



Original Article

A Study of Aetiology of Preterm Birth in a Tertiary Hospital in Central India

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ABSTRACT

Introduction: Most of the existing literature on preterm birth has been generated from well-resourced urban tertiary care and teaching hospitals equipped with comprehensive antenatal care services, fetal medicine facilities, and advanced neonatal intensive care units. In contrast, peripheral tertiary care hospitals predominantly cater to rural and semi-urban populations, where delayed antenatal registration, late referrals, maternal undernutrition, anaemia, genitourinary infections, and limited neonatal care facilities are more common. These differences may substantially influence both the distribution of risk factors and the relative proportions of spontaneous and medically indicated preterm births. However, evidence describing the epidemiological profile of preterm birth in such peripheral healthcare settings remains limited. Hence, the present study was undertaken to determine the aetiology of preterm birth in a tertiary hospital in Central India

Methods: This prospective observational hospital-based study was conducted in the Department of Obstetrics and Gynaecology of a peripheral tertiary care teaching hospital over 18 months, from 2025 to 2026 and a total of 142 women were studied. The study included pregnant women delivering before 37 completed weeks of gestation at the study institution during the study period. Both spontaneous and medically indicated preterm births, as well as booked and unbooked cases, were included after obtaining written informed consent

Results: A total of 142 women who delivered preterm (between 28 and 36 weeks 6 days of gestation) during the study period were enrolled and analysed. Owing to multiple gestations, these 142 deliveries yielded 152 neonates. Most women were aged 20–29 years (approximately 65%); women aged ≥ 35 years constituted only 9.9% and those below 20 years only 5.6%. Two-thirds belonged to a low socioeconomic stratum and 18.3% were unbooked. Spontaneous preterm birth (52.1%) and medically indicated preterm birth (47.9%) occurred in nearly equal proportions. Late preterm birth predominated (59.2%), and 89.4% of deliveries occurred at or beyond 32 weeks. Premature rupture of membranes (30.1%) was the most frequent primary precipitant, followed by infection (16.1%), multiple gestation and oligohydramnios (10.8% each). On the broader risk-factor profile, maternal undernutrition (BMI < 18.5 kg/m²; 45.8%) was the most prevalent factor, followed by moderate anaemia (40.0%), PPROM (39.1%), bacterial vaginosis (28.4%), urinary tract infection (27.5%) and severe anaemia (21.3%). Hypertensive disorders of pregnancy (33.8%) were the leading indication for medically indicated preterm birth, followed by fetal growth restriction (20.6%) and antepartum haemorrhage (13.2%).

Conclusions: Maternal undernutrition, anaemia, premature rupture of membranes, genitourinary infection, hypertensive disorders of pregnancy and fetal growth restriction emerged as the most important contributors, with hypertensive disease being the leading indication for medically indicated delivery and PPROM the leading single precipitant overall.

Keywords: aetiology, preterm birth.

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INTRODUCTION

Preterm birth, defined by the World Health Organization (WHO) as the birth of a live infant before 37 completed weeks (259 days) of gestation, remains one of the most significant challenges in modern obstetrics and neonatology. It is the leading direct cause of neonatal mortality worldwide and the second leading cause of death among children under five years of age, accounting for more than one-fifth of these deaths. Despite substantial advances in obstetric care, neonatal intensive care, and public health interventions, the global burden of preterm birth has remained largely unchanged over the past decades. Recognizing its persistent impact, the WHO and UNICEF described preterm birth as a "silent emergency" in the Born Too Soon: Decade of Action on Preterm Birth report published in 2023 (1).

Globally, an estimated 13.4 million babies were born preterm in 2020, representing nearly one in every ten live births, with almost one million neonatal deaths attributed directly to complications of prematurity (1,2). India contributes disproportionately to this global burden, recording the highest absolute number of preterm births worldwide, with approximately 3.02 million preterm deliveries annually. The national preterm birth rate has remained approximately 13% over the past decade despite considerable improvements in maternal and child health services (3). This persistent burden highlights the multifactorial nature of preterm birth, which results from a complex interplay of biological, nutritional, infectious, socioeconomic, environmental, and healthcare-related factors (4).

Rather than representing a single disease entity, preterm birth is a clinical syndrome that occurs through three principal pathways: spontaneous preterm labour with intact membranes, preterm premature rupture of membranes (PPROM), and medically indicated (iatrogenic) preterm delivery performed because of maternal or fetal complications (4,5). Each pathway is characterized by distinct underlying mechanisms, risk factors, and clinical management strategies. Furthermore, the relative contribution of these pathways varies considerably across different populations and healthcare settings, emphasizing the importance of understanding local epidemiological patterns to develop effective preventive and therapeutic interventions.

Most of the existing literature on preterm birth has been generated from well-resourced urban tertiary care and teaching hospitals equipped with comprehensive antenatal care services, fetal medicine facilities, and advanced neonatal intensive care units (6). In contrast, peripheral tertiary care hospitals predominantly cater to rural and semi-urban populations, where delayed antenatal registration, late referrals, maternal undernutrition, anaemia, genitourinary infections, and limited neonatal care facilities are more common. These differences may substantially influence both the distribution of risk factors and the relative proportions of spontaneous and medically indicated preterm births. However, evidence describing the epidemiological profile of preterm birth in such peripheral healthcare settings remains limited (6,7).

Hence, the present study was undertaken to determine the aetiology of preterm birth in a tertiary hospital in Central India

METHODS

This prospective observational hospital-based study was conducted in the Department of Obstetrics and Gynaecology of a peripheral tertiary care teaching hospital. The prospective design enabled systematic and standardized collection of maternal demographic, clinical, obstetric, and risk-factor data, along with maternal and neonatal outcomes.

The study was conducted over 18 months, from 2025 to 2026. The study included pregnant women delivering before 37 completed weeks of gestation at the study institution during the study period. Both spontaneous and medically indicated preterm births, as well as booked and unbooked cases, were included after obtaining written informed consent.

Inclusion Criteria

- * Women delivering between 28 weeks and 36 weeks 6 days of gestation.
- * Women delivering at or referred to the study institution.
- * Both spontaneous and medically indicated preterm births.
- * Women providing written informed consent.

Exclusion Criteria

- * Women delivering at or beyond 37 completed weeks of gestation.
- * Pregnancies with major fetal congenital anomalies incompatible with life.

Sample Size

The sample size was calculated using the standard formula for estimating a single population proportion:

The minimum required sample size was calculated using the standard formula for estimating a single population proportion:
$$n = Z^2 \times P(1 - P) / d^2$$

where P is the assumed prevalence of preterm birth in the region (taken as approximately 10%, i.e. $P = 0.10$); Z is the standard normal deviate corresponding to a two-sided 95% confidence level ($Z = 1.96$); and d is the absolute precision (0.05). Substituting these values yielded a minimum sample size of 139, which was rounded to 140 participants. The study

ultimately enrolled 142 women (comprising 152 neonates owing to multiple gestations), thereby exceeding the calculated minimum and ensuring adequate power for the primary descriptive objective.

Consecutive sampling was used. All eligible women meeting the inclusion criteria during the study period were recruited consecutively until the desired sample size was achieved.

After obtaining written informed consent, data were collected using a predesigned structured case record form. Information regarding maternal demographics, socioeconomic and educational status, antenatal booking, menstrual and obstetric history, previous preterm birth, abortion, interpregnancy interval, medical and surgical history, substance use, and associated obstetric risk factors was recorded. Gestational age was determined using the last menstrual period and confirmed by first-trimester ultrasonography whenever available.

A detailed general, systemic, and obstetric examination was performed. Routine laboratory investigations included haemoglobin estimation, complete blood count, blood grouping and Rh typing, platelet count, coagulation profile, liver and renal function tests, viral markers, urine analysis and culture, blood glucose estimation, and cervical swab culture when clinically indicated. Obstetric ultrasonography, Doppler studies, non-stress testing, and other fetal surveillance investigations were performed as required.

The type of preterm birth (spontaneous or indicated), associated maternal risk factors, indication for delivery, mode of delivery, and maternal and neonatal outcomes were documented. Participants were followed until discharge, and relevant information was obtained from labour room records, inpatient case records, operation theatre registers, and neonatal intensive care unit records.

Statistical analysis was performed using the Statistical Product and Service Solutions (SPSS) software, version 21 for Windows (SPSS Inc., Chicago, IL). Descriptive quantitative variables were expressed as mean \pm standard deviation, or as median with interquartile range where the distribution was skewed. Descriptive qualitative variables were expressed as frequencies and percentages. A 95% confidence interval was adopted, the level of significance (α error) was set at 5%, and the power of the study at 80%. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 142 women who delivered preterm (between 28 and 36 weeks 6 days of gestation) during the study period were enrolled and analysed. Owing to multiple gestations, these 142 deliveries yielded 152 neonates.

(Table 1 comes here)

Table 1 shows the age distribution of the 142 women included in the study. The majority of participants belonged to the 25–29 years age group, accounting for 50 (35.2%) cases. This was followed by the 20–24 years and 30–34 years age groups, each comprising 36 (25.4%) participants. According to their antenatal booking status, out of the 142 women included in the study, 116 (81.7%) were booked cases, while 26 (18.3%) were unbooked cases. Out of the 142 women included in the study, 94 (66.2%) belonged to the BPL category, while 48 (33.8%) did not belong to the BPL category. Out of the 142 women included in the study, 57 (40.1%) had attained secondary level education, making it the most common educational category. This was closely followed by 56 (39.4%) women who had completed primary education. Only 29 (20.4%) participants were graduates or had attained a higher level of education. Overall, nearly four-fifths of the study population (79.5%) had educational attainment up to the primary or secondary level, while approximately one-fifth had received graduate-level education or above. Overall, 72 (50.7%) participants were multigravida, while 49.3% were experiencing their first pregnancy. Thus, primigravidae formed the largest proportion of women with preterm birth in the present study.

(Table 2 comes here)

Table 2 depicts the distribution of primary indications among women who underwent indicated preterm delivery ($n = 68$). The most common indication was hypertensive disorders of pregnancy, observed in 23 (33.8%) women. This was followed by fetal growth restriction (FGR), which accounted for 14 (20.6%) cases. Antepartum hemorrhage and malpresentation in labour were each responsible for 9 (13.2%) indicated preterm births. Breech presentation in labour was documented in 5 (7.4%) cases. Less common indications included diabetes mellitus with complications and fetal distress, each contributing 3 (4.4%) cases, while previous lower segment caesarean section (LSCS) was the indication in 2 (2.9%) women. Overall, hypertensive disorders of pregnancy and fetal growth restriction together accounted for more than half (54.4%) of all indicated preterm births in the study population.

(Table 3 comes here)

Table 3 depicts the distribution of primary risk factors associated with preterm birth among the study participants. PPROM/PROM emerged as the most common risk factor, accounting for 28 (30.1%) cases. The second most frequent risk factor was maternal infection, observed in 15 (16.1%) participants. Multiple gestation and oligohydramnios each contributed 10 (10.8%) cases. Idiopathic preterm birth, where no identifiable risk factor could be established, accounted

for 9 (9.7%) cases. Anemia was present as the primary risk factor in 7 (7.5%) women, while uterine anomalies and polyhydramnios were identified in 6 (6.5%) and 5 (5.4%) cases, respectively. Cervical insufficiency was the least common risk factor, accounting for 3.2% cases. Overall, PPROM/PROM and maternal infections together constituted nearly half of all identified risk factors associated with preterm birth in the study population.

(Table 4 comes here)

Table 4 shows the distribution of maternal and obstetric risk factors identified among women with preterm birth. Maternal undernutrition (BMI <18.5 kg/m²) was the most frequently observed risk factor, present in 65 (45.8%) participants. This was followed by moderate anemia, which was identified in 34 (40.0%) women, and PPROM, which occurred in 34 (39.1%) cases. Among infectious risk factors, bacterial vaginosis was documented in 23 (28.4%) participants, while urinary tract infection (UTI) was present in 22 (27.5%) women.

Candidiasis was observed in 9 (11.3%) cases. Nutritional abnormalities were common, with high BMI (>25 kg/m²) identified in 36 (25.4%) women and mild and severe anemia observed in 21 (25.6%) and 19 (21.3%) participants, respectively. Other obstetric risk factors included polyhydramnios in 12 (14.6%) women, multiple gestation in 10 (12.3%), and uterine anomalies in 10 (11.9%) participants. An idiopathic aetiology, where no specific risk factor could be identified, was noted in 12 (15.0%) cases. With respect to maternal demographic factors, elderly gravida accounted for 14 (9.9%) participants, whereas teenage pregnancy was observed in 8 (5.6%) women. Overall, maternal undernutrition, anemia, PPROM, and genital or urinary tract infections emerged as the most frequently encountered risk factors among women with preterm birth in the present study.

(Table 5 comes here)

Table 5 shows the association between maternal age and type of preterm birth. Among women aged less than 20 years, 83.3% experienced spontaneous preterm birth, whereas only 16.7% had indicated preterm birth. In the age groups 20–24 years, 25–29 years, and 30–35 years, spontaneous preterm birth remained slightly more common than indicated preterm birth. In contrast, among women aged more than 35 years, indicated preterm birth predominated, accounting for 78.6% of cases compared with 21.4% spontaneous preterm births.

Among the 116 booked women, 60 (51.7%) experienced spontaneous preterm birth, while 56 (48.3%) had indicated preterm birth. Similarly, among the 26 unbooked women, 14 (53.8%) had spontaneous preterm birth and 12 (46.2%) had indicated preterm birth. Statistical analysis using the Chi-square test demonstrated no significant association between booking status and type of preterm birth ($\chi^2 = 0.038$, $df = 1$, $p = 0.845$).

Among women without severe anemia, 61 (87.1%) experienced spontaneous preterm birth, whereas only 9 (12.9%) had indicated preterm birth. In contrast, among women with severe anemia, the proportion of indicated preterm births increased substantially, with 10 (52.6%) women undergoing indicated preterm delivery compared to 9 (47.4%) who had spontaneous preterm birth. Statistical analysis demonstrated a highly significant association between severe anemia and type of preterm birth ($\chi^2 = 14.1$, $df = 1$, $p < 0.001$). Among the 103 women without a previous history of preterm birth, 51 (49.5%) experienced spontaneous preterm birth, while 52 (50.5%) had indicated preterm birth.

Among the 39 women with a history of previous preterm birth, 23 (59.0%) had spontaneous preterm birth and 16 (41.0%) had indicated preterm birth. Although spontaneous preterm birth was relatively more frequent among women with a previous preterm delivery, the difference was modest. Statistical analysis using the Chi-square test revealed no statistically significant association between previous preterm birth history and the type of current preterm birth ($\chi^2 = 1.01$, $df = 1$, $p = 0.314$).

Among women without cervical insufficiency, 53 (45.3%) experienced spontaneous preterm birth, whereas 64 (54.7%) had indicated preterm birth. In contrast, among women with cervical insufficiency, 21 (84.0%) experienced spontaneous preterm birth and only 4 (16.0%) underwent indicated preterm birth. The difference in the distribution of spontaneous and indicated preterm births between women with and without cervical insufficiency was found to be statistically highly significant ($\chi^2 = 12.4$, $df = 1$, $p < 0.001$).

Among the 82 women delivered by LSCS, 63 (76.8%) had indicated preterm birth, whereas 19 (23.2%) experienced spontaneous preterm birth. In contrast, among the 60 women who delivered vaginally, 55 (91.7%) had spontaneous preterm birth and only 5 (8.3%) had indicated preterm birth. Statistical analysis using the Chi-square test demonstrated a highly significant association between mode of delivery and type of preterm birth ($\chi^2 = 65.1$, $df = 1$, $p < 0.001$).

Among the 57 women who developed PPH, 36 (63.2%) had indicated preterm birth, whereas 21 (36.8%) experienced spontaneous preterm birth. Conversely, among the 85 women who did not develop PPH, 53 (62.4%) had spontaneous preterm birth and 32 (37.6%) had indicated preterm birth. Statistical analysis revealed a significant association between postpartum hemorrhage and the type of preterm birth ($\chi^2 = 8.90$, $df = 1$, $p = 0.003$).

TABLES

Table 1: Socio-demographic characteristics of the mothers

	Count	% of Total	Cumulative %
Age category (years)			
< 20	6	4.2	4.2
20–24	36	25.4	29.6
25–29	50	35.2	64.8
30–34	36	25.4	90.1
> 35	14	9.9	100.0
Booking status			
Booked	116	81.7	81.7
Unbooked	26	18.3	100.0
BPL status			
No	48	33.8	33.8
Yes	94	66.2	100.0
Maternal educational status		Percentage	
Primary education	56	39.4	
Secondary education	57	40.1	
Graduate and above	29	20.4	
Gravida			
1	70	49.3	
2	41	28.9	
3	29	20.4	
4	2	1.4	

Table 2: Distribution of primary indications for indicated preterm birth (n = 68)

Primary indication	Frequency (n)	Percentage (%)
Hypertensive disorders of pregnancy	23	33.8
Fetal growth restriction (FGR)	14	20.6
Antepartum hemorrhage	9	13.2
Malpresentation in labour	9	13.2
Breech in labour	5	7.4
Diabetes mellitus with complications	3	4.4
Fetal distress	3	4.4
Previous LSCS	2	2.9
Total	68	100.0

Table 3: Distribution of primary risk factors associated with preterm birth

Primary risk factor	Frequency (n)	Percentage (%)
PPROM / PROM	28	30.1
Maternal infection	15	16.1
Multiple gestation	10	10.8
Oligohydramnios	10	10.8
Idiopathic	9	9.7
Anemia	7	7.5
Uterine anomaly	6	6.5
Polyhydramnios	5	5.4
Cervical insufficiency	3	3.2
Total	93	100.0

Table 4: Distribution of maternal and obstetric risk factors associated with preterm birth

Risk factor	Frequency (n)	Percentage (%)
Undernutrition (BMI <18.5 kg/m ²)	65	45.8
Moderate anaemia	34	40.0
PPROM	34	39.1
High BMI (>25 kg/m ²)	36	25.4
Bacterial vaginosis	23	28.4
Urinary tract infection	22	27.5

Mild anaemia	21	25.6
Severe anaemia	19	21.3
Idiopathic	12	15.0
Polyhydramnios	12	14.6
Multiple gestation	10	12.3
Uterine anomaly	10	11.9
Candidiasis	9	11.3
Elderly gravida (≥ 35 years)	14	9.9
Teenage pregnancy (< 20 years)	8	5.6

Note: Multiple risk factors could be present in the same participant; therefore percentages do not total 100%.

Table 5: Association between risk factors and type of preterm birth

Characteristics	Spontaneous n (%)	Indicated n (%)	Total	P value
Age group (years)	5 (83.3)	1 (16.7)	6	Pearson $\chi^2 = 7.87$, df = 4, p = 0.096 (not significant)
< 20	19 (52.8)	17 (47.2)	36	
20–24	27 (54.0)	23 (46.0)	50	
25–29	20 (55.6)	16 (44.4)	36	
30–35	3 (21.4)	11 (78.6)	14	
Booking status	60 (51.7)	56 (48.3)	116	Pearson $\chi^2 = 0.038$, df = 1, p = 0.845 (not significant)
Booked	14 (53.8)	12 (46.2)	26	
Unbooked				
Severe anemia				Pearson $\chi^2 = 14.1$, df = 1, p < 0.001 (highly significant)
No	61 (87.1)	9 (12.9)	70	
Yes	9 (47.4) (70)	10 (52.6) (19)	19 (89)	
Previous preterm birth				Pearson $\chi^2 = 1.01$, df = 1, p = 0.314 (not significant)
No	51 (49.5)	52 (50.5)	103	
Yes	23 (59.0)	16 (41.0)	39	
Cervical insufficiency				Pearson $\chi^2 = 12.4$, df = 1, p < 0.001 (highly significant)
No	53 (45.3)	64 (54.7)	117	
Yes	21 (84.0)	4 (16.0)	25	
Mode of delivery				Pearson $\chi^2 = 65.1$, df = 1, p < 0.001 (highly significant)
LSCS	19 (23.2)	63 (76.8)	82	
NVD	55 (91.7)	5 (8.3)	60	
Postpartum hemorrhage				Pearson $\chi^2 = 8.90$, df = 1, p = 0.003 (significant)
Yes	21 (36.8)	36 (63.2)	57	
No	53 (62.4)	32 (37.6)	85	

DISCUSSION

Preterm birth remains the single largest contributor to neonatal mortality and to long-term childhood morbidity worldwide, and its burden is disproportionately concentrated in South Asia (6,8,9). The present prospective observational study was undertaken at a peripheral tertiary care institute to characterise the aetiological spectrum of preterm birth and to document the associated maternal and perinatal outcomes in a region-specific, resource-constrained setting. A total of 142 women who delivered before 37 completed weeks of gestation were enrolled, yielding 152 preterm neonates. The principal findings were a near-equal distribution of spontaneous (52.1%) and medically indicated (47.9%) preterm births, a predominance of late preterm deliveries (59.2%), a strikingly high prevalence of co-existing modifiable maternal risk factors — most notably maternal undernutrition, anaemia, premature rupture of membranes and genitourinary infection — and a substantial load of adverse neonatal outcomes, with 82.4% of neonates requiring neonatal intensive care unit (NICU) admission and an overall perinatal mortality of 5.9%. These findings are discussed below in relation to the existing national and international literature.

Sociodemographic profile:

In the present study the majority of women were in the 25–29 year age group (35.2%), and approximately two-thirds (65%) were between 20 and 29 years of age. Women of advanced maternal age (≥ 35 years) constituted only 9.9% of the cohort, and teenage mothers (< 20 years) only 5.6%. This concentration of preterm births within the optimal reproductive age band is consistent with the overall age structure of the obstetric population in Indian peripheral settings rather than indicating

that young maternal age is protective; similar age distributions among women with preterm birth have been reported by Mohapatra et al. and Patel et al. in their Indian cohorts (10,11). The association between maternal age and the type of preterm birth in our study did not reach statistical significance ($p = 0.096$), in keeping with the modest and inconsistent age effects observed in several hospital-based series, although large population based studies such as that of Lu and Li have demonstrated that both extremes of maternal age carry an increased risk of preterm delivery when sufficiently powered (12).

A high proportion of women in our cohort belonged to a low socioeconomic stratum (66.2% below the poverty line), and educational attainment was limited, with only 20.4% having completed graduate-level education. These observations reinforce the well-established socioeconomic gradient in preterm birth. Blumenshine et al., in their systematic review, and Vos et al., in their analysis of deprived neighbourhoods, both demonstrated that lower socioeconomic position is independently associated with an elevated risk of preterm delivery through pathways that include poorer nutrition, higher infection burden, chronic psychosocial stress and reduced access to antenatal care (13,14). The fact that 18.3% of our cohort were unbooked further underscores the role of inadequate antenatal surveillance in a peripheral setting, a determinant repeatedly highlighted in the Indian literature (12).

Type of preterm birth and gestational age distribution:

Spontaneous preterm birth (52.1%) marginally exceeded medically indicated preterm birth (47.9%) in our cohort. This near-parity contrasts with the classical distribution described by Goldenberg et al., in which spontaneous mechanisms (spontaneous labour and PPROM together) account for approximately two-thirds of preterm births (6). The relatively higher contribution of indicated preterm birth in our series most likely reflects the high prevalence of hypertensive disorders, fetal growth restriction and antepartum haemorrhage in this peripheral referral population, a pattern also reported by Ananth and Vintzileos, who attributed a large share of medically indicated preterm births to ischaemic placental disease (7). Indian hospital based studies have reported variable spontaneous-to-indicated ratios depending on referral patterns, and our findings fall within the reported range (11). The gestational age distribution was dominated by late preterm births (34–36+6 weeks; 59.2%), followed by moderate (32–33+6 weeks; 30.3%) and very preterm births (28–31+6 weeks; 9.9%), with extreme prematurity being rare (0.7%); overall, 89.4% of deliveries occurred at or beyond 32 weeks. This preponderance of late and moderate prematurity mirrors the global gestational age structure of preterm birth, in which late preterm infants constitute the largest subgroup (6,9), and is consistent with Indian data from Doddamani et al. and Jaiswal et al. (15,16). The clinical importance of this distribution lies in the fact that, although late preterm infants are individually at lower risk than very or extremely preterm infants, their large absolute numbers make them a major contributor to the overall neonatal morbidity burden, a point emphasised in the ACOG framework for medically indicated late-preterm delivery (17).

Aetiology and risk factors:

Among the identifiable primary risk factors, preterm/prelabour rupture of membranes (PPROM) was the most frequent (30.1%), followed by maternal infection (16.1%), multiple gestation (10.8%), oligohydramnios (10.8%) and idiopathic causes (9.7%). The pre-eminence of PPROM as a precipitant of preterm birth is well recognised and accords with both the pathophysiological model of Goldenberg et al. and the contemporary understanding of membrane weakening through infection-driven and inflammatory pathways (6). The substantial contribution of clinically apparent infection is consistent with the prospective Indian data of Tellapragada et al., who identified genitourinary and periodontal infection as important and potentially screenable determinants of preterm birth and low birth weight in pregnant Indian women (18), and with the reported association between urinary tract infection and preterm delivery described by Wang et al. (19). When the broader profile of co-existing maternal and obstetric risk factors was examined, maternal undernutrition (body mass index <18.5 kg/m²) was the single most prevalent factor, present in 45.8% of women, followed closely by anaemia (moderate anaemia in 40.0% and severe anaemia in 21.3%). This very high background prevalence of undernutrition and anaemia is characteristic of the Indian peripheral obstetric population and distinguishes our cohort from most high-income-country series. The contribution of low maternal body mass index to preterm birth has been documented in pooled analyses and is biologically plausible through mechanisms involving micronutrient deficiency and reduced uteroplacental reserve; conversely, the high body mass index observed in 25.4% of our women is itself a recognised risk factor for indicated preterm birth via hypertensive and metabolic complications. The strong association between maternal anaemia and preterm birth, particularly indicated preterm birth, is consistent with the case-control and cohort literature and with Indian determinant analyses, and severe anaemia in our cohort was significantly associated with the indicated phenotype ($p < 0.001$) (20,11). Bacterial vaginosis (28.4%) and urinary tract infection (27.5%) were also common, underscoring the infective contribution to spontaneous preterm birth in this setting and reinforcing the argument for systematic antenatal screening for lower genital tract and urinary infection (18,19). A previous history of preterm birth was present in 27.5% of women, in line with the recognised recurrence risk quantified by Phillips et al., who demonstrated a markedly elevated risk of recurrent spontaneous preterm birth in women with a prior preterm delivery (21). Cervical insufficiency was documented in 17.6% of women, and cervical cerclage had been performed in 15.5%; cervical insufficiency was very strongly associated with the spontaneous phenotype in our analysis (84.0% spontaneous; $p < 0.001$), consistent with its established role as a mechanical cause of recurrent mid-trimester and early preterm loss. Among the 68 women with medically indicated preterm

birth, hypertensive disorders of pregnancy were the leading indication (33.8%), followed by fetal growth restriction (20.6%), antepartum haemorrhage (13.2%) and malpresentation (13.2%). This hierarchy of indications closely parallels the ischaemic-placental-disease cluster described by Ananth and Vintzileos, in which pre-eclampsia, fetal growth restriction and abruptio together account for the majority of iatrogenic preterm deliveries (7), and is concordant with the ACOG guidance on hypertensive disorders and on medically indicated late-preterm delivery (22,17). The prominence of hypertensive disease as an indication also reflects the high background burden of pre-eclampsia in Indian tertiary practice and explains, in part, the relatively elevated proportion of indicated preterm births in our cohort (10,11).

The convergence of maternal undernutrition, anaemia, genitourinary infection, PPRM and hypertensive disease in a single high-burden population suggests that integrated, protocol-driven antenatal interventions — nutritional supplementation, anaemia correction, infection screening and timely management of hypertensive disease — have considerable potential to reduce both the incidence and the adverse consequences of preterm birth in such settings (6, 18).

Limitations

As a single-centre study employing convenience sampling, the results may be subject to referral and selection bias and may not be fully generalisable to community or other institutional settings. The analytical comparisons were based on univariate chi-square testing without multivariable adjustment; consequently, the reported associations may be confounded by the high degree of co-existence among risk factors in this population, and causal inference is not possible. The modest sample size limited the statistical power to detect smaller effect sizes, which may explain several non-significant associations for factors that are established risk determinants in larger studies.

CONCLUSION

This prospective observational study of 142 women delivering preterm at a peripheral tertiary care institute demonstrates that preterm birth in this setting is a multifactorial condition driven by a dense clustering of largely modifiable maternal and obstetric risk factors. Spontaneous and medically indicated preterm births occurred in almost equal proportions, and late preterm deliveries predominated. Maternal undernutrition, anaemia, premature rupture of membranes, genitourinary infection, hypertensive disorders of pregnancy and fetal growth restriction emerged as the most important contributors, with hypertensive disease being the leading indication for medically indicated delivery and PPRM the leading single precipitant overall.

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