tribal-dominated rural context of Manipur Valley. By applying the Cox Proportional Hazards Model, the analysis demonstrates that behavioural and socio-cultural factors exert a stronger influence on the duration of PPA than purely biological characteristics. Among all determinants, lactation emerges as the most significant factor, confirming its critical role in prolonging postpartum infecundability through sustained breastfeeding practices. The strong and statistically significant association between breastfeeding duration and delayed

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resumption of menstruation reinforces the well-established theoretical framework of proximate determinants of fertility. Additionally, child survival status is identified as a crucial predictor, with infant mortality significantly shortening the duration of PPA due to early cessation of breastfeeding and behavioural responses related to replacement fertility. Socio-economic variables, particularly family income, also influence PPA by shaping maternal behaviour and feeding practices, while cultural factors such as tribal affiliation reflect the importance of traditional norms and practices. In contrast, biological variables such as age at menarche, age at delivery, and parity do not exhibit significant independent effects when behavioural and socio-economic factors are controlled. Overall, the findings underscore that PPA is not merely a biological phenomenon but a socially embedded process influenced by cultural practices, economic conditions, and maternal behaviour. The study highlights the need for integrated maternal and child health interventions that promote optimal breastfeeding, improve child survival, and consider socio-cultural contexts to enhance postpartum fertility regulation and reproductive health outcomes.

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Table 1: Cox's Regression Analysis of PPA in Adjusted Model

Variable	β	**S. E**	**P**	RR	**95%CI for** RR
Age at menarche	-0.036	0.025	0.168	0.965	0.920–1.013
Age at marriage of husband	-0.012	0.011	0.273	0.988	0.969–1.009
Age at marriage of wife	0.031	0.022	0.171	1.032	0.989–1.078
Age at delivery	-0.014	0.019	0.510	0.986	0.951–1.023
Parity	0.043	0.097	0.678	1.044	0.861–1.262
Death of previous child in infancy	0.744	0.219	0.001	2.105	1.379–3.214
Number of living son	-0.111	0.091	0.224	0.895	0.751–1.065
Number of living daughter	-0.060	0.092	0.528	0.942	0.787–1.126

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Sex of the previous child	0.015	0.091	0.887	1.015	0.850–1.210
Desire No. of son by husband	0.009	0.116	0.952	1.009	0.805–1.265
Desire No. of son by wife	0.164	0.113	0.155	1.179	0.945–1.468
Desire No. of daughter by husband	-0.035	0.088	0.712	0.966	0.814–1.146
Desire No. of daughter by wife	0.018	0.081	0.842	1.018	0.872–1.191
Lactation	-0.013	0.003	0.000	0.987	0.981–0.993
Type of feeding	-0.172	0.097	0.084	0.842	0.696–1.018
Educational level of husband	0.014	0.013	0.298	1.014	0.990–1.039
Educational level of wife	-0.009	0.012	0.492	0.991	0.970–1.013
Family monthly income	0.004	0.001	0.031	1.004	1.001–1.007
Religion due to Hindu	-0.015	0.086	0.880	0.985	0.834–1.164
Religion due to tribals	0.303	0.157	0.057	1.354	0.997–1.835

Table 2: Cox's Regression Analysis of PPA in Stepwise Model

Step	**Variable**	β	**S. E**	**P**	RR	**95%CI for** RR
1	Lactation	-0.013	0.003	0.000	0.987	0.981–0.993
2	Death of previous child in infancy	0.762	0.203	0.000	2.142	1.456–3.168
	Lactation	-0.013	0.003	0.000	0.987	0.982–0.993
3	Death of previous child in infancy	0.775	0.204	0.000	2.171	1.470–3.205
	Lactation	-0.013	0.003	0.000	0.987	0.981–0.993
	Family income	0.004	0.001	0.005	1.004	1.001–1.007
4	Death of previous child in infancy	0.764	0.204	0.000	2.147	1.454–3.182
	Lactation	-0.012	0.003	0.000	0.988	0.982–0.994
	Family income	0.004	0.001	0.005	1.004	1.001–1.007
	Religion due to tribals	0.322	0.137	0.020	1.380	1.057–1.802
5	Death of previous child in infancy	0.768	0.204	0.000	2.156	1.462–3.183
	Lactation	-0.012	0.003	0.000	0.988	0.982–0.994
	Type of feeding	-0.186	0.094	0.040	0.831	0.692–0.998
	Family income	0.003	0.001	0.010	1.003	1.001–1.006
	Religion due to tribals	0.317	0.137	0.021	1.373	1.052–1.786