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Association of Maternal Obstetric Factors with preterm births in India: Evidence from National Family Health Survey 2019-21

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Abstract

An alarming rise in the preterm birth rates across the world has posed a major public health concern in our efforts to reduce the neonatal mortality. This study investigates the correlation between maternal obstetric factors and preterm births in India, using data from the 2019-21 National Family Health Survey. The information on the duration of the most recent pregnancy in the last five years before the survey was utilised in this study (n=168,615). Utilizing bivariate analysis and multinomial logistic regression, the study reveals that age, place of residence, order of delivery, and maternal BMI are a significant factor associated with preterm births. Pregnancy at a younger age i.e. <19 years and at age 35 and above was significantly associated with more chance of very preterm birth (RRR:1.43***, CI: 1.17-1.73; RRR:1.49***, CI: 1.16-1.9) as compared to the maternal age of 20-24 years. Uneducated mothers had a higher likelihood of very and moderate preterm birth. Those mothers with a previous history of child loss were found to have a significant risk of having very and moderate preterm with odds of 7.92 and 1.14. Specifically, policy recommendations include mandatory registration of all pregnant women in the government records, strict adherence to four or more ANC visits. Findings indicate that identification and follow-up of high-risk pregnancies and implementing targeted programs to address risk underlying preterm births can be beneficial in reducing preterm birth rates. This can be achieved by strengthening the field level monitoring by ASHAs and ANMs at Health &Wellness centers level of the public health system. Also access to specialized care units for preterm infants in both urban and rural areas at the Primary health care level should be improved.

Keywords

Birth outcomes, Healthcare policies, Maternal health, National Family Health Survey, Obstetric risk factors, Preterm births

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Introduction

Preterm birth or births occurring before completing 37 weeks of gestation is the leading and direct cause of early neonatal death(WHO, 2018) and death among children under the age of 5 years(Liu et al., 2019). It is responsible for around 27% of neonatal deaths annually. To worsen it, a lifetime of difficulties, such as learning challenges and vision and hearing impairments accompanied by preterm births, is a concern for many survivors(WHO Recommendations on Interventions to Improve Preterm Birth Outcomes., 2015) . With an alarming rise in preterm birth rates across the globe in the last two decades (Blencowe et al., 2012; Chawanpaiboon et al., 2019) preterm birth is a threat to population health(Cunningham et al., 2010) The burden of preterm birth is concentrated in Africa and South Asia (60%), where health systems are weak and inadequate(Beck et al., 2010). With an estimated 3.5 million preterm births in the country, India has the world's highest number of preterm births (WHO, 2018). Since child survival is an integral part of the growth of any nation, global efforts have been made to reduce neonatal deaths, especially those from preventable causes (Lahariya, 2009). Despite several policies and programs aimed at improving mother and child health during pregnancy and postpartum(Lahariya, 2009; Reproductive and Child Health Programme: Schemes for Implementation. Government of India, 1997) the country bears a disproportionately high burden of preterm births. Further, a considerable state-wise variation exists in the burden of preterm births(Jana et al., 2022)

Different maternal, foetal, and placental predisposing factors, i.e. obstetric factors (Gleason & Juul, 2018) combined, lead to preterm births, making identifying these pathways complex. These factors included spontaneous pre-labour rupture of membranes due to pre-eclampsia, a life threatening condition during pregnancy characterised by high blood pressure (Celik et al., 2008; Gleason & Juul, 2018), foetal distress (Weinmann et al., 2017), uterine over-distention and cervical incompetence due to weal cervical tissues; hormonal changes and bacterial infections (Villar et al., 2012). The other risk factors include a family history of preterm births, history of abortions, unplanned pregnancies, chronic diseases such as Hypertension and Diabetes Mellitus, maternal smoking, drug abuse, use of assisted reproductive technologies, and mental health disorders such as depression (Gleason & Juul, 2018). Previous studies have reported that too young or too old maternal age, very low or high Body Mass Index (BMI)(Simmons et al., 2010), inadequate ANC, and multiple infections are also associated with preterm birth(Mahande et al., 2013). The World Health Organisation states that receiving at least four Antenatal care during pregnancy increases the chance of getting maternal health interventions that are effective throughout the Antenatal care (WHO, 2024). More importantly, more than three-fourths of these deaths are preventable with essential care during childbirth and in the postnatal period. Evidence shows that in high-income countries, about 50% of preterm infants born at 24 weeks survive the neonatal period (the first 28 days of life), rising to 90% at 28 weeks gestation, whereas less than 10% of those born at 28 weeks survive in low-income countries, and only those born at 34 weeks or later have survival rates of >50%(Platt, 2014)

Given the high burden of preterm birth and child deaths, several studies have reported an increased risk of neonatal and childhood deaths among those with preterm birth in India and across the globe (India State-Level Disease Burden Initiative Child Mortality Collaborators, 2020; Kannaujiya et al., 2022; Katz et al., 2013). Unless the causes and factors determining preterm births are identified, the attempts to reduce the burden of preterm birth and achieve target three of the Sustainable Development Goals (SDGs) can't succeed. Since preterm birth is an issue addressed during pregnancy, less importance has been given to the long-term maternal factors contributing to it. Moreover, the interventions have been restricted to medical approaches like post-delivery care and therapeutic means to reduce morbidity and mortality. Studies related to preterm births have been limited to hospital-based case studies; however, an analysis of the National Family Health Survey would provide insight into the exact picture at a national level. This study aims to provide information on maternal factors associated with preterm birth, which is crucial in informing priorities and addressing the targets and gaps in programmes and policies aimed at improved birth outcomes.

Material and Methods

Study design

This study employed a cross-sectional design to investigate the association between maternal obstetric factors and preterm births.

Data source

The present study estimated the preterm birth in India across the last three rounds of the National Family Health Survey, a multistage, stratified, cross-sectional survey conducted under the guidance of the Ministry of Health and Family Welfare (MoHFW) throughout India. However, for examining the association of maternal obstetric factors with preterm birth in India, the latest National Family Health Survey (NFHS) 2019-21 was used. The survey provides population, health, and nutrition information for the country-specific 707 districts. The International Institute of Population Science (IIPS), Mumbai, was the nodal agency for conducting the survey. ICF & USA provided technical assistance through the Demographic and Health Surveys (DHS) Program, which USAID fund (National Family Health Survey (NFHS-5), 2019-21, 2021). A uniform sample design, which is representative at the national, state/union territory, and district levels, was adopted in each survey round. The survey adopted a two-stage sample design in rural areas and a three-stage design in urban areas. This round of survey has collected information from 636,699 households (98% response rate), 724,115 women (97% response rate), and 101,839 men (92% response rate) (National Family Health Survey (NFHS-5), 2019-21, 2021). Aligned with the objectives, the information on the duration of the most recent pregnancy in the last five years before the survey was utilised in this study. Thus, a total of 232,920 live births had occurred in the last five years before the survey, out of which 176,843 births were the last birth. An analytical sample of 168,615 was obtained after following the inclusion and exclusion criteria.

Outcome variable

Very preterm, moderate preterm and full term birth were the outcome variables for the study.

The information on the duration of the most recent pregnancy was available in months. The birth was considered 'very preterm' if the gestational age was >=6 and less than 8 months. The births occurring in the gestation age of eight months or more and before the completion of 9 months of pregnancy were regarded as 'moderate preterm', while the births after the completion of 9 months were categorised as 'full term' birth.

Independent variables

Maternal factors such as the mother's height (categorised as <145*cm*, 145-149*cm*, 150-154*cm*, and 155*cm*)(Teoh et al.,2024), age (<19, 20-24, 25-29, 30-34, and 35+ years), education (no formal education, primary educated, secondary educated, higher), BMI (underweight, normal, overweight, obese), anaemic status (anaemic or not), birth order (1st birth, 2-3, 4-5 and 6 or above), no. of antenatal visits (none, one, 2-3 and 4 or above), consumed iron syrup (yes or no), number of T.T. injections during pregnancy (none, one, two or more) were considered in this study.

BMI for mothers was calculated using the formula: weight in kilograms/height in meters squared. The BMI values for mothers were categorised as underweight if their BMI was below 18.5, normal or healthy if their BMI ranged between 18.5-24.9, overweight if their BMI ranged from 25.0-29.9, and obese if their BMI was 30.0 and above. Health investigators collected blood specimens with the respondents' consent for anaemia testing. Capillary blood was collected exclusively from a finger prick and was tested using a battery-operated portable HemoCue Hb 201+ analyser. Moreover, the Hemoglobin levels are adjusted for smoking and the altitude in enumeration areas that are above 1,000 meters. For non-pregnant women aged 15-49 years, a haemoglobin level <11.0 was considered anaemic, and for pregnant women aged 15-49 a haemoglobin level <12.0 were considered anaemic.

Other variables included ever lost a child (yes or no), sex of child (male and female), type of delivery (c-section or not), place of delivery (home, public health facility; private health facility), and smoking and alcohol consumption categorized as yes or no.

The household level characteristics included information on the number of children in the household (none, one, two, three, and above), wealth quintile (poorest, poorer, middle, richer, richest), self-reported caste (Scheduled Caste (SC), Scheduled Tribe (ST), Other Backward Castes (OBC) and others), religion (Hindu, Muslim, others), place of residence (rural, urban), geographical region (North, Central, East, North-East, West, South). The wealth index was calculated principal component analysis based on the number and kinds of consumer goods they own, ranging from a television to a bicycle or car, and housing characteristics such as the source of drinking water, toilet facilities, and flooring materials and then the distribution was divided into five equal categories, each with 20 percent of the population.

Ethical approval

The study utilized secondary data accessible from the DHS program website on request: https://dhsprogram.com/data/dataset_admin/login_main.cfm.

Statistical analysis

Descriptive statistics were calculated to understand the distribution of respondents by various socio-demographic characteristics. Bivariate analysis was employed to understand the prevalence of preterm, moderate and full-term birth by socio-economic and other demographic characteristics. The chi-square test enabled us to test the association between various dependent and independent variables. Multinomial logistic regression was applied to determine the relative risk ratios (RRR) of experiencing a preterm birth (very preterm and moderate preterm) in reference to a full-term birth. An RRR greater than 1 indicates that the outcome is more likely to be in that group compared to reference category. Data analysis was done using STATA version 17.

Result and Discussion

Figure 1 represents the trend in preterm birth across the last three rounds of NFHS. There has been an increasing prevalence of preterm births from NFHS 3 to NFHS 5.

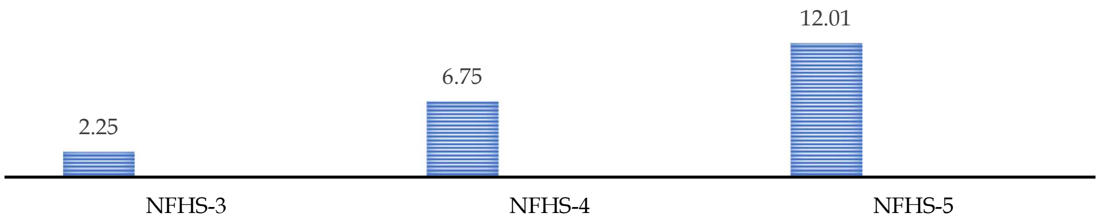

Figure 1: Trends in prevalence of preterm birth rates in India (%)

Table 1 represents the distribution of samples by various socio-demographic characteristics. Central and Eastern India saw the greatest number of births, with north-eastern India contributing less than 5% over the preceding five years. The majority of the women in the sample (51%) had just a secondary education, were Hindus (79%), belonged to the OBC caste, and lived in rural areas (71%). Most women who gave birth in the previous five years were in their twenties. A third of the female population was anaemic, and 39% were underweight, overweight, or obese. Around one-tenth of the respondents had ever lost a child, and one-fifth reported having a delivery by C-section (22%). Further, the public health facility was the most used delivery facility (62%), with almost three-fifths of the women having 4+ ANC visits. Most respondents reported receiving iron syrup (88%) and 2+ T.T. injections (76%) during pregnancy. Only a tiny percentage of the women in the sampled group—less than 1%—had the habits of smoking and drinking alcohol. Births in the second and third orders comprised half of the sampled births. 46 per cent of the newborns in the sample were female.

Table 1 Sample distribution of last birth preceding five years of the survey, NFHS-5

Background Characteristics	Frequency	Percentage
Region		
North	34,863	13.34
Central	45,395	26.30
East	34,658	25.64
North-East	29,296	4.11
West	16,858	13.07
South	24,557	17.54
Place of residence		
Urban	40,039	28.44
Rural	1,45,588	71.56
Wealth Quintile		
Poorest	47,282	22.83
Poorer	42,272	20.88
Middle	36,208	19.48
Richer	32,579	19.23
Richest	27,286	17.58
Religion		
Hindu	1,35,886	79.39
Muslim	26,635	15.98
Others[£]	23,106	4.62
Caste		
SC[#]	36,611	22.51
ST[$]	37,842	10.03

OBC[a]	69,938	42.90
Others	41,236	24.56
Maternal age at delivery (in years)		
<19	16,230	9.69
20-24	73,190	41.05
25-29	60,237	32.06
30-34	25,806	12.85
35+	10,164	4.36
Maternal height		
<145cm	20,238	11.65
145-149cm	45,893	25.53
150-154cm	61,485	33.83
>=155cm	53,186	28.99
BMI[b] of the mother		
Underweight (BMI<18.5)	31,784	18.27
Normal (BMI>=18.5 & BMI<25)	1,13,567	60.80
Overweight (BMI>=25 & BMI<30)	27,408	15.97
Obese (BMI>=30 & BMI<50)	7,746	4.96
Anaemic status of the mother		
Not anaemic	1,21,131	67.60
Anaemic(<10.9g/dl)	57,446	32.40
Educational status of the mother		
No Education	38,655	19.90
Primary	22,955	11.77
Secondary	96,601	51.22
Higher	27,416	17.12
Delivery by C-Section		
No	1,49,220	77.90
Yes	36,407	22.10
Place of Delivery		
Home	20,275	9.66
Public Health Facility	1,10,582	62.11
Private Health Facility	38,526	28.23
No. of Antenatal Visits		
None	11,054	6.28
1	10,560	6.67
2-3	48,428	28.07
4+	96,104	58.97
Iron supplements during pregnancy		
No	21,635	12.30
Yes	1,48,121	87.70
No. of TT[c] injections during pregnancy		
No	26,199	13.19
1	20,005	10.65
2 or More	1,39,423	76.16
Alcohol consumption status of the mother		
No	1,82,572	99.44
Yes	3,055	0.56
Smoking status of the mother		
No	1,85,313	99.92
Yes	314	0.08
Gestational age at which the child was born		
Very preterm	1,490	0.88
Moderate	18,759	11.4
Term	1,48,366	87.72
Birth Order		
1	59,847	32.74
2-3	98,602	53.87
4-5	21,336	10.70
6+	5,842	2.69
Experience of previous child loss		
No	1,68,156	90.67
Yes	17,471	9.33
Child Sex		
Male	1,00,428	54.31
Female	85,199	45.69

£Includes Sikhs, Buddhist/neo-Buddhist, Jain, Parsi/Zoroastrian and others; #Scheduled Tribe; $Scheduled Caste; [a] Other Backward Classes; [b] Body Mass Index; [c] Tetanus Toxoid

Table 2 represents the percentage distribution of preterm, moderate, and full-term births by socio-demographic characteristics in India. Overall, 0.88% of births were very preterm births, 11.40% were moderate preterm births, and around 88% had full-term births. Urban areas, as well as northern and western India, have higher rates of very preterm birth. The richest quintile of women had the lowest prevalence of very preterm delivery, while the poorer mothers had the highest prevalence of moderately preterm birth. The prevalence of very preterm births was highest among religious groups other than Hindus and Muslims, but the prevalence of moderate preterm births was highest among Muslims. The highest rate of very preterm births was among women from SC and ST castes. When the individual-level characteristics of the sampled women were considered, the prevalence of very preterm births was highest for women whose height was <145cm and whose age at delivery was <19 years. Similarly, underweight mothers were found to have a greater prevalence of very and moderate preterm births than mothers of normal weight. Further, those who delivered by C-section, births occurring in a private health facility, without any ANC and iron supplementation, were found to have a high prevalence of very preterm birth. However, the very preterm and moderate preterm birth prevalence was lowest among births occurring in a public health facility and with two or more T.T injections before birth. The proportion of very preterm births was higher among women who consumed alcohol, while the proportion of very/moderate preterm births was lower among women who smoked. Women with a previous history of child loss had a high prevalence of very/moderate preterm births. Very preterm birth was more prevalent in first-order births and higher age at delivery (35+).

Table 2 Prevalence of very and moderate preterm births by different characteristics in India

Background Characteristics	Very Preterm	Moderate	Chi²
Region			
North	0.95	15.69	<0.01
Central	0.93	12.85	
East	0.87	11.53	
North-East	0.92	9.71	
West	0.95	7.72	
South	0.71	8.84	
Place of residence			
Urban	0.95	10.58	<0.05
Rural	0.85	11.71	
Wealth Quintile			
Poorest	0.89	11.56	<0.01
Poorer	0.90	11.87	
Middle	0.90	10.91	
Richer	0.91	11.15	
Richest	0.80	11.42	
Religion			
Hindu	0.88	11.36	<0.01
Muslim	0.85	12.11	
Others	1.05	9.53	
Caste			
SC	0.95	11.44	
ST	0.95	9.05	<0.01
OBC	0.79	11.66	
Others	0.94	11.86	
Maternal age at delivery (in years)			
<19	1.35	11.50	<0.01
20-24	0.85	11.65	
25-29	0.79	11.03	

30-34	0.76	11.11	
35+	1.22	12.25	
Maternal height			
<145cm	0.95	11.45	>0.10
145-149cm	0.94	11.78	
150-154cm	0.83	11.45	
>=155cm	0.88	11.04	
BMI of the mother			
Underweight (BMI<18.5)	1.05	11.82	<0.01
Normal (BMI>=18.5 & BMI<25)	0.81	11.55	
Overweight (BMI>=25 & BMI<30)	0.98	10.54	
Obese (BMI>=30 & BMI<50)	0.88	11.01	
Anaemic status of the mother			
Not anaemic	0.91	11.56	<0.01
Anaemic(<10.9g/dl)	0.86	11.11	
Educational status of the mother			
No Education	0.78	12.65	<0.01
Primary	1.00	11.48	
Secondary	0.92	10.89	
Higher	0.80	11.42	
Delivery by C-Section			
No	0.83	11.60	<0.01
Yes	1.06	10.76	
Place of Delivery			
Home	1.05	12.00	<0.01
Public Health Facility	0.70	11.17	
Private Health Facility	1.20	11.57	
No. of Antenatal Visits			
None	1.20	12.21	<0.01
1	0.79	11.21	
2-3	0.90	12.91	
4+	0.82	10.66	
Iron supplements during pregnancy			
No	0.98	12.54	<0.01
Yes	0.86	11.21	
No. of TT injections during pregnancy			
No	1.19	12.20	<0.01
1	1.04	11.34	
2 or More	0.83	11.34	
Alcohol consumption status of the mother			
No	0.88	11.41	<0.01
Yes	0.92	8.43	
Smoking status of the mother			
No	0.88	11.4	>0.10
Yes	0.34	7.61	
Birth Order			
1	1.05	11.17	<0.01
2-3	0.78	11.32	
4-5	0.87	11.95	
6+	0.77	13.62	
Child Lost			
No	0.66	11.28	<0.01
Yes	3.07	12.51	
Neonatal death			
No	0.7	11.29	<0.01
Yes	11.74	17.53	
Child Sex			
Male	0.88	11.46	>0.10
Female	0.88	11.32	

Table 3 represents the relative risk ratios of having very preterm and moderate preterm births than having a full-term birth by various socio-demographic characteristics obtained using multinomial logistic regression. However, in the regression, many factors such as smoking, alcohol consumption of the mother, delivery by C-section, number of antenatal visits and Iron and calcium supplements during pregnancy were controlled.

The regional variation in the risk of occurrence of moderate preterm birth is noticeable. Except for the northern region, all other regions were significantly less likely to have moderate preterm than the central part. Similarly, the northern region has more likelihood of very preterm birth than central India (RRR:1.19*, CI: 1.00-1.41), while values for the remaining parts remain insignificant. Women from urban areas were at higher risk to have a very preterm birth than their rural counterparts (RRR:1.22***, CI: 1.06-1.41). Interestingly, the women of the richer wealth quintile had the highest likelihood of moderate preterm birth compared to the poorest category (RRR:1.12***, CI: 1.06-1.19). Hindu women were more likely to have a moderate preterm birth than their Muslim counterparts (RRR:1.07***, CI: 1.02-1.12). When analyzing across the caste groups, it was found that women of SC, OBC and other categories were found to have more likelihood of occurrence of moderate preterm birth as compared to the ST caste (RRR:1.14***, CI: 1.08-1.21; RRR:1.14***, CI: 1.08-1.2, RRR:1.19***, CI: 1.12-1.26). Younger age of pregnancy <19 years was significantly associated with more chance of both very and moderate preterm birth (RRR:1.43***, CI: 1.17-1.73; RRR:1.07**, CI: 1.01-1.15) as compared to the age group of 20-24 years. However, the women of age 35+ also had a higher risk of very preterm birth than women in the 20-24 age group (RRR:1.49***, CI: 1.16-1.9). Furthermore, underweight mothers (RRR:1.06***, CI: 1.01-1.1) and having a height of 145-149 cm (RRR:1.09***, CI: 1.04-1.14) were found to be riskier for moderate preterm birth as compared to those with normal BMI and a height >=155cm. Uneducated mothers had a greater likelihood of moderate preterm birth. Those mothers with a previous history of child loss were found to have a significant risk of having very and moderate preterm with odds of 7.92 and 1.14, respectively, with a p-value<0.001. The birth order was found to have a drastic and inverse relationship with the likelihood of very preterm birth, with first-order conception having the highest risk (RRR:5.35***, CI: 3.59-7.96).

Table 3 Relative risk ratios of very preterm and moderate preterm births by socio-demographic characteristics obtained using multinomial logistic regression, 2019-21

Background Characteristics	Very preterm			Moderate preterm		
	RRR	95 % Confidence Interval		RRR	95 % Confidence Interval	
		Lower CI	Upper CI		Lower CI	Upper CI
Region						
Central®						
North	1.19*	1.00	1.41	1.26***	1.20	1.33
East	0.89	0.75	1.05	0.83***	0.79	0.88
North-East	0.93	0.75	1.15	0.81***	0.76	0.87
West	1.04	0.85	1.28	0.72***	0.67	0.77
South	1.00	0.82	1.22	0.87***	0.82	0.92
Place of residence						
Rural®						
Urban	1.22***	1.06	1.41	1.02	0.97	1.06
Wealth Quintile						
Poorest®						
Poorer	1.01	0.86	1.18	1.08***	1.03	1.13
Middle	1.00	0.83	1.20	1.08***	1.02	1.14
Richer	1.01	0.82	1.24	1.12***	1.06	1.19
Richest	0.98	0.77	1.24	1.09**	1.02	1.17
Religion						
Muslim®						

Hindu	1.15	0.96	1.37	1.07***	1.02	1.12
Others	1.13	0.87	1.46	1.03	0.96	1.11
Caste						
ST®						
SC	1	0.83	1.2	1.14***	1.08	1.21
OBC	0.94	0.79	1.12	1.14***	1.08	1.2
Others	1.08	0.89	1.31	1.19***	1.12	1.26
Maternal age at delivery						
25-29®						
<19	1.43***	1.17	1.73	1.07**	1.01	1.15
20-24	0.93	0.82	1.07	1.06***	1.02	1.11
30-34	0.99	0.82	1.19	1.01	0.96	1.07
35+	1.49***	1.16	1.9	1.02	0.94	1.11
Maternal height						
>=155cm®						
<145cm	1.11	0.93	1.34	1.05*	0.99	1.11
145-149cm	1.03	0.88	1.19	1.09***	1.04	1.14
150-154cm	1.01	0.88	1.16	1.05**	1.01	1.1
BMI of the mother						
Normal (BMI>=18.5 & BMI<25) ®						
Underweight (BMI<18.5)	1.29***	1.13	1.49	1.06***	1.01	1.1
Overweight (BMI>=25 & BMI<30)	1.25***	1.08	1.46	0.91***	0.87	0.96
Obese (BMI>=30 & BMI<50)	1.31**	1.01	1.69	1.00	0.92	1.09
Educational status of the mother						
No Education®						
Primary	1.37***	1.12	1.68	0.94**	0.89	1.00
Secondary	1.38***	1.17	1.64	0.94***	0.89	0.98
Higher	1.35**	1.07	1.70	1.02	0.96	1.09
Experience of previous child loss						
No®						
Yes	7.92***	6.97	9.00	1.14***	1.08	1.21
Birth Order						
6+®						
1	5.35***	3.59	7.96	1.1	0.98	1.23
2-3	3.08***	2.11	4.49	1.09	0.98	1.21
4-5	1.72***	1.17	2.54	1.05	0.94	1.17
_cons	0.00***	0.00	0.00	0.12***	0.1	0.13

**p*<0.05, ***p*<0.01, ****p*<0.001*

Discussion

Since identifying the maternal factors contributing to preterm birth is crucial for reducing the risk of mortality among children and mothers, this study aimed to determine the maternal obstetric factors that increase the risk of having preterm births in India. The country's rate of preterm birth was around 12%, which is very high when translated into absolute numbers. However, preterm birth rates can present a distorted picture keeping in view the methodological challenges in estimating the gestational age. A significant association between wealth quintile and preterm birth was observed where women from richer households having the highest risk of moderate preterm births. Women from urban areas, pregnancy at the maternal age of <19 years or 35 and above were likelier to have a very preterm birth, underweight mothers and overweight or obese mothers had a higher risk of having very preterm births.

Many studies worldwide have established a relationship between maternal factors and preterm birth which were mostly retrospective case-control studies based on tertiary neonatal care setting(Alavi et al., 2021; Ayebare et al., 2018; Pickett, 2002; Xi et al., 2020). Findings indicate an increased risk of preterm births among the women of North India. These regional variations as observed in this study in preterm births can be attributed to both genetic and environmental factors, including healthcare access and quality (Bryant et al., 2010). Based on the findings of the present study, a pregnant woman can be categorized in a high-risk group in India if she has a previous history of child loss, the pregnancy is first order, with less education, is underweight, and height is less than 149 cm and is either has aged less than 19 or more than 35. Factors identified in this study i.e. child loss, maternal height, maternal age at delivery, birth order, wealth quintile, education, place of residence, and mother's BMI are essential in determining preterm birth are in line with previous studies (Alavi et al., 2021; Ayebare et al., 2018; Bryant et al., 2010; Pickett, 2002; Xi et al., 2020).

In line with our findings, studies have reported higher risks of preterm birth among women with a history of miscarriage and stillbirth (Chen et al., 2019). This problem emphasizes the significance of giving extra attention to those women who might require intensive care. First-order birth was found to have more risk of prematurity from the study. It was demonstrated that maternal health improves with future pregnancies using data on hospitalizations for medical pregnancy problems by (Brenøe & Molitor, 2018). A biological mechanism that improves maternal health with subsequent pregnancies and an improvement in maternal health with higher-order pregnancies were consistent (Brenøe & Molitor, 2018). Children who are born first are typically less healthy than their siblings who are born later. Their mothers are more likely to experience pregnancy difficulties, and they are more likely to be born preterm and with low birth weights (Pruckner et al., 2021).

It was evident from the study that higher maternal education is found to be associated with a slightly lower risk of preterm birth. This inference is congruent with several other studies conducted globally (Cantarutti et al., 2017)and nationally (Rai et al., 2019). Evidence from a hospital-based case-control study in southern India showed that having more education lowers the likelihood of premature births (Rao et al., 2014). Well-educated women can lessen information asymmetry during their pregnancies and seek medical attention when necessary, so maternal education is essential for enhancing favorable pregnancy outcomes (Rai et al., 2019).

Our findings on the association between maternal age at delivery and preterm delivery are compatible with a previous study(Beta et al., 2011). Young mothers of less than 19 years and older mothers of more than 35 years were vulnerable to preterm births. A large cohort study from QUARISMA has reported a U-shaped distribution between preterm birth risk and age groups(Fuchs et al., 2018). Healthcare professionals consider advanced maternal age a high-risk category due to a higher prevalence of chronic diseases, medical problems during pregnancy, and antepartum and labour complications (Newburn-Cook & Onyskiw, 2005). Lack of education, support and access to health care (Adolescent Pregnancy: Unmet Needs and Undone Deeds – A Review of the Literature and Programmes, 2007) often places young women at higher risk of having a preterm birth(Haldre et al., 2007). However, more clarity is required on whether increased maternal age directly impacts the pregnancy outcome or is an effect of indirect confounders such as maternal diabetes, hypertension and other comorbidities.

A higher risk of preterm birth among underweight/overweight mothers than among normal mothers was observed in this study. In line with our findings, low maternal weight has been reported to increase the risk of preterm labour (Goldenberg et al., 2008; Halimi Asl et al., 2017). According to previous findings, excess maternal weight has been linked to births occurring before 32 weeks and induced prematurity before 37 weeks (McDonald et al., 2009). Interestingly less stature of the mother contributed to more risk of preterm birth. Similar findings were derived from another study conducted on Swedish women where every cm of maternal height decrease was linked to a 0.2-day reduction in the offspring's gestational age and a higher likelihood of having a preterm birth. Moreover, the probability of preterm birth in all categories is highest in the shortest women but lowest in the tallest mothers (Derraik et al., 2016).

Another study that focused on low- and middle-income nations discovered evidence of statistically significant links between short maternal stature and adverse newborn outcomes like low birth weight and early birth. According to the study, there may be up to 6.5 million Small for Gestational Age(SGA) and/or preterm births in LMIC(Low and Middle Income Countries) due to factors correlated to short maternal height (Kozuki et al., 2015). Low uterine volume and/or small pelvic size, which may limit foetal growth, are two putative physiological mechanisms associating short height directly with SGA/preterm birth (Kramer et al., 1992). Also, if chronic maternal malnutrition is the cause of low height, it may lead to infections during pregnancy, which could have a negative impact on the pregnancy outcome (Semba, n.d.). Mothers with normal BMI were found to have less risk of very preterm delivery than underweight, overweight and obese mothers. Premature births, shoulder dystocias, late foetal deaths, and congenital abnormalities, such as spina bifida, cleft lip, cleft palate, and cardiac defect, were common in the neonates of obese women (Mandal et al., 2011). Singletons born to underweight women have higher odds of Premature birth (overall, spontaneous and induced) and LBW than those born to women of normal weight, according to a systematic review and meta-analyses(Han et al., 2011).

Although several provisions have been made to increase child survival and reduce the mortality due to preterm birth and its related complications in the country, the high burden of preterm births translates into higher neonatal deaths (Lawn et al., 2010) posing significant challenges to the existing health systems. To achieve Sustainable Development Goals and reduce neonatal and child mortality worldwide, addressing the issues concerning preterm birth is essential. Given the burden of preterm delivery, efforts are required to enhance the standard of care for all expectant mothers and children, especially preterm newborns. Moreover, preconception care services such as reducing adolescent pregnancies, optimal birth spacing, optimizing pre-pregnancy weights and healthy nutrition, and diagnosing and managing chronic disease will be beneficial in reducing the risk of preterm birth (Howson C P et al., 2012). More public-private partnerships and investment in Neonatal Intensive Care Units (NICU) establishment can result in critical service provisioning.

Conclusion

To conclude, this study deals with a large-scale representative sample and estimates the association between various maternal factors and preterm births in the country. The study emphasizes that pregnant women especially uneducated women should have access adequate information on good food practices which can be achieved through community health programs, educating women through campaigns and mobile clinics in remote areas. Implementing routine screenings for high-risk factors such as maternal underweight, short stature, and advanced maternal age during antenatal visits could be effective in reducing preterm birth. Distributing nutritional supplements to pregnant women, particularly those who are underweight or have a low BMI and community nutrition programs that offer healthy meals and nutritional education to expectant mothers, especially in rural and low-income areas can be beneficial. Financial incentives or subsidies for antenatal care visits and hospital deliveries, and improving transportation and healthcare infrastructure particularly for women from low-income households can improve access to antenatal and delivery services. Providing additional training for healthcare providers on the risks of elective cesarean sections and the benefits of natural childbirth, where possible could reduce the risk of cesarean section and thus reduce preterm births.

Limitations

The study is restricted to associations and not causality, as the analysis is made on cross-sectional data. Estimating preterm birth was based on self-reporting; hence the role of recall bias can't be eliminated. Despite the limitations, the study highlights various vital factors that, if adequately addressed, could reduce preterm birth rates in India and improve the overall child health indicators. However, research with a superior design, such as cohort studies, with an appropriate follow-up duration is required for precisely evaluating these characteristics.

Conflict of Interest

No conflict of interest was reported by all authors.

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