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## Original Article

## Risk factors associated with late preterm births in the underdeveloped region of China: A cohort study and systematic review



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## ABSTRACT

**Objective:** To determine factors associated with late preterm births in an underdeveloped region of China, and search for relevant reports in other underdeveloped regions by a systematic review.

**Materials and methods:** Data of births occurring between January 2004 and December 2008 from eight hospitals in Western Sichuan Province, China, were analyzed. Late preterm birth was defined as delivery at 34–36 6/7 weeks' gestation. Medline, Cochrane Library, and Google Scholar were searched for studies which reported the risk factors of late preterm births in undeveloped regions until January 31, 2014.

**Results:** During the study period there were 4711 late preterm births and 54,574 term births. The odds ratios (ORs) for a late preterm birth of mothers < 20 years and ≥ 35 years of age were 3.813 [95% confidence interval (CI): 3.256–4.465] and 1.872 (95% CI: 1.677–2.090), respectively, as compared with an age of 20–34.9 years. Mothers who received prenatal care were less likely (OR = 0.623, 95% CI: 0.582–0.667) and those with a multiple gestation were more likely (OR = 9.346, 95% CI: 7.813, 11.236) to have a late preterm birth. The systematic review found that the incidence of late preterm births ranged from 4.4% to 16%, and the most prominent risk factors were eclampsia, preeclampsia, placenta previa, placental abruption, and twin pregnancy.

**Conclusion:** A number of factors are associated with late preterm births, and the incidence in underdeveloped regions is high. The inconsistent results between our study and previous reports indicate more attention towards preventing late preterm births in undeveloped regions is needed.

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## Introduction

Many Western countries have experienced a sharp rise in the occurrence of preterm births in recent decades, with late preterm births contributing the most to this increase [1,2]. Late preterm infants, defined as being born between 34 0/7 weeks' gestation and 36 6/7 weeks' gestation, account for > 70% of preterm infants [3,4]. Compared with term infants, late preterm infants are at a higher risk of mortality, morbidities including hypothermia, hypocalcemia, hyperbilirubinemia, sepsis, seizures, respiratory distress, and feeding difficulty, readmission during the neonatal period, and neurodevelopmental problems, even though they are near term [5–8]. Furthermore, variations in the care of infants born late

preterm have been shown to influence the outcomes and readmission rates [9].

The reasons for the occurrence of late preterm births are not understood, although spontaneous idiopathic preterm labor is considered the principle cause [10–12]. The risk factors associated with late preterm births have been widely studied in developed countries [11,13–16], and studies have identified certain maternal factors that are correlated with the occurrence of late preterm births [13–15,17]. Frequently observed risk factors include multiple gestations, hypertensive disorders of pregnancy, antepartum hemorrhage, intrauterine growth restriction, and prelabor rupture of membranes (PROM) with or without chorioamnionitis [10]. However, it is unclear which of these risk factors has played the most important role in the increase of late preterm births during the past decade.

The occurrence of late preterm births and associated risk factors have not been well studied in developing countries such as China, and there may be differences in the risk factors for late preterm

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births in developed and underdeveloped regions. China is the largest developing country and has the largest population in the world, yet there is little data regarding the reasons for late preterm births in China. Limited late preterm birth data has been collected from Zhejiang, one of the economically strongest provinces in China, but the data were collected only from people of a single ethnicity [18,19]. Sichuan is an economically underdeveloped province located in Western China, and has a population of ~100 million consisting of multiple ethnicities. Not surprisingly, the risk factors for late preterm births and incidence of late preterm births in Sichuan Province are unknown. Knowledge of the risk factors for late preterm births may help to reduce their incidence, and thus improve neonatal outcomes. Furthermore, in economically deprived regions this information may help to most effectively allocate government resources.

The purpose of this study was to investigate the risk factors associated with late preterm births in Sichuan Province, China, and to perform a systematic review of the literature to identify studies that have examined the incidence and risk factor of late preterm births in the other underdeveloped regions.

## Materials and Methods

### Cohort study

The retrospective cohort study identified neonates born between January 2004 and December 2008 using the obstetric medical record databases from eight hospitals in Western Sichuan Province, China, that provide obstetrics and pediatric services and have high birth rates. Of the eight hospitals, four were located in Han ethnic (the main ethnicity in China) regions, and four were located in regions where Han ancestry does not constitute the majority of the people. Late preterm birth was defined as delivery at 34–36 6/7 weeks' gestation. Pertinent information on all mothers and neonates was collected by a questionnaire mailed to each hospital after they agreed to participate in the study. After the questionnaires were returned, trained staff tabulated and analyzed the data. The study and data collection was approved by the Ethics Committee of West China Second University Hospital, Sichuan University, Sichuan, China.

Infants who met the following criteria were included in the study: (1) complete infant birth records including gender, exact gestational age, parity, singleton or multiple gestation, birth weight, birth body length, data regarding amniotic fluid, the umbilical cord, and placenta, Apgar scores, and diseases found at birth including birth defects; and (2) complete maternal information including maternal age at delivery, prenatal care (mother registered at the hospital to obtain health care regularly throughout pregnancy), maternal diseases throughout pregnancy, mode of delivery, singleton or multiple gestation, parity (primigravida or pluripara), nationality (Han or minority nationalities such as Tibetan, Yi, Hui, Qiang, and Man), and habitation (town or countryside).

Maternal risk factors examined for their association with late preterm birth included maternal age, race, nationality, habitation, prenatal care, parity, maternal diseases, mode of delivery, and singleton or multiple gestations, and were based on factors examined in prior studies [10,20,21]. Risk factors such as education level and tobacco use were difficult to examine with the information available in the databases, and were not included in this study. Maternal conditions examined included intrahepatic cholestasis of pregnancy (ICP), history of a prior cesarean section, hepatitis B virus infection (HBV), PROM, hypertensive disorders of pregnancy (HDP), preeclampsia, antepartum hemorrhage, genital herpes, contracted pelvis, gestational diabetes, psychosis, lung disease, and cardiac diseases.

The study was conducted and results reported in accordance with the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) initiative [22].

### Systematic review

Medline, Cochrane Library, and Google Scholar were searched up to January 31, 2014, for studies which reported the incidence and risk factors of late preterm births in a rural or undeveloped region. Searches were performed using the following keywords: preterm birth, risk, predictor, cause, incidence, prevalence, epidemiology, trend, rural, and undeveloped. Reference lists of relevant studies were hand-searched. Studies were excluded if: (1) the study did not report an incidence or prevalence for late preterm births; (2) the epidemiologic results came from a tertiary hospital or a metropolitan area; and (3) the publication types were letters, comments, editorials, or case reports.

Two independent reviewers screened potentially relevant studies, and both had to agree on study inclusion. The following information was extracted from studies that met the inclusion criteria: the name of the first author, year of publication, study design, demographic data, study area, incidence of late preterm births, the percentage of late preterm births among all preterm births, and maternal factors associated with late preterm births.

### Statistical analysis

Categorical variables of data representing late preterm births and term births were presented as count and percentage. Fisher's exact test was performed to evaluate the associations of the categorical variables versus late preterm birth, and the crude odds ratio (OR) was calculated to evaluate the strength of the associations. Statistical analyses were performed with SPSS software version 15.0 (SPSS Inc., Chicago, IL, USA). A two-tailed value of  $p < 0.05$  was considered to indicate statistical significance.

## Results

Based on the review of medical records, 71,295 infants were born during the study period. Of the 71,295 infants, 60,730 met the inclusion criteria and of these 4711 were late preterm infants and 54,574 were term infants. The remaining 1445 infants were either postterm infants or early preterm infants, and were excluded from the study.

### Trends of late preterm births between 2004 and 2008

The percentages of late preterm births and term births were 7.4% and 89.8%, respectively, in the eight study hospitals between 2004 and 2008. During the period from 2004 to 2008, the percentage of late preterm births continuously increased from 6.4% to 8.0%. By contrast, the percentage of term births decreased between 2004 and 2008 from 91.4% to 88.9%. The total number of births was greatest in 2007 ( $n = 20,805$ ; Table 1).

### Maternal characteristics associated with late preterm birth

The associations of maternal characteristics with late preterm birth are presented in Table 2. In this study 4.5% and 8.4% of mothers who delivered late preterm infants were aged  $< 20$  years and  $\geq 35$  years, respectively, as compared with only 1.2% and 4.7%, respectively, of mothers who delivered infants at term ( $p < 0.001$ ). The ORs for a late preterm birth of mothers aged  $< 20$  years and  $\geq 35$  years were 3.813 and 1.872, respectively, as compared with a maternal age of 20–34.9 years. The percentage of mothers who

**Table 1**

Birth data for the period from 2004 to 2008.

Y	Total	Early preterm	Late preterm	Term	Postterm
2004	9263	172 (1.9)	593 (6.4)	8466 (91.4)	32 (0.3)
2005	9825	168 (1.7)	668 (6.8)	8941 (91.0)	48 (0.5)
2006	14,378	351 (2.4)	1050 (7.3)	12,911 (89.8)	66 (0.5)
2007	20,805	565 (2.7)	1623 (7.8)	18,558 (89.2)	59 (0.3)
2008	17,024	468 (2.8)	1362 (8.0)	15,134 (88.9)	60 (0.3)
Total	71,295	1724 (2.4)	5296 (7.4)	64,010 (89.8)	265 (0.4)

Data are presented as n (%).

received prenatal care was 74.0% and 82.0% for those who had a late preterm birth and term birth, respectively ( $p < 0.001$ ), and mothers who received prenatal care were less likely to have a late preterm birth (OR = 0.623). The percentage of multiple gestations in those who had a late preterm birth was 4.8% as compared with 0.5% in those who had a term birth ( $p < 0.001$ ), and mothers who had a multiple gestation (as compared with a singleton gestation) were more likely to have a late preterm birth (OR = 9.346). Mothers of Han nationality were less likely to have a preterm birth than those of other nationalities (OR = 0.894,  $p = 0.004$ ). No significant association between maternal habitation (town vs. countryside) or parity (single vs. multi) was found with late preterm birth.

#### Maternal factors associated with late preterm birth

The analysis of maternal factors and late preterm birth is shown in Table 3. Maternal diseases included intrahepatic cholestasis of pregnancy (ICP; 4.2%), history of cesarean section (3.0%), hepatitis B virus (HBV) infection (2.2%), PROM (1.9%), hypertensive disorders of pregnancy (HDP; 1.7%), syphilis (1.2%), preeclampsia (1.2%), and other diseases with a prevalence of < 1.0%. Approximately 35% of mothers who had a late preterm birth had at least one of the above maternal diseases, but only 12.1% of mothers with a term birth had one of the above maternal diseases ( $p < 0.001$ ). The following conditions were more common in mothers who had a late preterm

**Table 2**

Association of maternal characteristics and late preterm births.

	Late preterm births (n = 4711)	Term births (n = 54,574)	p	Crude OR (95% CI)
Maternal age (y)				
<20	211 (4.5)	663 (1.2)	<0.001	3.813 (3.256–4.465)*
20–34.9	4103 (87.1)	51354 (94.1)		Reference
≥35	397 (8.4)	2557 (4.7)		1.872 (1.677–2.090)*
Prenatal care	3484 (74.0)	44,755 (82.0)	<0.001	0.623 (0.582–0.667)*
Number of gestations				
Single	4489 (95.2)	54,287 (99.5)	<0.001	Reference
Multiple (all twins)	222 (4.8)	287 (0.5)		9.346 (7.813, 11.236)*
Habitation				
Town	1212 (25.7)	14,139 (25.9)	0.794	0.991 (0.925–1.060)
Countryside	3499 (74.3)	40,435 (74.1)		Reference
Maternal ethnicity				
Han	3790 (80.5)	44,830 (82.1)	0.004	0.894 (0.830–0.964)*
Other	921 (19.5)	9744 (17.9)		Reference
Maternal parity				
Primigravida	4144 (88.0)	47,842 (87.7)	0.562	1.028 (0.939–1.127)
Pluripara	567 (12.0)	6732 (12.3)		Reference

Data are presented as n (%).

CI = confidence interval; OR = odds ratio.

\* Indicates the corresponding OR obtained statistical significance.

**Table 3**

Association of maternal factors and late preterm birth.

	Late preterm births (n = 4711)	Term births (n = 54,574)	p	Crude OR (95% CI)
Total	1642 (34.9)	6597 (12.1)	<0.001	3.891 (3.645–4.153)*
ICP	504 (10.7)	1965 (3.6)	<0.001	3.207 (2.894–3.555)*
History of cesarean section	165 (3.5)	1637 (3.0)	0.055	1.174 (0.997–1.381)
HBV infection	108 (2.3)	1201 (2.2)	0.684	1.043 (0.854–1.273)
PROM	254 (5.4)	873 (1.6)	<0.001	3.506 (3.038–4.045)*
HDP	94 (2.0)	928 (1.7)	0.142	1.177 (0.950–1.458)
Syphilis	330 (7.0)	382 (0.7)	<0.001	10.686 (9.193–12.421)*
Preeclampsia	38 (0.8)	655 (1.2)	0.018	0.669 (0.482–0.930)*
Antepartum hemorrhage	108 (2.3)	382 (0.7)	<0.001	3.329 (2.683–4.130)*
Genital herpes	0	327 (0.6)	<0.001	NA
Contracted pelvis	19 (0.4)	109 (0.2)	0.008	2.023 (1.242–3.297)*
Diabetes	1 (0.01)	55 (0.1)	0.130	0.210 (0.029–1.521)
Psychosis	19 (0.4)	0	<0.001	NA
Asthma	1 (0.01)	5 (0.01)	0.392	2.317 (0.271–19.838)
Cardiac diseases	1 (0.01)	0 (0)	0.079	NA
Others	0	27 (0.05)	0.270	NA

Data are presented as n (%).

CI = confidence interval; HBV = hepatitis B virus; HDP = hypertensive disorders in pregnancy; ICP = intrahepatic cholestasis of pregnancy; NA = odds ratio was not available due to zero count; OR = odds ratio; PROM; prelabor rupture of membranes.

\* Indicates the corresponding OR obtained statistical significance.

birth than in those who had a term birth: ICP (10.7% vs. 3.6%, respectively;  $p < 0.001$ , OR = 3.207), PROM (5.4% vs. 1.6%, respectively;  $p < 0.001$ , OR = 3.506), syphilis (7.0% vs. 0.7%, respectively;  $p < 0.001$ , OR = 10.686), antepartum hemorrhage (2.3% vs. 0.7%, respectively;  $p < 0.001$ , OR = 3.329), contracted pelvis (0.4% vs. 0.2%, respectively;  $p < 0.001$ , OR = 2.023), and psychosis (0.4% vs. 0%, respectively;  $p < 0.001$ ). Preeclampsia (0.8% vs. 1.2%, respectively;  $p = 0.016$ , OR = 0.669) and genital herpes (0% vs. 0.6%, respectively;  $p < 0.001$ ) were less common in mothers who had a late preterm birth than in those who had a term birth.

#### Association between delivery mode and late preterm birth

Analysis of delivery mode and late preterm birth is shown in Table 4. Vaginal delivery was the main delivery mode for late preterm births (59.6%), although cesarean section was the main delivery mode for term births (60.2%;  $p < 0.001$ ). The proportions of induction of labor and emergent cesarean delivery in patients who had a late preterm birth were significantly higher than in those who had a term birth (40.6% vs. 4.1% and 34.1% vs. 17.0%; respectively,  $p < 0.001$ ). By contrast, the proportions of spontaneous vaginal deliveries and elected cesarean deliveries in patients who had a late preterm birth were significantly less than in those who had a term birth (19.0% vs. 35.7% and 6.3% vs. 43.2%; respectively,  $p < 0.001$ ).

#### Systematic review

Out of 355 studies initially identified, 310 were excluded and 45 were underwent full-text review. Of these, 41 were eliminated due

**Table 4**  
Association of delivery mode and late preterm births.

	Late preterm births ( <i>n</i> = 4711)	Term births ( <i>n</i> = 54,574)	<i>p</i>
Delivery mode			
Vaginal	2808 (59.6)	21,729 (39.8)	<0.001
Cesarean	1903 (40.4)	32,845 (60.2)	
Delivery mode			
Spontaneous vaginal delivery	893 (19.0)	19,469 (35.7)	<0.001
Induction of labor	1915 (40.6)	2260 (4.1)	
Emergent cesarean delivery	1606 (34.1)	9263 (17.0)	
Elective cesarean delivery	297 (6.3)	23,582 (43.2)	

Data are presented as *n* (%).

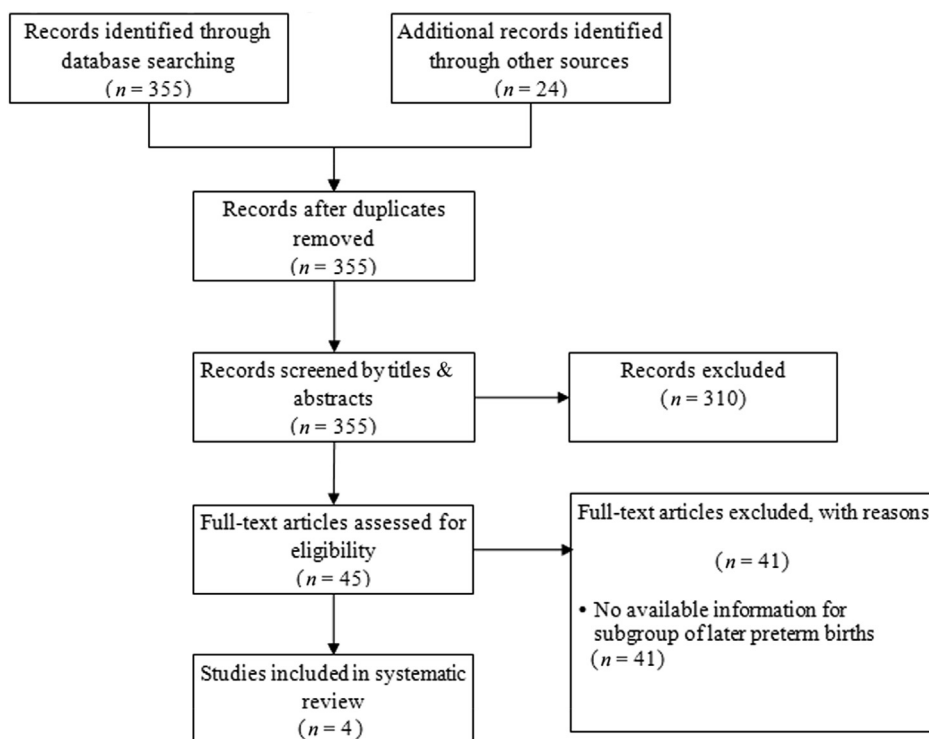
to no available information regarding late preterm births. Thus, four studies met the inclusion criteria and were included in the analysis [23–26]. The process of study selection is shown in Figure 1, and the four studies are summarized in Table 5. Of note, the exact study area was not mentioned in the report of Zhang et al [24], but based on the author affiliation was most likely Beijing.

The study areas were China, Lebanon, and southern Malawi, and the mean age of the mothers ranged from ~22 years to 30 years. Three studies [23–25] defined late preterm birth as occurring from 34 weeks' gestation to 36 weeks' gestation, whereas one study [26] defined it as 33–37 weeks' gestation. The incidence of late preterm births ranged from 4.4% to 16%, and the percentage of late preterm births among all preterm births ranged from 36.6% to 86.6%. Only two studies reported maternal factors associated with late preterm births. Mumtaz et al [25] found that consanguinity was a risk factor for early, but not late preterm birth. Zhang et al [24] reported that risk factors for late preterm birth were twin gestation, gestational diabetes mellitus, eclampsia and preeclampsia, placenta previa, placental abruption, and premature rupture of the membranes.

## Discussion

The results of this study suggest that the reasons for late preterm births are similar in Sichuan Province, and underdeveloped region of China, as in more developed countries and that there is a surprising lack of studies examining late preterm births in less developed regions of the world. Sichuan Province has the second largest population in China, and compared with the eastern provinces in China the economy in Sichuan Province is relatively weak. In this retrospective cohort study, the data collected from eight hospitals in Sichuan between 2004 and 2008 constitute a representative sample of the population of Sichuan, China. We found that the number of newborns delivered in these eight hospitals increased from 2004 and peaked in 2007. The percentage of late preterm births increased each year, with an average of 7.4% per year between 2004 and 2008, which is higher than that in other Chinese provinces, such as Zhejiang Province (6.2% in 2007) [18] and Beijing (2.7% in 2007) [19], and lower than that in Western countries such as the United States (9.1% in 2005) [3]. The reasons for these differences are not clear, but may be related to geographical area, race, economy, or medical conditions.

Our systematic review found only four studies that examined late preterm births in underdeveloped regions of the world, with a reported incidence as high as 16% in southern Malawi [26]. Importantly, only one study [24] fully examined factors associated with late preterm births, and the risk factors (twin gestation, gestational diabetes mellitus, eclampsia and preeclampsia, placenta previa, placental abruption, and premature rupture of the membranes) were generally consistent with those found in our study. However, as only one study fully examined risk factors in underdeveloped regions no conclusions regarding risk factors unique to underdeveloped regions can be drawn. These findings suggest that more study of the causes of late preterm births in underdeveloped regions is certainly warranted. This is especially relevant because as



**Figure 1.** Flow diagram of study selection.



**Table 5**

Summary of the four studies included in the systematic review.

Study	No. of mothers	Maternal age (y)	Study region	Study period	Definition of late preterm birth (wk)	Incidence, n (%)	% of late preterm births among all preterm births	Maternal factors associated with late preterm birth
Gladstone et al (2011) [23]	840	NA	Southern Malawi	May–Dec 2006	34–36	94 (11.2)	36.6	NA
Zhang et al (2011) [24]	539	30.7 ± 4.5	China	Jan 2007–Jun 2010	34–36	287	62	<ul style="list-style-type: none"> <li>• Twin pregnancy (OR = 7.918)</li> <li>• Gestational diabetes mellitus (OR = 4.308)</li> <li>• Eclampsia or preeclampsia (OR = 13.234)</li> <li>• Placenta previa (OR = 46.168)</li> <li>• Placental abruption (OR = 11.864)</li> <li>• Premature rupture of membranes (OR = 5.442)</li> </ul>
Mumtaz et al (2010) [25]	39745	<20 (n = 1242) 20–34 (n = 26,944) ≥35 (n = 6173)	Lebanon	Sep 2003–Dec 2007	34–36	1757 (4.4)	86.6	Consanguinity a risk factor for early, but not late preterm birth
van den Broek et al (2005) [26]	449	22.8 ± 5.6	Southern Malawi	NA	33–37	72 (16.0)	78.3	NA

NA = not available; OR = odds ratio.

compared with term infants, late preterm infants are at a higher risk of morbidity and mortality, readmission during the neonatal period, and neurodevelopmental problems [5–8,27,28].

Although in many cases a late preterm birth is unavoidable, some studies have shown that many late preterm births are the result of nonevidence based practices. Gyamfi-Bannerman et al [29] performed a retrospective cohort study of 2693 late preterm deliveries, and found that 32% were iatrogenic and 57% were delivered for nonevidence based indications. The results also showed that 56% of evidence-based deliveries result in neonatal intensive care unit (NICU) admissions, and early gestational age (34 weeks vs. 36 weeks) and cesarean delivery were most strongly characteristics associated with NICU admission. Similarly, Morais et al [30] examined late preterm deliveries at two Canadian tertiary referral centers and found that ~25% of late preterm births were the result of nonevidence based indications.

The number of late preterm births continues to rise in the United States, but there is no single explanation for this increasing rate. It is believed that there are many factors contributing to this increase such as demographic changes, increasing use of infertility treatments, increasing maternal age, increasing frequency of multiple gestations, and increasing obesity [31]. In this study, advanced maternal age, lack of prenatal care, multiple gestation, minority nationality (nationality other than Han), and various maternal conditions were associated with late preterm births, although maternal habitation (town vs. countryside) and parity were not shown to be related factors. Mothers younger than 20 years of age or older than 35 years of age were found to have a greater chance of delivering late preterm infants than those between the ages of 20 years and 35 years, which suggests that maternal age is one of the most important factors associated with the delivery of late preterm infants. Gilbert et al [32] also reported that teenagers (11–19 years old) experience a high rate of neonatal complications (e.g., delivery < 37 weeks' gestation and birth weight < 2500 g) compared with pregnancies in older women (20–29 years old). Among older women, there is an association between a higher rate of cesarean section and diabetes, preeclampsia, premature membrane rupture, and an Apgar score < 7 at the 5<sup>th</sup> minute [33]. Thus, mothers either younger than 20 years or older than 35 years require more prenatal care to decrease the likelihood of preterm births.

Studies have shown that a lack of prenatal care is associated with an increased rate of preterm births [34,35]. In our study, we

found that a lack of prenatal care was an important maternal factor associated with late preterm births. This finding implies that late preterm births may be avoided by regular prenatal care and adopting appropriate surveillance and medical interventions during pregnancy.

In addition to prenatal care, we found a number of maternal conditions such as ICP, PROM, contracted pelvis, and sexually transmitted diseases (Table 2) were associated with late preterm birth. Interestingly, we found that diabetes, hypertensive disorders of pregnancy, and HBV infection were not related to late preterm birth. A study has shown that pregnancy-induced hypertension, PROM, and multiple gestations are major causes of the higher morbidity and mortality of late preterm infants [18]. Lim et al [36] reported that among all of the neonates born to mothers with PROM, 83.3% were late preterm infants, which indicates that PROM plays an important role in late preterm births. Our results showed that ICP is one of the main factors associated with late preterm births in Sichuan Province. The incidence of ICP in southern China, such as in Sichuan Province, is much higher than that in northern China, and this may be related to economic development, climate, food habits, and race.

In this study we found that cesarean delivery was the main delivery mode of term births, and most of the cesarean deliveries were elective due to “social factors”, i.e., the cesarean deliveries were requested by the pregnant women and not medically indicated (data on file and Lei et al [37]). Elective cesarean delivery has become the preferred delivery method for term births by an increasing number of parents and physicians in Sichuan Province during the past decade because of the belief that it results in a considerable decrease in maternal and fetal risks. Meloni et al [12] reported that elective cesarean section results in a significantly greater number of late preterm than term deliveries, and Ma et al [18] reported that late preterm infants were associated with a higher cesarean section rate compared with the overall population (64.9% vs. 58.2%, respectively). However, we found that vaginal delivery, especially with induction of labor, was the main mode of delivery of late preterm births in our study (59.6%). The difference in results may be related to the fact that labor induction is considered by medical staff in Sichuan hospitals to be an effective way to decrease the risk of maternal and fetal complications, e.g., postpartum hemorrhage, stillbirth, or shock. Nevertheless, cesarean delivery accounted for a large proportion (40.4%) of the late

preterm births in this study, and the main reason for cesarean section was emergent, which is a different reason compared with term birth. Tomashek et al [27] reported that some of the increase in late preterm births is likely due to changes in obstetric practice, such as more frequent labor induction and use of cesarean delivery before 37 weeks' gestation in women at high risk for adverse pregnancy outcomes. These practice decisions are made after considering the fetal, maternal, and infant risks associated with preterm delivery.

We also found that multiple gestations were associated with late preterm births. A striking rise in late preterm births may be attributable, in part, to increased use of assisted reproductive technologies and, as a result, an increase in multi-fetal pregnancies [38,39]. In this study, 18.9% of the mothers were of a minority nationality and had an increased rate of late preterm birth. People of minority nationalities mainly live in mountainous areas in the western part of Sichuan Province where the weaker economy and reduced access to health care significantly limit the medical services accessible to pregnant women. Other studies have also shown that ethnicity may affect pregnancy and birth outcomes [32,40].

There are some limitations of this study that should be taken into account. Although a standardized format for data collection was used, collection of the data relied on individuals at each of the study hospitals, and thus is prone to the possibility of error and a nonunified collection. Although the collection of the data was relatively comprehensive, detailed information on each individual was not available and thus many possible statistical analyses could not be performed.

## Conclusion

A number of societal and maternal factors are associated with late preterm births. Because of the higher mortality and morbidity of late preterm infants, pertinent interventions related to these factors may reduce the occurrence of late preterm births and improve outcomes. More study is needed to analyze risk factors for late preterm births in underdeveloped regions.

## Conflicts of interest

The authors have no conflicts of interest relevant to this article.

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