



Original Research Article

DETERMINANTS OF POSTPARTUM ANEMIA AMONG POSTNATAL MOTHERS IN URBAN PUDUCHERRY: A COMMUNITY-BASED STUDY

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ABSTRACT

Background: Postpartum anemia remains an under-recognized public health concern despite widespread antenatal screening and iron supplementation programs. Persistent anemia during the early postnatal period may impair maternal recovery and functional capacity, yet evidence on independent determinants in urban South Indian settings remains limited. **Objective:** To estimate the prevalence of postpartum anemia and identify independent determinants among postnatal mothers residing in urban Puducherry.

Materials and Methods: A community-based analytical cross-sectional study was conducted in the urban field practice area of an Urban Health and Training Centre in Puducherry, India. A total of 170 women who delivered at ≥ 37 weeks of gestation were assessed at 6–8 weeks postpartum. Hemoglobin concentration was measured using standardized laboratory methods. Postpartum anemia was defined as hemoglobin < 12 g/dL. Sociodemographic, obstetric, and intrapartum variables were collected using a pre-tested questionnaire. Bivariate associations were examined using the Chi-square test, and variables with $p < 0.05$ were entered into multivariate logistic regression. Adjusted odds ratios (AOR) with 95% confidence intervals (CI) were reported.

Results: Postpartum anemia was identified in 42.0% of participants (95% CI: 34.5–49.5). Mild anemia accounted for 27.0%, and moderate anemia for 15.0%; no severe cases were observed. In bivariate analysis, nuclear family structure and household size < 5 members were significantly associated with anemia. After adjustment, nuclear family structure (AOR 2.09; 95% CI: 1.14–3.87) and smaller household size (AOR 2.56; 95% CI: 1.24–5.27) remained independent determinants. Obstetric and intrapartum variables were not significantly associated.

Conclusion: More than two-fifths of postnatal mothers in urban Puducherry remained anemic at 6–8 weeks postpartum. Household-level social determinants particularly nuclear family structure and smaller household size were independently associated with anemia. Strengthening postpartum screening and incorporating social vulnerability assessment into postnatal care may improve maternal recovery outcomes.

Keywords: Postpartum anemia; determinants; multivariate analysis; urban health; maternal health; Puducherry.

INTRODUCTION

Anemia remains one of the most pervasive nutritional and hematological disorders affecting women of reproductive age worldwide. Despite decades of public health interventions, the global burden of anemia continues to be disproportionately concentrated in low- and middle-income countries. Women in the reproductive age group are particularly vulnerable due to menstrual blood loss, repeated pregnancies, and increased nutritional demands. Although anemia during pregnancy has been extensively studied and integrated into antenatal screening programs, the postpartum period has received comparatively limited research attention, despite its physiological and clinical importance.^[1]

The postpartum phase represents a critical window for maternal recovery. Following childbirth, women experience substantial physiological adjustments, including plasma volume contraction, replenishment of iron stores, and restoration of erythropoietic balance. Blood loss during delivery, whether vaginal or operative, may further deplete hemoglobin levels. When iron supplementation is inadequate or dietary intake remains suboptimal, hemoglobin restoration may be incomplete, resulting in persistent postpartum anemia. The clinical implications extend beyond laboratory parameters; postpartum anemia has been associated with fatigue, impaired physical performance, decreased cognitive function, and increased risk of postpartum depressive symptoms. These sequelae can influence maternal caregiving capacity and early infant development.^[2]

Globally, estimates suggest that approximately one-third of women of reproductive age are anemic, with higher prevalence reported in South Asia and Sub-Saharan Africa. Studies from developing regions have documented postpartum anemia prevalence ranging between 30% and 60%, indicating that anemia frequently persists beyond pregnancy. In India, national surveys have consistently reported a high prevalence of anemia among women aged 15–49 years. While antenatal anemia has been prioritized in national health strategies, structured postpartum screening remains less consistently implemented. Consequently, women who enter the postpartum period with depleted iron reserves may remain undiagnosed and untreated.^[3]

The determinants of postpartum anemia are multifactorial. Biological contributors such as antenatal hemoglobin status, intrapartum blood loss, and birth spacing have been widely acknowledged. However, increasing attention is being directed toward social and household-level determinants. Family structure, socioeconomic position, dietary practices, and caregiving support may significantly influence maternal nutritional recovery during the postnatal period. In particular, the availability of familial assistance may determine a woman's ability to adhere to supplementation, maintain adequate dietary intake, and obtain rest during recovery. Such

contextual determinants are especially relevant in rapidly urbanizing regions where traditional support systems may be changing.^[4]

Within the Union Territory of Puducherry, data on anemia among non-pregnant women indicate a persistent burden; however, focused evidence on postpartum anemia in urban communities remains limited. The absence of region-specific determinant analyses restricts the ability of public health programs to identify high-risk subgroups and tailor interventions accordingly. Understanding independent predictors through multivariate modeling is essential to distinguish between biological and social influences and to inform targeted strategies within postnatal care services.^[5]

Given this background, the present study was undertaken to estimate the prevalence of postpartum anemia and identify independent determinants among postnatal mothers residing in an urban area of Puducherry using multivariate analysis. By elucidating the relative contribution of sociodemographic, obstetric, and household factors, this study seeks to strengthen the evidence base for integrated postpartum anemia prevention strategies.

MATERIALS AND METHODS

Study Design and Setting

A community-based analytical cross-sectional study was conducted in the urban field practice area attached to an Urban Health and Training Centre (UHTC) of a tertiary care teaching institution in Puducherry, India. The study setting comprised a defined urban population with established primary healthcare coverage and routine antenatal registration services.

Although the broader research framework included prospective follow-up from late pregnancy to the postnatal period, the present analysis focuses on determinants of postpartum anemia assessed at 6–8 weeks after delivery.

The study was carried out over a period of 18 months to ensure adequate recruitment, follow-up, and stabilization of seasonal influences on nutritional intake and health service utilization.

Study Population

The study population included postnatal mothers residing in the selected urban field practice area who had completed at least 37 weeks of gestation and were available for follow-up at 6–8 weeks postpartum.

Inclusion Criteria

- Women aged 18–45 years
- Residents of the defined urban area
- Delivered at ≥ 37 weeks of gestation
- Provided written informed consent
- Available for postnatal hemoglobin assessment

Exclusion Criteria

- Women with previously diagnosed hematological disorders (e.g., hemoglobinopathies)

- Women with chronic systemic illnesses known to influence hemoglobin levels
- Temporary residents not available for follow-up

Sample Size Estimation

The sample size was calculated using the standard formula for estimating prevalence in cross-sectional studies:

$$n = \frac{Z^2 \times p \times q}{d^2}$$

Where:

- n = required sample size
- Z = standard normal deviate at 95% confidence level (1.96)
- p = anticipated prevalence of postpartum anemia (47.3% or 0.473), based on prior regional evidence
- q = 1 - p (0.527)
- d = absolute precision (8% or 0.08)

Substituting the values:

$$n = \frac{(1.96)^2 \times 0.473 \times 0.527}{(0.08)^2}$$

$$n = \frac{3.8416 \times 0.249}{0.0064}$$

$$n \approx 149$$

After accounting for potential non-response and loss to follow-up, the final sample size was increased to 170 participants.

Sampling Technique

Eligible pregnant women registered at the Urban Health Training Centre were identified from antenatal registers. Consecutive sampling was adopted, and participants were enrolled during the late antenatal period. These women were followed up and reassessed at 6–8 weeks postpartum.

Data Collection Procedure

Data collection was conducted in two phases.

Phase I: Late Antenatal Assessment

Baseline demographic and obstetric information was collected using a pre-tested semi-structured questionnaire during late pregnancy (after 37 weeks gestation). Antenatal hemoglobin values were obtained from hospital laboratory records.

Phase II: Postnatal Assessment

Participants were visited at their residence between 6 and 8 weeks postpartum. This interval was selected because maternal hemodynamic changes stabilize during this period, allowing reliable hemoglobin assessment.^[6]

During the postnatal visit:

- Sociodemographic information was reconfirmed
- Household characteristics were documented
- Obstetric and intrapartum details were recorded
- Postnatal events including bleeding and iron supplementation were assessed
- Venous blood samples were collected for hemoglobin estimation

Measurement of Hemoglobin

Venous blood samples were collected under aseptic precautions by trained personnel. Hemoglobin concentration was measured using standardized automated hematology analyzers calibrated according to manufacturer specifications. Quality control procedures were adhered to throughout the study period to ensure analytical reliability.

Postpartum anemia was defined as hemoglobin concentration <12 g/dL at 6–8 weeks postpartum, in accordance with World Health Organization criteria for non-pregnant women.^[7]

Severity was categorized as:

- Mild: 11.0–11.9 g/dL
- Moderate: 8.0–10.9 g/dL
- Severe: <8.0 g/dL

Study Variables

Dependent Variable

- Postpartum anemia (Yes/No)

Independent Variables

- Age
- Educational status
- Socioeconomic status
- Type of family
- Total number of family members
- Age at menarche
- Parity
- Birth spacing
- Number of antenatal visits
- Mode of delivery
- Intrapartum blood loss
- Blood transfusion

Data Management and Statistical Analysis

Collected data were reviewed for completeness and coded prior to entry. Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were summarized as mean ± standard deviation (SD). Categorical variables were expressed as frequencies and percentages.

The prevalence of postpartum anemia was calculated as the proportion of women with hemoglobin <12 g/dL at follow-up.

Bivariate associations between independent variables and postpartum anemia were assessed using the Chi-square test. Variables demonstrating statistical significance (p <0.05) were entered into multivariate logistic regression analysis to identify independent determinants. Adjusted odds ratios (AOR) with 95% confidence intervals (CI) were computed.

Model adequacy was evaluated using standard logistic regression diagnostics.^[8]

All statistical tests were two-tailed, and a p-value <0.05 was considered statistically significant.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of the affiliated medical institution. Written informed consent was obtained from all participants prior to enrollment.

Confidentiality was maintained through anonymized data coding. Women identified with anemia were counseled and referred for appropriate management as per national guidelines.^[9]

The study adhered to ethical principles outlined in the Declaration of Helsinki for research involving human participants.^[10]

RESULTS

Participant Characteristics

A total of 170 postnatal mothers completed follow-up at 6–8 weeks postpartum and were included in the

final analysis. The majority of participants were within the 24–29-year age group (81; 47.7%). Nuclear family structure was observed in 82 women (48.2%), while 88 (51.8%) belonged to joint or extended families. Most households comprised fewer than five members (123; 72.4%), with the remaining 47 (27.6%) having five or more members.

Educational attainment was predominantly at secondary level or above. Nearly all women had received routine antenatal care and delivered in institutional settings.

Detailed baseline characteristics are presented in Table 1.

Table 1: Sociodemographic Characteristics of Study Participants (N = 170)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	<24	52	30.6
	24–29	81	47.7
	≥30	37	21.8
Type of Family	Nuclear	82	48.2
	Joint/Extended	88	51.8
Family Size	<5 members	123	72.4
	≥5 members	47	27.6
Education	Up to High School	19	11.2

Prevalence and Severity of Postpartum Anemia

At 6–8 weeks postpartum, 71 women (42.0%) were found to have hemoglobin levels below 12 g/dL, while 99 (58.0%) had normal hemoglobin levels.

Among the anemic women, 46 (27.0%) had mild anemia and 25 (15.0%) had moderate anemia. No cases of severe anemia were recorded in the study population.

These findings indicate that although severe forms were absent, a substantial proportion of women continued to experience residual anemia during the early postpartum period.

The distribution of postpartum anemia and severity categories is shown in Table 2.

Table 2: Prevalence and Severity of Postpartum Anemia (N = 170)

A. Prevalence

Hemoglobin Status	Frequency (n)	Percentage (%)
Non-anemic (≥12 g/dL)	99	58.0
Anemic (<12 g/dL)	71	42.0

B. Severity Distribution

Severity Category	Frequency (n)	Percentage (%)
Mild (11–11.9 g/dL)	46	27.0
Moderate (8–10.9 g/dL)	25	15.0
Severe (<8 g/dL)	0	0

Bivariate Analysis of Sociodemographic Determinants

The association between sociodemographic characteristics and postpartum anemia was assessed using the Chi-square test.

Postpartum anemia was significantly more common among women residing in nuclear families (42; 51.2%) compared to those in joint families (29; 33.0%) ($\chi^2 = 5.69$, $p = 0.017$). Women from nuclear families had more than twice the odds of anemia (OR 2.09; 95% CI: 1.14–3.87).

Similarly, anemia was more prevalent among women from households with fewer than five members (59; 48.0%) compared to those from larger households (12; 25.5%) ($\chi^2 = 6.663$, $p = 0.01$). The crude odds ratio indicated a 2.56-fold higher likelihood of anemia in smaller households (95% CI: 1.24–5.27). Age group, educational status, religion, and socioeconomic status were not significantly associated with postpartum anemia.

Detailed bivariate analysis is presented in Table 3.

Table 3: Bivariate Analysis of Sociodemographic Determinants of Postpartum Anemia

Variable	Category	Anemic n (%)	Non-Anemic n (%)	χ^2	p-value	Crude OR (95% CI)
Type of Family	Nuclear	42 (51.2)	40 (48.8)	5.69	0.017	2.09 (1.14–3.87)
	Joint/Extended	29 (33.0)	59 (67.0)			Reference
Family Size	<5 members	59 (48.0)	64 (52.0)	6.663	0.01	2.56 (1.24–5.27)
	≥5 members	12 (25.5)	35 (74.5)			Reference

Association with Obstetric and Intrapartum Factors

Obstetric variables including age at menarche ($p = 0.082$), parity ($p = 0.726$), birth spacing ($p = 0.961$), and number of antenatal visits ($p = 0.961$) were not significantly associated with postpartum anemia.

Intrapartum factors such as mode of delivery ($p = 0.535$), reported intrapartum blood loss ($p = 0.632$),

and receipt of blood transfusion ($p = 0.394$) also did not demonstrate statistically significant associations. These findings suggest that biological and delivery-related factors were not major contributors to persistent anemia at 6–8 weeks postpartum in this cohort.

The detailed analysis is shown in Table 4.

Table 4: Association Between Obstetric and Intrapartum Variables and Postpartum Anemia

Variable	Category (if applicable)	Crude OR (95% CI)	p-value
Age at menarche	≤13 vs >13 years	1.86 (0.92–3.77)	0.082
Parity	Primiparous vs Multiparous	1.12 (0.60–2.08)	0.726
Birth spacing	<2 years vs ≥2 years	1.03 (0.51–2.09)	0.961
Antenatal visits	<4 vs ≥4 visits	1.03 (0.26–4.79)	0.961
Mode of delivery	Cesarean vs Vaginal	1.24 (0.67–2.29)	0.535
Intrapartum blood loss	Yes vs No	0.27 (0.03–2.33)	0.632
Blood transfusion	Yes vs No	—	0.394

Multivariate Logistic Regression Analysis

Variables that were statistically significant in bivariate analysis (type of family and family size) were included in a multivariate logistic regression model.

After adjustment, both variables remained independently associated with postpartum anemia.

Women residing in nuclear families had 2.09 times higher odds of postpartum anemia (AOR 2.09; 95% CI: 1.14–3.87; $p < 0.05$). Similarly, women from

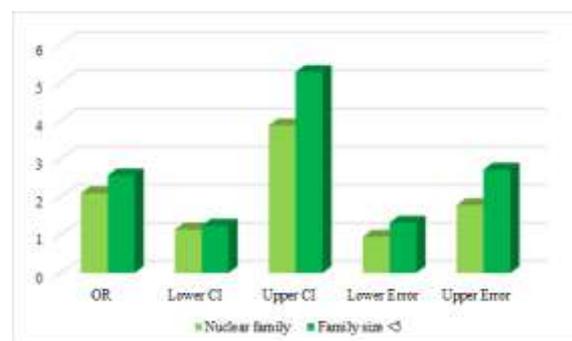
households with fewer than five members had 2.56 times higher odds of anemia (AOR 2.56; 95% CI: 1.24–5.27; $p < 0.05$).

The adjusted model confirms that household structure and size are independent predictors of postpartum anemia in this urban population.

The multivariate regression results are presented in Table 5, and the magnitude of associations is illustrated in Figure 1.

Table 5: Multivariate Logistic Regression Model for Determinants of Postpartum Anemia

Variable	Adjusted OR	95% CI	p-value
Nuclear family (vs Joint)	2.09	1.14–3.87	<0.05
Family size <5 members (vs ≥5)	2.56	1.24–5.27	<0.05

**Figure 1: Independent Determinants of Postpartum Anemia****DISCUSSION**

The present study identified postpartum anemia in 42% of postnatal mothers at 6–8 weeks following delivery. Although severe anemia was not observed,

the predominance of mild and moderate anemia indicates that hematological recovery remains incomplete for a substantial proportion of women during the early postnatal period. These findings demonstrate that postpartum anemia continues to be a clinically relevant concern even in urban settings characterized by high institutional delivery coverage. The prevalence observed in this study aligns with reports from other low- and middle-income countries, where postpartum anemia has ranged between 30% and 60%.^[11] Similar magnitudes have been documented in South Asian and sub-Saharan African settings, suggesting that persistence of anemia beyond childbirth remains common despite antenatal screening initiatives. The relatively high prevalence observed in this urban population indicates that institutional delivery alone may not guarantee optimal hematological recovery during the postpartum phase.

A central finding of this study is the independent association between nuclear family structure and postpartum anemia. Women residing in nuclear households had more than twice the odds of anemia compared to those in joint or extended families. This observation highlights the potential influence of household-level social support mechanisms on maternal recovery. In extended family systems, caregiving responsibilities and domestic workload may be distributed among multiple members, thereby allowing postpartum women adequate rest and improved nutritional intake. In contrast, women in nuclear families may experience increased physical and caregiving demands, potentially limiting opportunities for recovery and dietary adequacy.^[12] These findings underscore the need to consider social determinants alongside biological factors in postpartum health assessments.

Similarly, smaller household size (<5 members) emerged as an independent predictor of postpartum anemia. This reinforces the hypothesis that reduced household support may adversely influence postpartum nutritional recovery. In urban contexts where nuclearization of families is increasingly common, traditional support structures that historically facilitated postpartum care may be diminished. The persistence of statistical significance after multivariate adjustment suggests that these associations are not explained by measured obstetric variables and likely reflect contextual social influences.

Interestingly, obstetric and intrapartum factors including parity, birth spacing, number of antenatal visits, mode of delivery, and reported intrapartum blood loss did not demonstrate statistically significant associations with postpartum anemia in this cohort. Previous literature has frequently identified antenatal anemia and excessive delivery-related blood loss as major contributors to postpartum hemoglobin decline.^[13] The absence of significant associations in the present study may reflect relatively standardized antenatal and intrapartum care in this urban setting. High rates of institutional delivery and effective management of obstetric complications may have mitigated the impact of delivery-related factors on long-term hemoglobin status.

The lack of association between intrapartum blood loss and postpartum anemia warrants careful interpretation. While biologically plausible, reliance on self-reported bleeding and absence of quantitative measurement may have introduced non-differential misclassification, potentially attenuating observed associations. Furthermore, prompt clinical management of hemorrhage in institutional settings may reduce sustained hematological impact.^[14]

The absence of severe anemia in this study population may indicate partial effectiveness of antenatal iron supplementation programs. However, the persistence of mild and moderate anemia suggests that continuation of iron-folic acid supplementation during the postnatal period may be inadequate.

National guidelines recommend ongoing supplementation after delivery, yet adherence may decline once pregnancy concludes.^[15] Strengthening postpartum counseling, emphasizing dietary iron intake, and ensuring structured follow-up at 6–8 weeks could enhance recovery.

Taken together, the findings of this study suggest that postpartum anemia in urban Puducherry is influenced more strongly by social and household determinants than by obstetric variables. This has important programmatic implications. Postnatal care strategies that focus exclusively on clinical risk factors may overlook women who are socially vulnerable. Incorporating simple screening questions regarding family structure and household size during postnatal visits may help identify women at increased risk.

Strengths and Limitations

This study has several strengths. The community-based follow-up design and objective hemoglobin estimation at a standardized postpartum interval enhance internal validity. The use of multivariate logistic regression allowed identification of independent determinants while controlling for measured confounders.

However, certain limitations must be acknowledged. First, the cross-sectional analytical framework at postpartum follow-up limits causal inference. Second, dietary intake and biochemical markers of iron stores such as serum ferritin were not assessed. Third, intrapartum blood loss was based on reported data rather than quantified measurement, which may have led to measurement bias. Residual confounding by unmeasured variables cannot be excluded.

Implications for Practice and Policy

The findings emphasize the need to strengthen postpartum anemia surveillance beyond pregnancy-focused interventions. Routine hemoglobin assessment at 6–8 weeks postpartum should be institutionalized within maternal health programs. In addition, targeted counseling and follow-up of women residing in nuclear or smaller households may be warranted.

Public health strategies aimed at reducing postpartum anemia must integrate biomedical management with recognition of social determinants. Addressing household-level vulnerabilities may improve maternal recovery, functional well-being, and caregiving capacity.

CONCLUSION

The present study demonstrates that postpartum anemia remains a substantial public health concern among postnatal mothers in urban Puducherry, with more than two-fifths of women affected at 6–8 weeks after delivery. Although severe anemia was not observed, the high prevalence of mild and moderate anemia indicates incomplete hematological recovery during the early postpartum period.

Importantly, this study identifies household-level social determinants specifically nuclear family

structure and smaller household size as independent predictors of postpartum anemia. These findings suggest that postpartum anemia in this population is influenced not only by biological and obstetric factors but also by contextual and social environments that shape maternal recovery. In contrast, obstetric and intrapartum variables did not independently predict anemia in this cohort, highlighting the relative contribution of social vulnerability within an urban setting characterized by institutional delivery coverage.

These results underscore the need to strengthen postpartum care beyond routine clinical surveillance. Integration of structured hemoglobin screening at 6–8 weeks postpartum, reinforcement of continued iron–folic acid supplementation, and identification of socially vulnerable mothers should be prioritized within maternal health programs. Public health strategies aimed at reducing postpartum anemia must incorporate both biomedical management and recognition of social support structures that influence maternal nutrition and recovery.

Future research should explore dietary intake patterns, iron storage biomarkers, and longitudinal hemoglobin trajectories to further elucidate mechanisms underlying persistent postpartum anemia. Addressing this neglected phase of maternal health is essential to improve women’s functional well-being and to strengthen the continuum of care from pregnancy through the postnatal period.

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